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Student Teacher Participation in Interpretative Classroom Research Projects

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An orientation towards "listening to pupils' thinking" can promote a learning environment that is conducive and sensitive to pupils' own mathematical sense making. This paper introduces and reflects on recent developments in German elementary teacher education programs with respect to a "listening" orientation towards mathematics teaching. The paper focuses on student teachers' professional learning processes while they collect, collectively interpret, and analyse qualitative data from primary classrooms episodes in which pupils argue mathematically. While the approach of student teacher participation in qualitative research projects does not relate to one specific study, it provides a common structure and has proven itself in a variety of different research projects co-ordinated by the authors. In this paper, data excerpts from student teachers' self-evaluation of their professional learning with respect to pupils' thinking and their own classroom instruction are discussed.

Student Teachers as Teacher Researchers

The involvement of student teachers as teacher researchers is compatible with the idea of developing a community of practice (Lave & Wenger, 1991) in which they experience how scientific analyses can help enlighten them to those aspects of classroom practice, professional skills and knowledge that they personally perceive as important (Jungwirth, Steinbring, Voigt, & Wollring, 2001). Recent publications (e.g., Zack, Mousley, & Breen, 1997) stress the importance of teachers' inquiry for educational change, because teacher researchers not only develop their own professional skills, but also their research findings inform mathematics education research and curriculum development. In the context of a pre-service education system, student teachers can benefit in a similar way to classroom teachers. The Austrian/German mathematics education researchers, Jungwirth, Steinbring, Voigt and Wollring (2001) for example, have shown this with respect to the interpretative classroom research approach. Analysing their experiences in both teacher pre-service and in-service education, they found that interpretative studies can help "to reveal what is hidden in practice and what is important" (p. 43) in order to learn how to teach effectively and/or to change mathematics teaching. Similarly, Krainer (1998) notes a current international trend in mathematics teacher education, noting that "there are more and more international reports about involving (prospective or practising) mathematics teachers in research projects and integrating research components in teacher education courses where reflection and networking are important dimensions" (p.7). The voluntary participation of student teachers in qualitative research projects has become increasingly popular in several universities across Germany which offer mathematics teacher education programs.

The current trend towards the involvement of student teachers in qualitative research projects which is referred to as "diagnostically enriched didactics" (Peter-Koop, 2001a) has the following characteristics:

1. The student teachers are usually concerned with one sub-question within the entire research project. However, at the same time they become familiar with the research interest, methodology and analysis of a substantial part of, if not the whole, project because they work in co-operation with fellow student teachers who have been involved in the past or also have just become involved in the project.
2. The student teachers have the opportunity to draw their own conclusions and consequences from the research results obtained from their own and their fellow students' involvement. Therefore, they are not solely dependent on research findings described in the literature and/or the lectures.
3. The student teachers become sensitive to empirical findings and the respective research designs. Furthermore, they frequently experience how difficult it is to translate a supposedly simple empirical question into an appropriate research design, how many specifications are involved in the design, and how the findings can be assessed.

It is expected that active involvement in a didactical research project will help student teachers not only to develop a rather imperative perspective with respect to mathematics education in the sense of learning how to teach (best), but also, a diagnostic perspective. In order to manage the variety of different approaches chosen and explored by pupils as part of their mathematical learning process, teachers have to assess how their individual approaches can contribute to and influence classroom discussion. Therefore, teachers need diagnostic abilities on the basis of mathematical subject knowledge as well as knowledge about the social-interactive dimension of mathematics learning. Furthermore, it is a desirable aim of teacher education programs to enable prospective teachers to realise and understand the "universal in the special case" (Brügelmann, 1982) and to approach the special case in a diagnostic way. Such a diagnostic approach is required in the daily practice of classroom teachers. This explains why classroom oriented research (and especially projects that include student teachers as qualitative researchers) should not solely focus on 'typical' effects in the sense of frequent classroom occurrence but also reflect on significant yet less frequent cases. These cases, rather than the common and widespread ones, present crucial challenges for teachers.

Context and Aim of the Investigation

This paper seeks to highlight the potential benefits of the interpretative classroom approach for student teachers. After a brief introduction to the objectives and the development of the interpretative research paradigm and its research methods, data from a student teacher evaluation questionnaire will be discussed.

During the last decade several research projects employing the interpretative approach have been conducted by the two authors of this paper. While Wollring

conducted two larger studies focussing on "Stochastical intuition and forming of concepts of prep and elementary children" and "Spatial visualisation and its encoding in elementary children's drawings" (both studies were funded by the German Research Foundation), Peter-Koop investigated the classroom behaviour and mathematical problem solving processes of highly gifted children in grades 1 - 4. The questionnaire data, which provided the basis for the analysis of student teachers' experiences with interpretative research, stems from a recently completed research project on interactive real-world problem solving strategies of third and fourth graders (children aged 8 - 9 years) that was developed and co-ordinated by Peter-Koop (2001b). These projects are characterised by different content specific research questions, related didactical questions, and largely similar organisation structures. The specific findings of these projects however, are not important for this publication, rather it is that all four projects have been successful particularly because of the participation of student teachers and their research focus on children's own productions (German "Eigenproduktionen", Selter, 1993). Their research involvement enabled the prospective teachers to observe children from a specific didactical perspective.

In Peter-Koop's (2001b) study, the interpretative research paradigm was chosen as the methodological approach and the research design specifically included the participation of student teachers in the data collection in classrooms as well as in the interpretative data analysis. Overall, 23 student teachers participated in the study by investigating sub-research questions as part of their *first teacher state exam* thesis which clearly has a scientific character and which, together with written and oral examinations, concludes the university based elementary teacher based training program.

The student teachers worked in three "generations" during the three 12-month stages of data collection, interpretation, and reporting involved in the entire research study (as is discussed below). The fourth year of the project was dedicated to the collection and meta-analysis of the individual results reported by the participating student teachers and the preparation of a comprehensive research report. Student teacher participation in the project was voluntary and resulted from their prior participation in methods classes, conducted by the project co-ordinator, in which theoretical bases and research literature relevant for the study had been discussed. After the submission of the first state examination thesis, each student teacher anonymously completed an evaluation questionnaire (details of this questionnaire are described below) focussing on the reflection of individual experiences and learning processes in the project.

The research question that guided the data analysis reported in this paper is as follows: How far can student teachers benefit from their participation in an interpretative project and gain insights in classroom interaction and pupils' learning of mathematics in ways that are not available in traditional teacher training programs?

Interpretative Classroom Research

The interpretative research paradigm was developed by Bauersfeld and his colleagues in the 1980s (see Bauersfeld, 1986). They analysed the understanding processes of individuals to detect and classify typical interactional structures of mathematics teaching and learning. Researchers conducting interpretative classroom research seek to investigate typical structures by analysing single cases which are regarded as exemplary. Their focus is the 'universal in the special case' and the goal of the interpretation is to perceive and understand comprehensively the (inter)actions of the observed individuals. According to Voigt (1985), interpretative studies aim "to find how teachers and pupils make sense and establish order of what happens in the classroom. The focus of interest is not primarily on individual, private interpretations, but rather on the natural and mutually controlled patterns of interaction and action" (p. 7).

The significance of the interpretative research paradigm is related to an international trend away from content-based and individual-psychological approaches towards interpersonal human relations in (mathematics) education in the past decade. Current theoretically based research contributions increasingly stress the social dimension of both mathematics (Davis & Hersh, 1981) and mathematics teaching and learning (Steffe, Nesher, Cobb, Goldin, & Greer, 1996) for the development and extension of mathematical knowledge. With respect to qualitative research methods, clinical interviews are frequently criticised for ignoring the influence of the interviewer on the answers and activities of the interviewees. And while there is an international tendency in curriculum documents and educational policies to promote a shift from a teacher-centred towards a pupil-centred classroom, to date, as Voigt had already pointed out in 1996, positive research based descriptions of the new teacher role have yet to be provided. Interpretative classroom based studies that allow the researchers to focus on both the pupils' and the teacher's behaviour and (inter)actions can help to provide such descriptions.

Research Method

Data collection and interpretation phases of studies employing the interpretative classroom approach usually follow a strict procedure consisting of four stages: video recordings, comprehensive transcriptions of the video recordings with respect to either the full document or selected segments of the recording that are relevant to respective research questions, the *sequential interpretation* of the data by a team of four or five individuals, and the *specific interpretation* of the results on the basis of relevant literature and research findings by an individual researcher or student teacher researcher.

In the study of elementary pupils' collaborative problem solving competencies mentioned above, each of the student teachers involved was responsible for the analysis of a specific sub-question in relation to a selected data sample (i.e., in most cases that data sample consisted of the work of one group of children). The general

procedure for data collection and analysis outlined above was enacted in the following way.

Video Recordings

The elementary mathematics classes involved in the study were split into small groups, which were then simultaneously videotaped while solving the set task. Each group was video-taped on four occasions while solving a particular open-ended real word problem. Two student teachers assisted each group. In turns they adopted either the teacher role assisting the group work, if necessary, or they controlled the video recording. This procedure served two purposes: the student teachers could later include their own teacher behaviour in the data analysis, and each group was under teacher supervision during the video recording.

Transcription of the Videotape

Prior to the transcription of the videotape the researcher and the student teacher responsible for the analysis of a particular group work viewed the video document together and identified those segments relevant to the specific research subquestion that should be transcribed in detail for later analysis in addition to the videotape itself. The student teacher then divided the transcripts into small sequences to prepare them for group interpretation with peers. It is important to acknowledge that the transcripts are already an interpretation by the student teacher responsible for their preparation and that a transcript no matter how careful and detailed its preparation is, never exactly duplicates reality. However, the advantage of working with transcripts is that pupils' work and argumentation can be collaboratively analysed and reflected upon at different points in time. It is the discourse of several participants who are involved in the data analysis that ensures multiple interpretations of students' thinking and argumentation and, consequently, a higher degree of validity (Maier, 1991). The specific value of the transcripts as basis for the interpretation in addition to the video recording is discussed in detail in a following section.

Sequential Interpretation

During the *sequential interpretation* the student teacher responsible for the transcript is supported by a group of four peers who are interested in the interpretative classroom research approach and who become fully involved in the project at a later stage. Their participation is also voluntary. The interpretation team considers section after section of the video recording of the pupils' group work and its supporting transcripts, and the individuals offer possible explanations and interpretations for the pupils' verbal statements, actions and gestures. The interpretation process starts with the first small sequence of the video document and or transcript while the rest of the text remains hidden. Once all members of the interpretation team agree that they cannot find any further interpretations, the next sequence of the video or transcript is revealed and the process continues until the entire document is analysed. The intention of this 'sequential revealing' is to ensure

that possible interpretations are neither prematurely excluded nor generalised. The members of the interpretation team become fictitious participants in the situation and can offer temporary suggestions as to how they would have reacted in that situation, or which hypothesis they would anticipate in order to explain what they have just seen, or what they expect to see in the next sequence. Through the successive revelation these hypotheses are continuously filtered and the interaction process can be interpretatively duplicated. The *sequential interpretation* allows multiple perspectives and a high density of interpretations following the principle of validation by consensus as described by Maier (1991).

Specific Interpretation

The next step is a specific interpretation in which the student teacher who prepared the transcript analyses the results of the group interpretation, taking into account relevant research literature. The necessary literature review has been prepared either parallel, or prior to, the sequential interpretation process. Ideally, such an interpretative project involves several 'generations' of student teachers. In this project each generation is based on a network of four or five student teachers who simultaneously develop several case studies regarding the same, or similar, sub-questions by analysing different groups from one class. Each generation tries to implement the findings of the previous generation in its interpretations and then passes on its own findings and – if appropriate – suggestions for the modification of the research design to the following generation. Ultimately, the project supervisor presents, connects and discusses the findings of the several sub-studies in a detailed research report.

Findings - Student Teachers' Learning Processes

In many cases the student teachers' perception of the observed 'classroom research reality' evolves through several phases (Wollring, 1994). Immediately after the recording, the participating student teachers seem to under rate the richness of the pupils' contributions while they tend to over rate their own moderation and instructional abilities. Quite frequently they express their initial disappointment with the quality of the data collection and question the suitability of the data sample for in-depth-analysis. During the first viewing of the video document these perceptions start to change, and the performance of the children involved in the study appears to be richer than first envisaged. This impression often develops during the transcription process when suddenly informative and differentiated perspectives on the observed classroom episode arise. The following interpretative analyses frequently lead to the identification of more differentiated and specialised (research) questions. Furthermore, the research project on collaborative problem solving introduced above is an attempt to integrate research experiences with respect to some of the social aspects of the mathematics classroom and the evaluation of, and reflection on, these experiences in a mathematics teacher education program. Among others, Pateman (1996) highlights the importance and challenges of the social dimension for the teaching (and learning) of mathematics:

> The most difficult question for the future will be precisely how does the teacher of mathematics learn about these social aspects and then use the knowledge to positive effect in creating a classroom in which children learn mathematics. (p. 319)

The value of the participation of the student teachers as teacher-researchers (Peter-Koop, 2001a) is reflected in the self-evaluation of their work. An evaluation questionnaire that was given to the student teachers after the completion of their project (including their teacher state exam theses) addressed the following aspects:

- their individual motivation for their involvement in the project;
- their learning about real-world problem solving and student interaction during group work;
- their experiences with the preparation of transcripts, the data interpretation and the technical requirements of the study;
- the benefits and difficulties of the peer co-operation during the interpretation process;
- their reflection on pupils' learning and their individual teacher behaviour; and
- their opinion on whether the involvement in interpretative classroom research projects should become a compulsory part of the teacher preparation program.

In the following, some of the aspects relevant to teacher preparation that are addressed in the questionnaire with respect to the comments, attitudes and views of the involved student teachers are highlighted.

Motivation for Student Teacher Involvement

All questionnaire responses related to the motivation of the student teachers in one way or another stressed the importance of the "practical orientation" of the project. The following statements from the questionnaires[1] are a representative selection and highlight the practical dimensions of this particular project, that is, the chance to closely observe children in the classroom, student teacher involvement in the data collection, and the opportunity to related classroom based experiences to educational theory.

> I decided to get involved because this project has a real practical orientation and does not only require theoretical work, which I suppose is important as well, like most other topics offered for the state exam thesis.

> This is an innovative project which is related to the reality of the classroom and allows me to work with children in a real classroom situation and to observe their co-operative learning processes.

[1] Originally all student teacher statements were written in German. The quotes included in this paper have been selected and translated into English by the first author with the assistance of a professional translator.

> I became interested in the project because the research design included my own involvement in the preparation and implementation of the data collection as well as its analysis.

Transcripts and Data Interpretation

The preparation of the transcripts turned out to be a critical aspect of the interpretative project. All participating student teachers commented that the preparation of the detailed transcripts of the video data were extremely time consuming and often frustrating, because they had to repeatedly watch short sequences of the videotape in order to record the parallel and consecutive verbal statements, and non-verbal actions of the children involved in the group work. Nevertheless, 18 out of the 23 participants argued along the lines of the two quotes below and stressed the practicality of the transcripts for the *sequential interpretation* together with peers.

> Although the preparation of the transcript was very time consuming and sometimes boring, it turned out to be an important basis for the interpretation, because you have much more time to listen and carefully think about the pupils' remarks and actions than by only watching the video.

> The transcript provided lots of details that you miss by just watching the tape. You can (individually) go back to prior sequences at any time and, for example, directly compare statements.

Several student teachers pointed out that working with the transcripts enabled the interpretation team to focus in detail on how each individual pupil interacted with other group members and how far each individual contributed to the problem solution.

> The transcripts allowed us to see connections that you might miss by simply watching the tape, because it is very difficult to focus on the more 'quiet' children in the group who at first sight do not contribute much to the solution process.

The danger of overlooking and subconsciously ignoring these 'invisible' children in the class (whose contributions are often softly spoken and who do not frequently verbally contribute to the classroom or group interaction) and their achievements and ideas was also noted. Another student wrote that, through the intense viewing of the video document during the preparation of the transcript, she became aware of these children and their often interesting, but 'unheard,' contributions. Another advantage that was pointed out was the recognition that "the members of the interpretation group who never personally met the children involved are less biased", as yet another student teacher expressed it. As mentioned above, among all the obvious advantages of the transcripts, almost all participants from the first two generations in one way or the other commented on the fact that a lot of "unnecessary transcription" had to be done. Unnecessary transcription work was generally perceived when only one or two children speak(s) or interact while the other group members observe these children or view the material provided, or when the children get distracted from the problem and discuss topics not relevant to the solution process such as planned afternoon

activities, soccer results eetcetera. This issue was jointly discussed with the six student teachers who formed the third generation. It was decided to modify the procedure to avoid time consuming transcription work that is either superfluous to the research question because in the corresponding sequences of the video the children become sidetracked from the actual problem or because the intentions of the acting individuals are obvious and therefore do not leave much room for a variety of interpretative approaches. In the modified procedure (which is described above), the student teacher responsible for the transcript and the supervisor watch the whole video recording together in order to decide which sequences will need careful transcriptions and which sections can be interpreted on the basis of the actual video recording.

Peer Co-operation during the Interpretation Process

Since the focus of the broad research study was on interactive learning processes the participating student teachers should experience the benefits of co-operative work. Therefore, they worked in pairs or groups of three during the data collection. Each student teacher was also involved with a group of four peer student teachers who contributed to the *sequential interpretation*. Therefore, peer co-operation occurred on two levels: within the teams of students (generations) who were each responsible for a sub-study within the broad research project co-ordinated by the supervisor, and within the interpretation teams during the sequential interpretation.

The majority of the student teachers clearly expressed satisfaction with the results of the group interpretation and point out that their group worked together well. They stated that their fellow interpreters were reliable (some of the groups worked on the interpretation on several sessions for a total of 30 hours or more), motivated and generated a number of different interpretative approaches to the consecutively revealed sequences.

> It was a good feeling to know you were not alone and solely responsible for the data analysis. During the transcription I realised that there were several sequences in which I really could not figure out what had happened or why the children reacted the way they did. When we looked at them together we usually found several ways to explain the behaviour of the pupils.
>
> The group interpretations worked really well. Everybody was really motivated because we were dealing with authentic classroom data. I was surprised about how many different interpretations were generated with respect to single sequences.

In addition, the first of the two statements highlights an important feature of the interpretative research approach – that is to be part of a network of researchers. The student teachers experience a 'research community' and shared responsibility in contrast to the typical division of labour between the one who sets a task (usually the supervisor) and the one who has to solve it or carry it out (the student).

Since the project was 'advertised' with a strong emphasis on the co-operative aspects and conditions, most student teachers already came in pairs or small

groups for the first consultation with the supervisor. Prior to their involvement, they had already carefully considered which partner they wanted to work with more closely, whilst the supervisor was responsible for the selection of the peer students for the interpretation team. Apart from minor problems (see the quote below), this procedure proved to be successful and reliable.

> Sometimes I felt a bit left out during the group interpretation, because my team members knew each other really well, but I was very happy with the results. The co-operation with my partner (who is my best friend) in the classroom situation worked really well.

Reflection on Teacher Behaviour and Pupil Learning

Apart from the research perspective, an additional aspect of the involvement of student teachers in the data collection and interpretation was the opportunity for them to reflect on their individual teacher behaviour, their relationship with elementary children, and on the children's learning. These reflections on the data interpretation turned out to provide important and powerful insights for the majority of the student teachers involved. The following representative statements reflect the strong impact of the outcomes of the interpretative analyses on student teachers' attitudes and knowledge about interactive learning processes in mathematical problem solving, as well as the role of the teacher:

> It is quite stressful to see your instructional mistakes over and over again during the process of transcription and its subsequent interpretation, but it makes you aware of the fact how easily you can misunderstand and even confuse a child and distract him or her from a possibly correct and meaningful path.

> I realised to what a large extent children draw upon their previous in- and out-of-school experiences and try to make use of these experiences with respect to the problem to be solved. I was very much surprised at what kind of strategies and ideas children develop in order to overcome difficulties that they are confronted with while trying to solve a problem. Children often think completely differently from adults and try to make sense of mathematical, natural or social phenomena that they come across.

> I learned that children can achieve very much without the well meant, but often superfluous, assistance and support of the teacher or other adults. I gained confidence in the willingness and ability of children to learn and to master a problem (that they perceive as relevant).

> It also became clear to me that children need time to work on a problem without being disturbed or distracted.

These illustrative comments offer valuable insights regarding their future profession and classroom practice. Most importantly, these insights are meaningful starting points for further learning about how to teach, because they are actively constructed or developed from personal experiences, observations of, and reflections, on one's own classroom interaction and behaviour, in contrast to knowledge about teaching acquired through professional reading and/or lectures and seminars.

Conclusion

In summary, the student teachers' responses to the evaluation questionnaire suggest that the benefits of the interpretative classroom approach, with respect to teacher preparation, can be seen on three different levels, which, of course, may partly overlap.

Firstly, student teachers learn about an important aspect of elementary mathematics, in this particular case real-world problem solving, while their personal experiences and reflections as well as their interpretative analyses are based on authentic classroom episodes.

Secondly, the above mentioned statements demonstrate that the student teachers learn to "listen" to pupils' thinking and interactive problem solving strategies. All student teachers indicated that they appreciated their involvement in this interpretative research project, because it provided them with opportunities for intense observation of children and children's learning. The student teachers deal with, and reflect on, real examples of pupils' behaviour, learning, and interaction, which seem to be more powerful than examples reported by the lecturer (Jungwirth et al., 2001). In other words, through their involvement in this as well as the other interpretative studies mentioned above, the student teachers acquired *foundations of didactical decisions* in their future mathematics classrooms – and not simply decision patterns.

Finally, research designs based on the interpretative approach can enable the involved student teachers to learn about themselves as teachers. During the interpretation stages most student teachers used the opportunity to reflect critically on their individual classroom behaviour, interaction and instruction skills that became evident during their assistance of the pupils' group work. This particular aspect was highlighted in the student teachers' responses to the final question of the project evaluation questionnaire, dealing with whether involvement in an interpretative classroom research project should in the future become a compulsory element of the mathematics teacher education program. Only two out of the 23 participating student teachers expressed concern about the extra time and effort required. The vast majority argued that, from their personal experience, they could recommend the inclusion of such a project into mathematics teacher education programs. The following concluding statement, which is representative for the majority of the replies, highlights the importance of active involvement and the opportunity for personal reflection for the individual student teacher:

> In my opinion interpretative analyses are an important addition to lectures and school practice. But you have to conduct the teaching yourself, be responsible for the transcription and actively involved in the interpretation of your transcript. Only then you can find out how well you can relate to children, learn about your mistakes and how children react to you.

Informal observations of, and discussions with, the participating student teachers in several interpretative studies, lead the authors to believe that their active engagement in qualitative research helps them to connect theory and practice with respect to mathematics education – in other words "theory is enlightened by practice" as Jungwirth et al. (2001) characterised the outcomes of

interpretative studies for the involved (student) teachers. This experience will hopefully not only make student teachers more appreciative of research reports in professional journals and research monographs, but also enable them to apply interpretative approaches on a smaller scale in areas that they personally identify as interesting and important in their own classrooms. Despite a current lack of studies on the development of teachers who during their initial training participated in interpretative classroom research, one can hope that these teachers develop continuing interest and activity in conducting research in their own classrooms.

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