

TEACHERS' COLLEGIAL REFLECTIONS OF THEIR OWN MATHEMATICS TEACHING PROCESSES

Part 1: An analytical tool for interpreting teachers' reflections

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Abstract. *The research presented in this paper offers a theoretical approach to the analysis of teachers' professional development by collegial reflection. The analysis of the reflections is applied to teaching episodes observed by videos and transcripts. The communication processes of constructing interactive mathematical knowledge with regard to develop together a more and more professional reflection of the student/ teacher mathematical interactions are seen here from a complementary perspective: (1) The construction process of an analytical tool for describing the reflection process of teachers; (2) The reflection process of mathematics teachers on the videos and transcripts of a diagnostic episode showing their own interviewing. This paper as the first of two papers concentrates on the first perspective.*

1. INTRODUCTION: THE RESEARCH PROJECT AND ESSENTIAL RESEARCH PERSPECTIVES

The presented research frame deals with discussion and results of the epistemological analyses of mathematical interactions in different social contexts (cf. Nührenbörger and Steinbring, 2009). In this article, we will concentrate on the development of teachers' professional learning by reflecting together their own teaching episodes. We will discuss an analytic tool for describing the reflection process with regard to a professional development of a more and more sensible interpretation and analysis of the students' mathematical interactions in the course of the teaching episodes observed. This research focus is one important element besides other research questions of two broader projects dealing with questions of the mathematical teaching and diagnosis of students' mathematical abilities in grades 1 and 2.

- a. *›Mathematics teaching in multi-age learning groups – interaction and intervention‹ (Malin). The question of this larger research report is: In which way do the teachers professional perspectives on their own role of teaching develop during the interactive lesson process with regard to the collegial reflections? For two years, eleven teachers from four elementary schools participate in the research project with their multi-age classes (grades 1 & 2). All teachers have been introduced to mathematics instruction in multi-age groups (cf. Nührenbörger and Pust, 2006). Each school year the partner work of two children (of different age) is video graphed in five lessons. The children work in pairs on open or structure-analogue tasks, which are supposed to permit an interaction and reflection from different points of view for both of them. After each term (four times over two years), the teachers of each school meet for a collegial reflection, in which video graphed episodes are watched out of their own instruction and analysed with the*

help of corresponding transcripts. The objects of their critical analyses are video episodes from their mathematical classroom that contain two types of mathematical communication in two different social contexts: “A short episode of two students interaction without the teacher's presence” and “A following short episode of the two students interaction with the teacher's participation”.

These interaction settings are taken as a productive opportunity for making sense of the students' processes of mathematical understanding within these two sub-settings and of constructing mathematical knowledge in view of their own interventions (cf. Nührenbörger and Steinbring, 2009).

- b. “*Mathematics talks with children – individual diagnosis and supporting*” (MathKiD). The question of this research report is: In which way do the teachers' professional perspectives on their own role of talking with one child develop during a diagnostic interview by means of structured talks of reflections? For one year, five teachers from two elementary schools participate in the research project with their children (grade 1 or 2). All teachers have been introduced to diagnostic situations in mathematics instruction. In one year, the interaction between the teacher and one child of his class is video graphed about six times. The teacher and the child talk about “pure” math situations or playing situations with implemented math situations. They are supposed to permit diagnostic findings about the mathematics abilities of the child. In one year, the teachers of each school meet three times for a structured talk in which video graphed episodes out of their own diagnostic talks will be watched and analysed with the help of belonging transcripts and the intervention of a moderator (project leader). The objects of their critical analysis are video episodes from their diagnostic talks that contain interesting situations under three different analytic perspectives: “Analysing the understanding of the child”, “Analysing the intentions and actions of the teacher” and “Analysing the interactions between the teacher and the child.”

The cooperative reflection of mathematics teachers constitutes a practice-orientated discourse for constructing professional teacher knowledge. This research approach aiming at the analysis and reflection of the teachers' *own* teaching activities in the course of their professional development differs from those approaches that offer exclusively theoretically elaborated patterns of teachers' activities for reflection and imitation. The main focus of this paper is on the problem of developing an adequate tool for describing the process of collegial reflection with regard to the construction of a more professional knowledge for the learning and teaching process of mathematics. This leads directly to the research question of this contribution:

In which way teachers become aware of and understand carefully the students' interactive mathematical interpretation processes in relation to their own intervention possibilities for stimulating students' mathematical understanding processes?

In the last decades, research studies on mathematics teachers' professional development have more and more emphasized the importance of video graphed

episodes of mathematics teaching and interactions for sensitizing the teachers for their own teaching and talking activity in and about math (i.e. Maher, 2008; Benke et al., 2008). In this frame it is important to recognize that teaching itself is not a mere routine task of transferring more or less finished mathematical knowledge, which the teacher has prepared, to the students. Steinbring (2008, 372) points out that “school mathematics, as finished given knowledge, is not the *actual subject of teaching* in an unchanged way. Mathematical knowledge emerges and develops only in an effectively new and independent way within the instructional interaction with the students. Thus, finished, elaborated mathematics is not an independent input of the teacher into the teaching process which could then become an acquired output by means of students’ elaboration processes.”

During the process of teaching, the teachers are involved directly in the interaction with the student(s) and cannot play the role of a distanced observer of the events. The teacher has to draw directly a conclusion of the situation. “Normally, whenever we hear anything said we spring spontaneously to an immediate conclusion, namely, that the speaker is referring to what we should be referring to were we speaking the words ourselves. In some cases this interpretation may be correct; this will prove to be what he has referred to. But in most discussions which attempt greater subtleties than could be handled in a gesture language this will not be so” (Ogden & Richards, 1972, p. 15). But the development and change of the activity of teaching requires a critical consideration and thus a distance of one’s own activity (cf. Krainer, 2003). Collegial reflections offer the teachers an “unusual” view of interaction processes. Possibly they will be irritated, they observe greater subtleties and thereby view the situation in another way (cf. Gellert 2003).

Otherwise one cannot see a typical dilemma of mathematical teaching routines: Mathematical teachers know, on the one side, of the importance of interactive learning processes during a learning environment, supporting the active-exploring work of students. But on the other side, the talk of the teachers during the teaching is affected by an attitude that mathematical knowledge is a *complete and clear product*, which can be developed directly by the students (cf. Steinbring, 2005). Hence, it might be the danger that teachers act on the assumption to support the students’ learning processes with open learning environments. But due to the direct involvement in the mathematical teaching process, teachers tend to their personal views on knowledge. Their spontaneous work bases on own experiences and routines: Their talk to students is characterized by leading, funnelling and product-orientating, so the students have no choice to develop active own mathematical interpretations (cf. Bauersfeld, 1995). The teachers involved in the teaching process cannot see this dilemma. It is only noticeable in the distance and in a critical-reflected talk with colleagues observing by a video of their teaching. The distanced observation of a communication process in the classroom can highlight causal relations between the learning and teaching process. “During the common systematic reflection in a group of teachers about their own teaching processes with students thus emerges a

further communication system, which again has to deal with the necessary interrelation between one's own consciousness and common communication. This communication now has communication processes as its subject and it is supposed to animate a professional consciousness" (Steinbring 2008, 379). However, the reflection of one's own activities that temporally separates from the teaching situation looks to future teaching activities. These future teaching processes can relate to the results of the distanced reflection (cf. Krainer 2003; Sherin and Han, 2004).

As a basis of professional teacher development we see an active, self-responsible and reflective elaboration of one's own practice with colleagues (cf. Altrichter, 2003, Krammer et al., 2006). „Systematic reflection on mathematical interactions that focus on the students' learning and understanding processes, as well as on one's own interaction behavior, represents an essential professional competence of teachers" (Scherer & Steinbring, 2006, p. 166, cf. Mason, 2002).

The growth of new insights refers to the active process of reflecting one's own teaching and learning. „If mathematics education is to be influenced in a positive way and ameliorated, the teachers have to be the ones who initiate these changes, and their reflection on their own activity is crucial" (Scherer and Steinbring, 2006, 165). Professional development needs to talk with the professional group about the own practice. In this sense, we mean with "collegial reflection" the common discussion and negotiation of teachers watching a video of a teaching episode and reading the transcript.

In this article, we will discuss the question, how the collegial reflections support teachers with the help of videos and transcripts to be sensitive to the power of the mathematical negotiating process of students: In which way teachers develop in the course of collegial reflections differentiated mathematical interpretations and interrelations? In which way teachers look to the possibilities to attend the students with open, mathematical focused and interactive orientated interventions?

2. THE DESIGN OF THE COLLEGIAL REFLECTIONS

In the context of the two research projects, the teachers take part on distanced collegial reflections of their own or of known (this means known lessons held by colleagues) teaching lessons. In this sense, the projects do not focus on the imitation successful teaching and learning strategies. Both projects aim at the commonly constructed reflection of interaction processes with the focus on the understanding of the students' mathematical thinking, on the role of interaction for constructing mathematical knowledge, and on the patterns of the interactive teaching and learning process. The collegial reflection focuses on classroom cases (Malin-Project) or diagnostic talks (MathKiD-Project).

Teachers can be encouraged to reflect their own talking activities and to make conscious decisions by learning how to "read" and interpret an episode of talks in a

complex classroom situation or in a diagnostic situation. In addition, the collegial reflection follows some guidelines for initiating joint analyses:

Continuity: The teachers meet more than one time a year. The long-term meetings are necessary to grow into and to stabilise the reflection process of exemplary cases. Furthermore, each teacher of the group of 3 to 5 teachers should be one or two times a year in the focus of the reflection.

Collegiality: The teachers work together and reflect their view of the real teaching episodes in a new way.

Familiarity: It is necessary to integrate the collegial reflection process in a trustful atmosphere to experience a positive learning community. A concentrate altercation of the teachers with the episode relates to the familiarity of the video episodes.

Concentration on teaching and learning: The analyses focus is on the teaching and talking activity, not on the teachers (cf. Stigler and Hiebert, 1999) - the teachers do not want to evaluate the teacher, they want to understand the teaching process and the practice of instructing - they give only alternative teaching offers (cf. Seago, 2004).

Concentration onto the teachers: The teachers will and should not analyse the transcripts like researchers. They have their own interests in working with the transcripts, just like the socio-cooperative possibilities of learning or the everyday constitutions of their practice.

The teachers can take different roles in the course of the analyses. The results discussed in this article bases on the research project “Malin”. The researcher takes the role of a cautious moderator to initiate the collegial reflections.

Cautious moderator

After an empirical analysis the researcher chooses one video episode of the classroom teaching lessons of one participant. The video episode contains a potential for discussing the interactive knowledge construction of the children in relation to the intervention of a teacher. At the beginning the teachers get an orientation of the teaching episode by the teacher involved. The researcher offers the video episode and the corresponding transcript. Furthermore, the teachers discuss different perspectives for the interpretation process – such as special features of the mathematical understanding of a student, of the interactive construction of mathematical knowledge, or of the teachers` attitudes and verbal interventions and their consequences of the students` behaviour and knowledge construction (cf. Scherer et al, 2004). The video episode is structured in three sequences and each sequence is an “object” of the teachers’ cooperative and joint reflection:

- a. Mathematical interpretation processes of two cooperating students
- b. Mathematical interpretation processes of the intervening teacher
- c. Mathematical interpretation processes of the two cooperating students after the leaving of the teacher

Firstly, the teachers see and discuss only the first sequence with the help of the transcript without knowing the teacher intervention. The researcher as a moderator

has mainly the task to choose and structure a comprehensive teaching episode and to moderate cautiously the collegial reflection. At the end, he animates the teachers to a short review – in form of a “flashlight” – on the collegial reflection and on their learning process. The cautious moderation guarantees a negotiation of deep structures that seems to be important for the professional development process of the teachers` group. Furthermore, the teachers have the opportunity to adopt the collegial reflection as a school-internal way of professional learning. In this sense, we hope that this may guide the teachers to understand their school as a place where also teachers can learn.

3. THEORETICAL COMPONENTS OF ANALYSING TEACHERS` COLLEGIAL REFLECTION

In this report we concentrate exclusively on exemplary cases in order to elaborate the particularities of collegial reflections that were analysed in the Malin-Project. The qualitative data is carefully evaluated in an interpretative way and analysed with regard to the classification of specific interpretation dimensions (for the research approach of qualitative and interpretative analyses of mathematical interaction processes see e.g. ZDM (2000)).

The collegial discourse creates a new context, in which the teachers talk in a different way of teaching mathematics as during the lessons. The teachers` interpretations during the different collegial reflections of their own teaching episodes can be compared with the reconstruction of a “case”. Their discussions are effected by the search for evidences to clarify the case. The results of the analyses lead to the assumption that the teachers construct an understanding of the interpretation to an agreed case – likewise teacher and students negotiate common mathematical interpretation during the lessons. For a collegial reflection, we will differ three main analysing aspects, which relate to the professional development of the teachers:

- The constructing of a case (What teachers are talking about the empirical event?)
- The reading (How teachers are speaking about the case?)
- The generation of case knowledge (Which knowledge teachers are expressing to make sense to their case?)

The constructing of a case: The teachers watch a video episode of a teaching sequence and read the corresponding transcript. Their discussions differ from spontaneously reflections in or after a teaching episode. The teacher involved in the case gives a lecture of his thinking of the named case. In the collegial reflection, the teachers frame firstly the empirical event in different ways. Here, we can mainly distinguish between three frames, which seem to be important for a professional development of mathematical teaching:

- An interactional frame containing utterances to the social learning of students, to their cooperative activities, to the dialogues between students or between students and teacher depending on their social roles (cf. Nührenbörger and Steinbring, 2009, e.g.: “*The starting situation, that [the student] Klaus decides and Sönke is*

in the role of working and writing, is changed, when a teacher comes to the students. Klaus is very orientated to the teacher telling him what they have already done”)

- An epistemological frame containing utterances to interactive construction of mathematical interpretations of the students and to the mathematical understanding of the teachers themselves in the distanced situation of the collegial reflection (e.g.: “Ah, these four plus four idea.” “I think also this crux of the matter. Well, I mean, with six plus two and two plus six it is obvious, that they are exchange exercises which have the same result, but which are the other way round. And with four plus four. (...) It is in fact also an exchange exercise...” “But Ben, with your theory, well I am considering right now. If one puts them into a line and then you would have one plus seven, but also two exercises.”)
- An organisational frame containing utterances to the conditions of teaching (i.e. presentation of a task, time management etc.) and to the development of their own teaching (i.e. the effects of diagnostic questions etc.)

The relation between the empirical event and the frame of the teacher describes the case which the teachers construct in their collegial reflection and which is the focus of their understanding. The teachers pick different cases as a central theme during the active reflection of the different sequences. Five main cases can be differed: learning of mathematics with focus on results and algorithmic or on arithmetical and geometrical processes, social learning of the students, teaching of the teachers, mathematical context, diagnose of competences.

However, the teachers construct a case in the collegial reflection, they do not discuss a staged case. The constructed case must be proved (on) by the empirical event.

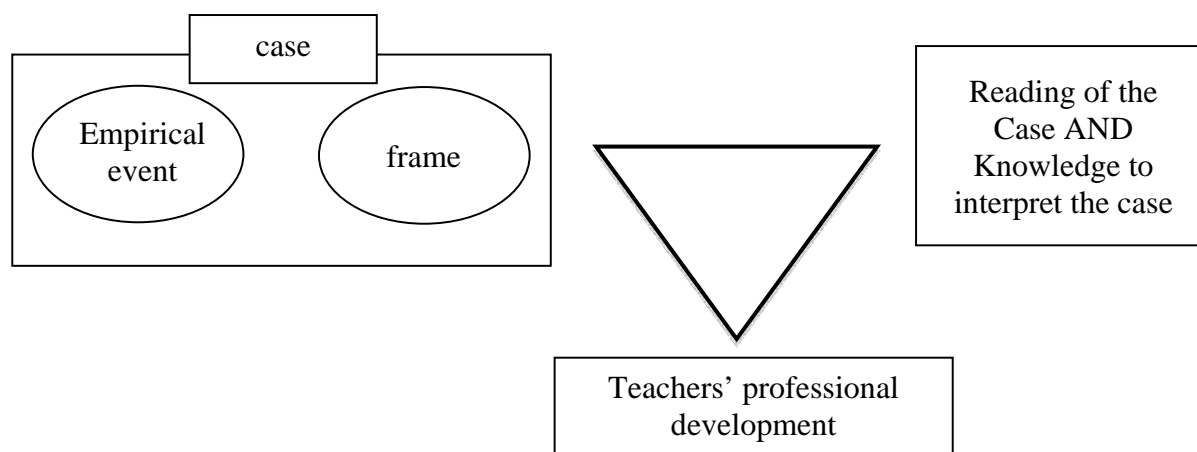
The reading of the case: The teachers can articulate the constructions of the cases in different ways. If teachers – after reading the transcript or watching the video - think to know and understand the interaction process, they *narrate* and *evaluate* the text in a biased-spontaneous way. A more open-reflected approach contains different *paraphrase* and *interpretations*. What will we mean with these notations indicating the access of the teachers to the case?

Description: The teachers concentrate on aspects of the episode and give a detailed or a short description. If the teachers illustrate the attitude or the talks as a clear and understandable learning episode, they tend to *narrate* the scene in a short way. But if the teachers illustrate different phenomena of the teaching and learning process in a neutral and accurate way, they tend to *paraphrase* the scene.

Evaluation: The teachers link their descriptions with personal views on the situation to evaluate the attitudes and talks in the teaching and learning process.

Interpretation: The attempt to clarify the teaching and learning episode must not go along with an evaluation. When the teachers describe the scene in a detailed way and try to analyse the different acts and utterances, they begin to interpret the scene. The interpretation leads to different explanations without regard to own experiences.

The readings of the case interrelate to a different case knowledge of the teachers. The analysis of the collegial reflection in the Malin-Project shows three different types of practice case knowledge (knowledge by observation, by experience, by transfer, by interrelation) that the teachers activate to clarify the case. However, in this sense the case relates to the common professional knowledge. The following diagram shows the coherences between the case and the construction of professional knowledge.



The generation of knowledge: During the reflection process the teachers bring in their knowledge to construct and understand a case. On the one hand, they use their common experiences and observations to clarify an utterance or an act of the students or of the teachers. This case knowledge relates to old knowledge (e.g.: “*I think it is typical. The older guy tells the younger one what to do. Klaus says to Sönke, how it will go.*”). In this sense, the interpretation of the case is used to confirm one owns pedagogical and mathematical beliefs. A teacher will use his case knowledge by *observation* to describe and reconstruct the empirical event. When teachers use experiences of their own teaching practice that relates to the empirical event observed by the video, they activate case knowledge by *experience*. This means that they construct retrospectively an adequate perspective to give a plausible explanation for the colleagues.

On the other hand, teachers can pick the case as a central theme for constructing new relations dynamically. If the case provides a basis for a productive irritation, it can inspire the previous knowledge of mathematical topics (e.g. see the discussion of the teachers above, if there exist an exchange task to $4 + 4$: The way of the students` interpretation of a mathematical task can lead to a new discussion about mathematical patterns), mathematical interpretations of children and mathematical interactions (e.g.: “*The schizophrenic thing is, I as a teacher have given them a partner work, but I do not lead the student-teacher-conversation as a partner-work-conversation*”). If a teacher reproduces the ideas of the other teachers in relation to his old knowledge, he constructs new case knowledge by *transfer and interrelation*.

4. CLOSING REMARKS: THE PROFESSIONAL DEVELOPMENT OF TEACHERS' IN RELATION TO THE COLLEGIAL REFLECTIONS

The teachers construct and negotiate different cases in different ways if they have the opportunity to reflect together their own teaching process. The analyses of the reflections in the Malin-Project (cf. Nührenbörger and Steinbring, 2009) showed that teachers activate different types of case knowledge to interpret the empirical events. We described a professional development of the teachers as a growth of the reading of a case in an open and reflected way (paraphrase and interpret). Likewise, one can see a growth of professional practice by the construction of relations between the case and the knowledge by transfer and interrelation based on a productive irritation by the teachers. Besides the organisational frame, the conditions and the trustful willingness of the teachers to open up for the exchange with their colleagues, it seems to be essential that the collegial reflections were founded on scenes from one's own teaching. But which role has the moderator?

The analysis of the collegial reflections showed that many times, the teachers discussed a scene without a mathematical orientated frame. They used the empirical event to talk about common pedagogical and organisational topics. What will happen if the moderator leaves the cautious role and takes a more active role? We have the hypothesis that the role of the moderator can focus on the discussions of the teachers on one case and can provoke a more open and reflected reading of a case with the use of knowledge by transfer and interrelation. An *active moderator* looked for special features which he wants to discuss with the teachers and which they shall notice. We will discuss a collegial reflection structured by an *active moderator* in the second part of this paper with regard to the MathKiD-Project.

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