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The meaning of numbers

**A discursive approach to learning processes in
mathematics classroom**

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The meaning of numbers – a discursive approach to learning processes in mathematics classroom

¹Abstract

A discursive approach to research on learning in schools draws attention to language use and interaction. Different discursive approaches have different foci and thus, raise epistemological questions of how the discourses should be analysed and interpreted. This paper reports some early analysis from a study designed to explore teaching- and learning processes of mathematics in primary school. In mathematics education at this level, the teacher usually introduces a new concept or a procedure by means of material tools. These material tools are supposed to provide bridges between familiar skills or information and those needed to solve new problems. In the analysis of the empirical examples, I discuss how different analytic perspectives affect the interpretation of classroom interaction.

Introduction

A discursive approach to research on learning in school draws attention to language use and communication in the construction of knowledge. This paper reports some early analysis from a Ph.D.-study designed to explore teaching- and learning processes of mathematics in primary school.

Traditionally, research on learning of mathematics has focused on the individual learner and how the individual constructs knowledge. According to Sfard (1997) there has been a shift from a cognitive to a discursive approach. In more recent studies we can see a tendency to look at learning processes as more complex than viewing the individual child constructing knowledge by itself without being influenced from other factors. The perspective has changed from an individual centred view to look at cognitive processes like thinking as dependent of social, cultural and historical factors. This means more attention to communication and activities.

Children entering school have some experiences with and ideas about mathematics. However, the language they use about mathematical phenomena diverges from the teacher's language. Children's utterances are characterised by pictorial language and experiences with concrete objects. For them it is natural to use objects or drawings/icons as representations of numbers

¹ This paper was presented at Genre 2001 (Genres and Discourses in Education, Work and Cultural Life: Encounters of Academic Disciplines on Theories and Practices), Oslo, May 13 – 16, 2001

instead of numerical symbols. Many children find it difficult to use formal symbols. Hughes (1986) points to the fact that in spite of the heavy emphasis on numerical training, lots of pupils prefer to go on using iconic or idiosyncratic symbols. For many children it means a great challenge to learn to use the symbols and the representational conventions of mathematics.

The teacher's presentation of mathematics topics is assumed to bridge this gap between the known and the unknown, between the children's prior knowledge and "new" mathematical knowledge. In order to support the pupils' learning, different kind of teaching aids (manipulatives, visual aids, pictures, computer software etc.) is made available to the pupils. A key claim of a sociocultural perspective is that in order to understand the learning process, we need to focus on the learning mediated through employing such resources (Wertsch 1991).

Children's numeracy and how they understand symbols and concepts of mathematics have been investigated frequently in earlier studies (Ahlberg 1992, Ekeblad 1996, Hughes 1986, Neuman 1987, Resnick 1983, Steffe et.al 1983).

There seems, however, to be a need for a deeper insight into the discourse practice of mathematics at primary level. A micro-level analysis, in which a dialogical approach to communication and cognition is used, indicates a complex dynamic relationship between teaching and learning and between the participants in the classroom, the act of learning, the language and the topic. The main research question in the project is: How is mathematical meaning created through communicative processes? The analytical focus is the communication between the teacher and the pupils. The empirical basis is audio taped mathematics lessons and notes and sketches on the spot.

The aim of this paper is to discuss how different discursive approaches will focus on different aspects of the interaction in mathematics lessons and subsequently influence how learning processes are interpreted.

Studying classroom interaction

The discursive analytic perspective on learning focuses on studying interaction and cognition in a situated context. A crucial question that arises on this background is how interaction should be investigated. The problem of analysing discursive practice is assumed to be a major methodological problem for all research projects that focus on observing classroom processes. Even if every teaching episode is a unique event, it can be read in many different ways and every reading offers a different perspective. Different approaches have contributed to the understanding of classroom interaction by focusing on different aspects of the discourse. Inspired by Grenfell (1998) I will in the next chapter outline some approaches that I find interesting for my project.

Discursive psychology

The theoretical roots of discursive psychology are mainly found in linguistics, ethnomethodology and semiotics (Edwards 1996, Edwards & Mercer 1987, Potter & Wetherell 1987, Potter 1996). Recent development within this tradition has made important contributions to the understanding of children's learning, challenging views of the child as a lone organism, constructing a succession of general models of the world as each new stage is mastered (Edwards 1996). In discourse analysis cognition is not regarded as processing information separated from interaction, but treated as something that is managed in, constituted in, and constructed in interaction. Talk and texts are not regarded as routes to, or windows into mind, or other sorts of phenomena such as attitudes, knowledge, motives, identity and reported events" (Potter 1996). Analysis of classroom discourse asks "not *what* do children think but *how* do children think" (Edwards 1993: 216).

Edwards & Mercer's approach to the construction of classroom knowledge through discourse is influenced by the work of Vygotsky (1978, 1987). From a Vygotskian perspective, thought and language are very close, and are immanent in social interactions. A socio-cultural view of learning implies then that children learn by participating in a socio-cultural context and in socially situated practices. A fundamental claim of this approach is that mental functioning is assumed to be inherently situated with regard to cultural, historical and institutional contexts. This view is based on the idea that human beings develop cultural identity by participating in cultural activities and by doing this; acquire the instituted meaning of the activity.

Knowledge is socially constructed, and language is the medium for such construction. Language arises as a way for the child to communicate with others. According to Vygotsky, more sophisticated mental processes like thinking in concepts, will develop as a transformation of semiotic activity. The semiotic activity will start as an external social activity and then be internalised. Cultural tools and signs *mediate* the relationship between individual human subjects and objects in the environment.

The tool's function is to serve as the conductor of human influence on the object of activity; it is externally oriented; it must lead to changes in objects. It is a means by which human external activity is aimed at mastering, and triumphing over, nature. The sign, on the other hand, changes nothing in the object of a psychological operation. It is a means of internal activity aimed at mastering oneself; the sign is internally oriented (Vygotsky 1978: 55).

Educational knowledge is viewed as “handed over” or made mutual as part of classroom interaction. Knowledge and learning are discursive and social, and occur in what Vygotsky calls the Zone of proximal development as determined through problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with capable peers (1978: 86). For a learner in any situation, there is a zone of proximal development - a window of potential learning - that lies between what he or she can manage to do unaided and what he or she can achieve with help.

Bruner (1985) describes the adult’s support for children to build their own understanding as “scaffolding”. This is a metaphoric term for describing the way the teacher makes it possible for the child to internalise interpersonal knowledge and convert it into tool for conscious control. The teacher supports the pupils’ learning by means of cultural tools (linguistic and non-linguistic). Scaffolding is understood as “assisted performance”. Much of the description of scaffolding in the literature, however, deals with mother/child or expert/novice dyads and practical activities. Mercer (1995) suggests that scaffolding can offer a metaphor for teacher’s participation in pupils’ learning, but then has to be reinterpreted if it is to be useful in analysing classroom practice. Scaffolding may involve helping pupils to apply frames of reference that they only partially grasp and are inexperienced in applying. It also needs to be a process, which involves more than two people to be generally applicable to a classroom context. It seems obvious that scaffolding in a whole class situation is a complex enterprise.

Focusing the IRF-structure

Within linguistic/socio-linguistic approaches there are analysis of the classroom discourse by researchers as Sinclair and Coulthart (1975), Stubbs (1976), Barnes (1976) and Barnes and Todd (1977). These writers demonstrate how classroom knowledge is structured and built through identifiable patterns. For example, the IRF exchange structure, where initiation (I) of talk by the teacher leads to response (R) from a pupil, to which the teacher provides a feedback (F). One of the distinctions that need to be made is hinted at by the difference between the two terms that have been used to describe the third move in the three-part exchange. Sinclair and Coulthart (1975) refer to it as Follow-up, while Mehan (1979) and others refer to it as Evaluate. Evaluation is certainly a dominant function of the third move, in which the teacher checks the students' knowledge of the theme in focus.

Mercer (1992) on his side argues that the triadic dialogue is justified as an effective means of monitoring children's knowledge and understanding. The third move functions as *follow-up*, as an opportunity to extend the student's answer, to draw out the significance of the topic, or to make connections with other parts of the students' total experience during the unit. Thus, according to Wells (1999), the "triadic dialogue" in itself is neither good nor bad; rather "it merits – or demerits – depend upon the purposes it is used to serve on particular occasion, and upon the larger goals by which those purposes are informed" (p. 169). Wells (1999) has on this background developed a framework, an analytic tool, for describing discourse in the classroom by combining Leontjev's *activity theory* and Halliday's *genre theory*. Analytical attention to processes of knowledge production falls on the language choices made to represent a particular instructional discourse, which is to be taught, in each classroom genre. Genres are types of linguistic practices or ways of speaking associated with particular institutional practices.

The genre has also a regulative function systematically distributed forms of control embedded in types of situations. "The most obvious point of intersection between the two theories is to be found in the notion of goal-oriented social process" (Wells 1999: 238). The concept of action (Leontjev) and the concept of genre (Halliday) are both concerned with patterned ways of doing things that are culturally recognised; both are structured in terms of the goal in view,

and both “require for their realisation the strategic deployment of relatively routinized forms of behaviour that are appropriate to the prevailing conditions” (Ibid: 238).

Pedagogic genre

A sociological approach to classroom talk and knowledge focuses on the institutional context and power relations and brings macro issues into the analysis of classroom interaction.

Ethnographic studies (Willis 1977, Heath 1983) have been used to account for the ways pupils’ social class background contributes to their level of academic achievement. In these cases, a predominate message, that of class reproduction, appears to be more important than the medium. As Bernstein has put it ” it is as if the specialised discourse of education is a voice through which other speaks (class, gender, religion, race, region)” (1986: 206).

Bernstein (1990) directs the focus of research towards the analysis of pedagogic communication per se, as the medium through which power relations and dominant cultural values are constituted. In order to analyse the medium of communication he elaborated on the concept of *pedagogic discourse*. Thus, talk in classroom does not always serve the pedagogic purpose of “fine tuning” as described by Bruner (1983), Barnes (1992), but rather has a regulative function in

- controlling each pupil’s rate and quality of activity and
- constructing pedagogic knowledge which avoids content input and emphasis procedural tasks

This regulative function of talk has influence on the nature of learning. The knowledge produced may not relate to the pupils’ own way of understanding and, therefore, they may make it difficult for pupils to control their own learning. The constitution of knowledge comes about from a constant circulation and appropriation of subject-matter knowledge (or discourses), which enter the classroom from the outside (their primary context of emergence and use). In this way subject-matter knowledge is transformed or recontextualised into pedagogic knowledge, and this transformation has essentially a regulative function rather than a purely educative one.

Bourdieu's cultural theory

According to Grenfell (1998) the approaches mentioned above, do not take into account the different worldview between teacher and pupil, the distinct cognitive practices they each may be utilising. A methodological approach derived from Bourdieu would entail re-conceptualising this site case in terms of ¹field and ²habitus. The field structure might be the hierarchy of methods within the mathematical discourse, the legitimate procedures and language used to represent them. Habitus would be present in participants, in their present and past experience, and the schemes of thought – hard/nice, legitimate methods etc. – used in interaction with the constituted pedagogical discourse. The teacher has a method, a procedure, and sequence, to solve the problem. What happens when the pupil produces a procedure according to his own habitus (cognitive schemes to generate thinking) is that he is brought back “on line”. What is left uninvestigated is his habitus response, and how this might be productive in the pedagogic act. That is not to say that the pupil’s “wrong” answer should be accepted, or that he should be left alone to find a correct solution according to his own method. It is rather that it is a naive realist’s view to accept what went on in utilitarian terms as “scaffolding”. It is, as Bourdieu might say, “too real to be true, since it grasps at once mental category and a social category, socially produced only by superseding or obliterating all kinds of differences and contradictions” (Bourdieu 1989c: 38 ff, referred in Grenfell 1998). As an alternative, it is possible to deconstruct the word scaffolding of Bruner ” in epistemological terms in order to analyse the fully reality of the process, with all its tensions and contradictions”.

Dots and dice: the meaning of numbers

To illustrate some of the aspects I have made above, I will give an example of some analysis of classroom transcripts. The following episode is from a class in year two (aged 6-7). There are eight pupils in the class. The pupils are seated in two groups of four. The class is working on addition (the numbers between zero and ten). In the first part of the lesson the pupils are working on the positions of numbers on the number line (the sequential meaning of numbers).

¹ A *field* site is the structurally identifiable space which marks out sphere of social activity. Education is a field made up of identifiable interconnecting relations.

² *Habitus* – The social agents’ inheritance of the accumulated experiences of their antecedents

The teacher then draws two big dice on the blackboard and says they are going to do some arithmetic.

Dice used as teaching aid in primary school mathematics are quite common. The idea behind this kind of material tool is that this will support the child's mental strategies (Vygotsky 1978). Since the teacher cannot transmit her/his knowledge of arithmetic directly to the child, she must try to base this on something well known for the children, and something that can be verbalised and visualised in a way that the children can understand. In connection with addition the material tools could be a support for many children that are not yet able to add mentally. This does not mean that they do not have mental strategies, but rather that the children ascribe the object they are counting with a particular meaning. The teacher can choose between common tools, e.g. money, calendars, rulers, dice, or special developed educational materials like Multilink and Unifix cubes. Teaching aids are part of the real world, but at the same time they are artificial objects supposed to express certain theoretical relationships. Therefore, finding suitable tools and use them in a way that helps pupils to understand how these are related to the concepts, procedures and other aspects of mathematics is a didactical challenge.

Die is a common tool that children know, though from other contexts like playing games etc. In this lesson the dice are supposed to be used in a new situation for the children – in addition of numbers. In the mathematical activities of this lesson, the pupils are supposed to handle various forms of visual and mental representations of numbers as

- Pictorial (e.g. drawings of dice)
- Iconic (e.g. drawings of the dots on the dice)
- Symbolic (the formal number symbols)

What are they talking about?

The teacher tells the pupils that they are going to work on dice. In the next excerpt it is noticeable that there is a tension or discrepancy in the interaction between the teacher and two of the pupils. We may ask if this is due to a fixed structural pattern (pedagogic genre) or to the

subject-matter content (mediation aspects). Talk is always about something and for it to be effective it is important that the interlocutors are talking about the same thing. The “talking about the same thing” can be termed the clarity of *discursive focus* (Sfard 2000). Even when discursive focus seems clear, there can be a discrepancy between the words that we use to identify the object of our attention and what we are attending to. We can think of discursive focus as divided into components. We have the *pronounced* focus, which is what we say and the word we use. The *attended* focus is what we are looking at or attending. The third one, the *intended* focus, is less tangible than the other two, which is what seems to be the interlocutors’ interpretation of the pronounced and attended focus. When there are good fit between these three, the communication will be “effective”. In the following excerpt we may ask if different foci cause trouble in the interaction.

Excerpt I

74. ³T: Now you are going to work together two and two .. later with ... dice ... whi .. how many dots do you see here Chris? (POINTING AT ONE OF THE DRAWN DICE ON THE BLACKBOARD)
75. Chris: Three
76. T: Then I write the number .. three ... how many dots do I have here (POINTING AT ANOTHER DIE ON THE BLACKBOARD.)
77. Jack: (SHOUTS) Si-i-ix!!
78. T: Six .. then I write the number six
79. Jack: (BANGING AT HIS DESK)
80. T: Now this is important that you follow and that you learn how the die .. the dots on the die look like
81. Rich: I know that
82. T: Well, not all pupils know .. you see Rich .. now I will show how we do it .. if we are going to draw two .. dots .. if we are going to draw .. two dots let’s have a look
83. Rich: We already know that
84. T: (DRAWING) We have to practice a little
85. Rich: All of us already know!

The teacher (74) tells the pupils what they are going to do, but first she poses some questions to the pupils. She nominates the pupil who is going to answer without waiting for the pupils to put their hands up. Chris answers “three” and the teacher says she is writing three. She then asks Jack a new question and points at the dots on a die she has drawn. Jack shouts six.

³ Pause < 2 secs. = ..
 Pause > 2 secs = ...
 Overlapping speech = [
 Emphasis on a word = __

The teacher does not remark why Jack is shouting. She repeats the word six and says she is writing six.

Jack makes noise by hitting his fist at his desk. The teacher becomes a little vague to whom she is talking and what she emphasises as important (80). At first she says that it is important that "you" (Norwegian plural "dere") pay attention, but then continues that you (Norwegian singular "du") learn this. Probably is the last "you" posed to Jack that makes noise. Then she says that it is important to learn what the *die* looks like, but then corrects herself immediately to what the *dots* on the die look like. Rich says he knows (81). The teacher says that not everybody knows and adds, "you see Rich". The last "you see" can be an expression of resentment of the interruption or it might be because she wants to remind Rich that he should pay respect to his fellow pupils in the class.

The teacher seems a little bit confused as to pronounced focus (82). Rich does not give in and repeats his claim, but now by including the whole class, "we certainly know that" (83). The teacher is talking about "we" as well (84). The teacher does not answer Rich's statement directly. Rich then tries again and claims that *all of us* already know, and of course he does, if we look at the pronounced focus. Any pupil in year two would claim that he/she knows what the dots on a die look like. The meaning of the teacher's utterance is more likely to be how the dots are positioned on the die (attended focus), because that is what she refers to when she is drawing on the blackboard. Rich's and the teacher's intended foci are not "compatible" (Sfard 2000).

Operations by means of dice

The teacher then hands out dice to the groups, four to one group, but then she discovers that she is in short of dice. Accordingly, one of the groups gets only two dice. The teacher shows on the blackboard how to use the dice. As mentioned, visualisation by means of concrete tools does not work automatically. The children have to interpret and structure them by themselves:

There is no direct way from visual material to the student's thinking, at best different difficult detours. The property of the number 3 is not visible at three smarties or three Lego bars, as if the child through simple contemplative observation could derive it. It is an abstraction, which does not work by merely leaving out the supposedly unimportant (Lorenz 1995: 10, quoted in Steinbring 2001).

The child itself must be responsible for the abstractions by reading new, but invisible relations and structures into the visualising material. A crucial question is if for example dice used in this context are of any help for the children.

The teacher tells the pupils to work together and work out what “becomes two” by adding two dice. Mary answers there are “one there and one there”, pointing towards the two dice on the blackboard. The teacher repeats Mary’s answer and writes on the blackboard.

Excerpt II

86. T: Now you should try to collaborate .. now you are going to make an arithmetic problem for me ... with the dice .. it might well happen that it will turn out differently for each group .. and .. the number that the die adds up to .. that is four .. please do collaborate .. agree about how you will set the problem .. when you have finished you put your hands up
87. Jack: I don’t have any die
88. T: You have two dice .. and you should cooperate .. unfortunately I do not have enough dice for everyone so we have to work together four and four .. however that will be all right .. then I ask .. Jim’s group
89. Jim: Two plus two
90. T: Two dots (DRAWS) .. and two dots become .. two plus two becomes four .. do you have any other suggestion?
91. Kim: Yes
92. T: Yes .. let me hear
93. Kim: Four plus zero
94. T: Four .. but you should use two dice?
95. Kim: Eh
96. T: But it will pass .. but four plus zero it .. just now we should use the dice you know two dice .. there is no zero .. there is no side of the dice without a dot on .. on all [sides
97. Kim: [One plus three

In excerpt II we notice that the teacher opens up for suggestions and says that there might be various answers. She emphasises that the pupils should collaborate (86). Jack says that he has no die. He is in the group, which got only two dice. The teacher answers that they have to work together four by four, without giving any explanation how to do it and goes on and asks Jim’s group (88). The teacher asks for other suggestions and Kim suggests four plus zero equal four (93). He has probably forgotten that they were supposed to use the dice and is just thinking of “ what becomes four”. The teacher repeats Kim’s answer, but then reminds him of using the two dice. She brings him back into the discourse (where dice should be used).

Kim seems confused, and the teacher then hurries up saying that this will pass, but not just now, because of the dice (96). Before the teacher has finished her utterance, Kim comes with a new suggestion that fits with the look of the dice (97).

Kim manages what in fact is an important aim in arithmetic; that is to say adding up “in his head” without using concrete aids. It is highly probable that he can add up without the dice, also with respect to larger numbers. He realises, however, that this is not what the teacher wants him to do. The dice represent some limits to what he can suggest.

What is it to collaborate?

Something that disturbs and distresses the activity focus is the lack of dice in one of the groups. The dice seem to become a problem instead of a support. The pupils pay more attention to the dice than the content of the question. Some of the pupils certainly can solve the arithmetical problems without the dice, but they become frustrated because they are not able to do the operations they are asked to do. Probably they find this situation quite unfair comparing with the other group where they have four dice.

Excerpt III

98. T. One dot .. plus .. pay attention back there Mary .. do you turn around? .. One dot (COUNTING WHILE DRAWING).. two, three .. that becomes .. one plus .. three equal ?
99. Rich: Four
100. L: Rich?
101. Jim: Yes but may I say something?
- 102.T: Yes?
- 103.Jim: Certainly we cannot use two dice when we just have two
- 104.T: Well yes because you collaborate all four of you you four work together for the first time you are supposed to work together a little
- 105Jim: (VAGUELY)
- 106.T: We try again .. two dice are now going to equal .. the number ... eh seven

Rich answers before the teacher nominates him (99). Still the teacher asks him after he has given his answer. Perhaps she wants Rich to repeat the answer in order to maintain the structure of the conversation or to be sure that the other pupils should hear his answer. The next we should notice is Jim’s polite ”⁴question if he is allowed to say something (101) and

⁴ Schegloff 1980 describes utterances like ”Can I ask you something” as preliminary to preliminaries

how the teacher answers him. For Jim it is important to clear up the problem with the lack of dice. Instead of asking directly, he asks if he is allowed to say something. He argues that four pupils are not able to operate with two dice as they only have two. The teacher again refers to collaboration - all four of them should collaborate. It seems to be a real problem for this group to do this in practice. They are not able to handle the task they are given. The teacher does not seem to notice that the group has a real problem. She continues her questioning, and the pupils at the group with two dice give up using them.

Discussion

By analysing these three excerpts from the primary classroom we may ask what the interaction between pupils and the teacher tells us about communicative conditions for learning and knowledge construction.

With the perspective of Edwards & Mercer I should be tracing scaffolding in the interaction. Scaffolding, as mentioned, is a metaphor that tries to capture the dialogical nature of the social and the psychological in learning processes. Some of the teacher's moves could be interpreted as a way of supporting the pupils' struggle for manipulating the dice and use these tools as a means for doing arithmetical operations. The teacher told the pupils what she was doing simultaneously with writing the numbers on the blackboard, emphasising the connection between the oral, the written numbers and the formal symbols (e.g. 76, 78, 90). She reminded the pupils of the look of the dice and requested the pupils' suggestions. According to current theories of pedagogy (Barnes and Todd 1977, Bruner 1985, Barnes 1982), such practice of fine-tuning is crucial in the process of learning, because it pushes the pupil's understanding a bit further than its current limit, thus stretching the pupil's learning threshold.

Wells (1999) emphasises that the *third move* in the IRF-structure should be used to extend the mathematical content. This is a way to support the child in constructing new knowledge. In the described episode, the interactional structure followed mainly this pattern – the teacher demand and the pupils give. Focusing on the participation of the pupils, I have identified contributions of different kinds; some of them gave the “expected” answer and followed up

the teacher's requests, others gave their opinion and initiated expanding arguments. If I follow Wells (1999) and his idea of the possibilities of the third move, there is, however, little extension of content in these excerpts. We may ask why the teacher did not grasp the pupils' initiative more seriously, requesting their opinion.

Using Bernstein's concept of *pedagogic discourse*, the main impression is that this mathematics lesson offered little space for pupils' initiating moves. If we take a deeper insight into e.g. Rich and Jim's utterances, we can notice that what they said was highly relevant for the mathematical task. The teacher seemed to take their initiatives more as a disturbance and an interruption of the turn-taking structure. The authority of the teacher is never in doubt. In the transcripts we can see how the pupils were brought back into the discourse (e.g. 80, 94, 104). The knowledge produced was related to what the teacher focused on and not what the children focused on in the task.

The teaching of mathematics of this lesson emphasised procedures – how to do it. According to Edwards and Mercer (1987) institutionally produced knowledge, rather than involving conceptual understanding of the “principles” of educational knowledge, *principled* knowledge, often subordinate this understanding to the power relations of the classroom interaction and to the constraints of the lesson. Thus a *procedural* type of knowledge is emphasised, a knowledge of knowing how to execute classroom activities. As Edwards & Mercer point at procedural knowledge will, when not accompanied by an understanding of the principles of the activity, often give rise to *ritual* knowledge, knowledge which do not connect the pedagogic activity with explanations and the pupils own ways of understanding.

Using dice is a well-known activity of children at this age, but not in mathematics lessons. The teacher had probably an intention of using just dice as teaching aid, hoping to bridge the gap between everyday life and mathematics. However, we may ask if the strong emphasise on the dice in the situation caused more trouble than support for the pupils. Rather than being a mediating tool for understanding number structures, the operation with dice became “different difficult detours” (Lorenz 1995). Teaching aids removed from the contexts and deconstruction of objects may lead to ritual knowledge instead of principled knowledge. The dice were here used in a new and unknown way for the children.

The discrepancy between the foci of pupils and the teacher in the example given could be analysed by means of Bourdieu's concepts *habitus* and *field*. In order to go beyond the images of teaching, the concepts of *field* and pedagogic *habitus* offer a way to highlight the relationship between teacher and pupil, located in time and space, together with the ways these are expressed in and through language. It is necessary to see these relations as governed by principles immanent in the structuring and structures identifiable in human discourse and praxis. Teaching knowledge is not the transference of known things to unknown subjects (pupils), but the transformation from unknown to known things in relationship with a pedagogic other. The extent this can happen depends on pupils' and teachers' *habitus* and their interplay with a field context.

The teacher's behaviour could be understood as tension and conflict in the pedagogic dilemma. On this background the teacher's intention to teach seems more powerful than her intention to understand the pupils.

According to Bourdieu, teacher's thinking, teacher's intentions should be connected to a hierarchy of valued practices and knowledge within the pedagogic discourse – the field. *Habitus* brings with it field and field the notion of *habitus*. The two are mutually constituted for particular, practical purposes. According to Bourdieu (1977a) pedagogic language can be seen as the product of a particular field context. As such, it will be governed by what is valued in that field, what is legitimate, what is excluded. As Grenfell (1998) points out this is not only the language of an interaction, but

the whole site – the time and place such exchanges take place – and the way a particular field connects with other fields within education. There is an issue of what is legitimate and who defines it. There is another issue of how this is represented in schools and classroom through language. A third is the effect of individual habitus, for both teachers and pupils, in the field. A fourth is the extent to which such differences of language can be expressed in terms of social class and what other generating principles might be present in classroom discourse (p. 87).

Concluding remarks

In order to learn mathematics, the pupils must become engaged in the learning activities and build a relationship with the setting that defines the pedagogic situation. As we have seen in these excerpts, the pupils are engaged and eager to contribute to the discourse. My analysis of the communication so far illustrates some interesting aspects.

First, the discursive foci of the teacher and the pupils in some of the sequences can be analysed as “incompatible” and thus cause frustration and “miscommunication” between the participants. According to Vygotsky, in communication between an adult and a child they may both refer to the same object, but think of it within their own framework. The child’s framework is often related to the situation, the adult’s related to concepts.

Second, instructional discourse has its own structure that easily comes to emphasise procedural knowledge (know *how* to do it). The teacher’s “scaffolding” purpose in the example seems to come in conflict with some of the pupils’ experiences and understanding of the mathematical operation. The pupils’ initiating moves are seldom followed up and extended. The procedure gives little space for bringing in new topics. There is a tension between the goal-oriented activity of mathematics, the time-pressure and the teacher’s implicit dilemmas on one hand and on the other hand, the needs of the individual pupil to participate on his own conditions.

Third, it is not easy to plan a learning process of others “that can realise the journey from concrete material to abstract mathematical understanding “ (Szendrei (1996). Even if the concrete tool (here dice) is well known, the use that the teacher introduces seems complicated for the pupils to understand. We do not know what kind of tools the pupils would have preferred if the decision as to whether to use a concrete tool, when to use it, how to use it and in what order, was theirs.

As a summary, in my view classroom communication is a rich source for studying learning processes. Interactional features of classrooms discourse differ from daily life settings, but

there are also differences between schools and classrooms that give rise to different cultures of learning mathematics. Qualitative methods, however, like observation and recording classroom talk imply among other things how to handle own subjectivity and own values as an observer. Any analysis of the interaction involves the selection and application of analytic perspectives. As I have tried to show in this paper, my description and interpretation of what is going on in the mathematics classroom is affected by the choice of theoretical framework and focus of interest.

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