

**HELGA JUNGWIRTH, HEINZ STEINBRING, JÖRG VOIGT, BERND WOLLRING**  
**INTERPRETATIVE CLASSROOM RESEARCH IN TEACHER EDUCATION**

**1. Introduction**

Over the last few decades the didactics of mathematics has been established as a scientific *discipline* in tertiary education in German speaking countries. The application of standard scientific approaches can however lead to an unsatisfactory *discrepancy between theory and practice*. This discrepancy manifests itself in teachers as a loss of confidence in the didactics of mathematics as they were promised that the direct application of scientific results would help them to optimise their teaching practice. Interpretative studies in teacher education programs therefore offer a possibility to connect theory and practice by preventing a "short circuit" between them. The understanding of practical classroom activities prior to their assessment and the acquisition and application of theoretical knowledge in practice, appear to be of crucial importance. Interpretative studies rely on detailed documentation of authentic teaching and learning situations for analysis and reflection. They aim to reveal what is hidden in practice and what is important and what one has to understand in order to change mathematics teaching, e.g. subconscious routines, gender specific problem solving strategies, implicit beliefs and attitudes towards school mathematics or intuitive conceptions. Interpretative studies in teacher education programs intend that theory makes practical sense for pre-service and in-service teachers.

The participating teachers and student teachers can experience how scientific analyses may help them to enlighten those aspects of their classroom practice that they perceive as important. At the same time we as teacher educators are forced to relate our research work directly to practical classroom situations. Interpretative studies are based on certain theoretical hypotheses. The authors share the understanding that mathematical symbols and manipulatives as well as classroom actions etc. do not have a meaning per se. The meanings which students and teachers attach to them and their practical approaches have to be investigated. Among other factors the teaching and learning of mathematics is determined by students' and teachers' subjective interpretations of meaning, their beliefs and attitudes towards mathematics and by personal processes that create inter-subjectivity. The analysis of respective documents requires interpretative approaches in addition to the mathematical investigation. Therefore, we interpret the documents, mainly video recordings or transcripts (protocols of spoken text and non verbal actions) resulting from classroom situations or diagnostic interviews and learning experiments, in co-operation with teachers and student teachers.

**2. Different foci and forms of studies**

Interpretative studies in German speaking teacher education programs have different foci.

- In *interaction analysis* the inter-personal processes between teacher and students and between individual students are investigated on the basis of pre-existing documents. For example, the question of how spontaneously the teacher reacts to mathematical statements from the students and what kind of effects these reactions have on the students (JUNGWIRTH, 1991, VOIGT, 1995).

- In the *practical interaction study* the participants of a preservice or inservice session are asked to work with students and to document the observed interactions before they analyse them. For example, by working with a small group of children student teachers are requested to enable and encourage children to draw on their prior experiences when dealing with difficult mathematical problems. The student teachers produce transcripts of the corresponding video tapes and analyse these in working groups.
- In *epistemological classroom analyses* the systematic study of school mathematical knowledge in everyday teaching and learning processes is the focus of interest. In contrast to the above mentioned studies the epistemological analysis concentrates more on the features of the (mathematical) topic of a classroom discussion than on the characteristics of the discussants and their reciprocal influences. For example, the modes of representation of mathematical knowledge (eg. geometrical, functional and context related representations) students choose in comparison to the teacher and what significance the modes of representation gain for the understanding of the mathematical topic are investigated (STEINBRING, 1997).
- In the *communication analysis* the language of discourse in the classroom has high significance. Such studies for example explore the extent to which students misunderstand the language of the teachers, because the students cannot attach the intended mathematical meanings to the teacher's words but rather their meaning in everyday life (MAIER, 1991).

In the *diagnostic interview*, the research interest is focussed on the interviewed person rather than on the interpersonal processes between this person and the interviewer. The diagnostic interview can be considered as a part of interpretative classroom research when the analysis of the interview is based on interpretative methods. For example, student teachers are investigating the reasons for learning difficulties of individual children. The analysis of the documented interview does not then aim at assigning of the interviewed child to a certain category from a previously determined list and according to given behavioural criteria but rather, the individuality of the child and his/her inner world of imagination are the subject of the investigation (WOLLRING, 1994).

### **The importance of the documents**

Independent of the individual research focus, interpretative studies are based on audio-visual documents or rather, their transcripts.

#### ***Some advantages of documentation.***

BAUERSFELD (1986), among others, describes the following advantages of the use of video documents and transcripts in teacher education:

- One can react to classroom (inter)action in a detached and reflective way because other than the classroom participant, one is not exposed to continual assessment and decision making pressures.
- The documents can be viewed as often as required. One can change the focus of attention without being dependent on one's memory. In particular, one can break away from the bias resulting from routine interpretation patterns that have developed in one's own classroom practice.
- Structures of incidents which are either hidden or too obvious can be revealed. The backgrounds of individual actions, interactive processes and mathematical topics can be related to evidence from the documents.

- The sensitive multi-layered interpretation of student activities which the teacher involved would perceive as vague or accidental, can yield new insights into the students' world of imagination.

### ***Viewing a document from a variety of perspectives***

After an extended analysis the advantage of the use of documents becomes clear to the participants once their progress in understanding is contrasted with their first impressions. Nevertheless, one should not expect that the analysis of the documents will lead to an objective judgement of subjective ideas from the individuals observed.

During the course of the analysis, one becomes more conscious of the *dependence of the interpretation on preconditions* because the analysis of the documents by a group of interpreters generally leads to a variety of interpretations which may contradict each other or challenge reasons which are either related to empirical evidence or theoretical assumptions. In this respect the interpretations become more and more objective but they will always remain incomplete.

The variety of interpretations of a document implies a special advantage for teacher education, because university based teacher training is characterised by a co-existence of several disciplines: mathematics, educational sciences, psychology etc. In the analysis of a document, the *different content related perspectives* can be related to one another.

### **3. Experience-based learning**

Arrangements that allow teachers or student teachers an experience-based learning have a special significance. The participants evaluation of the interpretative studies is intensified through the direct reference to their individual role and experiences. Furthermore, in this way the danger that participants deny the relevance of the results of the analysis for their professional practice is minimised. The use of transcripts of video recordings from external sources may increase the risk that the participants will not immediately identify with the observed participants, in the sense that something similar could happen to themselves. In this case they deny the analysis of the external document, arguing that they would not act as the observed teacher.

The following experience-based arrangements have been used so far:

The classroom discussion that will be the subject of analysis is produced on the spot in the form of a *free role playing game*: one participant acts as the teacher and several others as the students. Our experience shows that the participants reproduce typical routine classroom situations. In this way the analysis of the material allows the participating teachers to transfer the role playing situation to their own teaching. Nevertheless, two disadvantages of this arrangement have to be considered: The transcript has to be produced on the spot in a very short time, in order to allow a detailed analysis by the participants. Therefore, in general only a raw transcript covering some salient segments can be provided. Another disadvantage is that the teachers easily tend to exaggerate the behaviour of the students.

Another type of *classroom simulation*, which brings to life the experiences of the learners, allows the participants to almost unconsciously adopt the role of the student. The inservice session starts in the form of a lecture and then without further announcement funnels into a narrow discussion that is otherwise only usual in a classroom lesson.

Another form of the role playing game in teacher education requires the participants to prepare and act out a *lesson feedback session* based on the joint analysis of the transcript. Small groups of participants develop the individual roles of the professionals involved in the feedback session: the teacher concerned, a colleague etc. The advantage of this form resides in the fact that the participants think about their traditional teacher perspectives through the different roles that they adopt and that some roles require them to relate characteristics of the documented lesson to general backgrounds beyond the school environment.

An arrangement that allows the participants to personally *experience the mathematical problems* of a particular teaching unit arises when the participants themselves are confronted with the mathematical content, eg when they are asked to solve a given problem in groups. In this arrangement it may become clear which different basic ideas learners use to approach mathematical problems, how brittle and incomplete the understanding of new content is under the surface of the true/false-decisions of the teacher, or which diverse effects the teacher's assistance and explanation can have on the learners (VOIGT, 1993).

#### **4. The modified relationship between theory and practice**

The relationship between theory and practice has been a virulent and much lamented and discussed problem in mathematics education. Empirical investigations of the practice of teaching and learning of mathematics have the advantage that they relate scientific theories and concrete phenomena to each other. Nevertheless, the sole communication of the results of empirical studies to participants of teacher education seminars and the use of transcripts as only illustrative materials would create a distance between scientifically oriented teacher pre-service and inservice programs and classroom practice.

Therefore, in our opinion it is crucial that the participants themselves gain insights through the analysis of transcripts and that their practical experiences are addressed.

In this way the subsequent transfer of these insights to their own teaching practice appears to us to be more likely. This is especially valid if the transcripts are documents of their own interaction with learners. Before we discuss the modified relationship between theory and practice in our teacher education seminars we would like to quote a student who recounts her experiences from the interpretation of her own interviews with children (SORGER & WIECHMANN & WOLLRING, 1994):

"To a lesser extent in the interview situation but more so during the analysis of the interviews I have gained important insights into the behaviour of children and the interaction during a discussion in general which cannot be recognised in the course of a lesson or an interview. Only during the retrospective viewing of a video recording did I become aware of processes which for various reasons could not be perceived at the time of their occurrence. ... The insights that we have gained from the empirical work and the scientific work in general have fundamentally changed my attitude towards literature and the publication of research studies in general. Not only do you contemplate studies more critically, but also you recognise and acknowledge all the work involved. Within my work it was also necessary to review all of the literature relevant to our topic. The knowledge that we obtained in this way had a direct practical dimension and did not solely aim to reproduce what we had read."

### ***The relationship between research and teaching***

The special merit of interpretative methods in contrast to other research methods is that the pre-service teachers can establish connections between the action of evaluation and their everyday competencies at interpreting.

With the first teacher state exam theses some *exam groups* contribute results to the research projects of their supervisors (see SORGER & WIECHMANN & WOLLRING, 1994). The single thesis for example consists of the design, the documentation and the analysis of diagnostic interview with three pupils in response to a given mathematics education research question. Participation in research projects yields a special motivation. The exam candidates are prepared to independently access difficult literature because in this way they gain new knowledge in the understanding of documented practice. They can see the benefits of their work not only in their personal qualification but they also comprehend their work as a contribution to mathematics education and therefore consequently for the improvement of mathematics teaching and learning.

In addition, our co-operation with *regular groups of teachers* in inservice sessions results in a productive connection between research and teaching (VOIGT, 1991; von HARTEN & STEINBRING, 1991). The teachers prepare recordings of their own lessons which they offer to a group of teachers for joint analysis. The inservice facilitator can use the documents for his/her further research and gains a special insight into the knowledge and beliefs of teachers through the joint interpretation. The benefits for the teachers include the opportunity for reflection on their own teaching, the acquisition of a professional vocabulary used to describe teaching and learning processes and the experience that classroom practice can be viewed from different perspectives. Some teachers publish the transcripts of their lessons and describe their personal experiences in addition to our scientific analyses (KÄMMERER, 1987; MÖRCHEN, VOIGT & MÜNZINGER, 1991).

### ***Enlightenment through individual interpretation rather than through practical models and scientific technology***

It is a characteristic of the hermeneutical tradition of interpretative studies that the universal in the special case should be highlighted. From this result two arguments, of which the first one is particularly relevant to teacher professional development and the second for teacher pre-service training. Firstly, the generalisation of interpretatively gained statements does not mainly occur through the expertise of the scientists but rather develops in the "head of the participant". The participants have to relate the results of analysis to their own professional practice. Therefore, we select special arrangements for experience-based learning. The interpretation of the document of a student activity or a classroom situation is (implicitly) a reflection on the students and on classroom practice of the interpreting teacher. In the successful case, this externally produced document works like a mirror in which the interpreting teachers can recognise themselves and their students. Secondly, the "universal in the special case" not only implies the generalisation of empirical statements, we also select the cases in a way that theoretical knowledge can be exemplarily explicated during the interpretation. The theoretical knowledge should serve as a "pair of glasses" with which one can recognise something in further cases that would otherwise not have been seen. In this respect, interpretation is not about the (general) validity of an empirical statement, but rather about the prerequisites required in order to make such a statement. For example, instead of only seeking for empirical indications regarding the decision as to whether the observed student (or many students)

really understand(s) a mathematical problem in a certain way, the question is which theoretical ideas of the cognitive and epistemological development of mathematical knowledge lead us to this presumption.

Opposed to our objectives as inservice co-ordinators to help the participants to deepen their research-based reflection on teaching, is often their expectation that by dealing with concrete examples they can learn how (not) to behave as a teacher. In order to mediate between the interests of the participants in practical classroom ideas and the intentions of the inservice co-ordinators the following measures present themselves. They are based on the fundamental objective of teacher education that both the *enlightenment* through analysis and reflection and the *hands-on approach* require practical suggestions and individual ideas:

- One contrasts two qualitatively different episodes which allow comparison according to the topic of the inservice session. Our experience shows that after intensive analysis the picture painted does not remain black and white, but rather advantages and disadvantages are recognised in the light of the contradictory sets of goals underlying the mathematics lesson.
- One selects classroom examples in which the teacher shows a special effort to realise desired mathematics teaching and learning. The detailed explanation of the teacher's intentions prevents the participants from measuring the lesson against goals other than the ones intended. Nevertheless, according to our experience the tension between intention and reality is especially highlighted.
- Cases are being analysed in which new tasks and classroom ideas of the facilitator shall be realised. One notices that constructive didactical suggestions do not function in the sense of technological measures, but rather that the determining factors are implicit teacher attitudes towards mathematics and mathematics education, classroom routines and the interactive dynamics of the classroom.
- One reserves a phase of the seminar for the development of the didactical creativity of the participants through the preparation of alternatives which is supported by suggestions from the facilitator. This can already be achieved on a small scale by revealing the document only up to its key point. Before the participants are confronted with the continuation of the episode they are asked to consider how they themselves would have continued the lesson.

## 5. Conclusions

Originally our interpretative studies were conducted for the purposes of research projects. The motivation to go along new paths in teacher education remained only in the background of our work. Consequently, during our first attempts to realise interpretative studies in teacher education courses we had to change our views and connect the search for new scientific insights with practical education interests. The specific conditions and purposes of teacher education require modified procedures and standards of interpretative work. In summary, interpretative studies in teacher education are guided by the following goals:

- The relationship between theory and practice shall be highlighted in the analysis of different cases. The understanding of theory and the understanding of practice appear to be two sides of the same coin.
- In the cases to be analysed, what is universally valid should become clear and should be connected with the individual experiences of the participants. Therefore, the selection of cases and the arrangement of the teacher education seminars are crucial elements.

- The teachers participate as "researchers" (ALTRICHTER & POSCH, 1990) in the analysis of (their own) teaching. The teacher is regarded as a "reflective practitioner" (SCHOEN, 1983) who also in his/her daily classroom practice constructs and evaluates interpretations of classroom incidents, even when these interpretations are intuitive and made under the pressure of the need for an instant response in the classroom situation. The teacher would be overlooked and the relationship between theory and practice would be short-circuited, if the discovery of the "rules of teaching and learning" by methods used in the natural sciences would result in scientifically grounded "technological" measures, which the practitioner only has to apply.
- Corresponding to the insight that mathematical education is not solely determined by mathematical content but also by classroom processes, the interaction between facilitator and participants has an important function. The joint interpretation is, in the sense of an analogy, supposed to be exemplary for classroom interaction, so that in addition to the explicit education of the participants a desired "habitus" of (future) teachers is also supported (BAUERSFELD, 1993).

## REFERENCES

- ALTRICHTER, H. & POSCH, P. (1990). *Lehrer erforschen ihren Unterricht. Eine Einführung in die Methoden der Aktionsforschung*. Bad Heilbrunn: Klinkhardt.
- BAUERSFELD, H. (1986). Warum Interaktionsanalysen in didaktischer Forschung und Lehrerfortbildung? In H. Bauersfeld, J. Voigt & W. Münzinger (Eds.), *"Habt Ihr das immer noch nicht kapiert?" - Fachspezifische Interaktionsanalysen für Schule und Unterricht* (pp. 10-19). Kassel: Hessisches Institut für Lehrerfortbildung.
- BAUERSFELD, H. (1993). Die Tragödie der Grundschullehrerausbildung. In H. Bauersfeld & R. Bromme (Eds.), *Bildung und Aufklärung - Studien zur Rationalität des Lehrens und Lernens* (pp. 16-41). Münster: Waxmann.
- HARTEN, G. von & STEINBRING, H. (1991). Lesson transcripts and their role in the inservice training of mathematics teachers. *Zentralblatt für Didaktik der Mathematik*, 23 (5), 169-177.
- JUNGWIRTH, H. (1991). Interaction and gender-findings of a microethnographical approach to classroom discourse. *Educational Studies in Mathematics*, 22 (3), 263-284.
- KÄMMERER, E. (1987). Energieverschwendung beim Kochen - Die Odyssee einer "praktischen" Aufgabe. In W. Münzinger & E. Liebau (Eds.), *Proben auf's Exempel. Praktisches Lernen in Mathematik und Naturwissenschaften* (pp. 154-169). Weinheim: Beltz.
- MAIER, H. (1991). Analyse von Schülerverstehen im Unterrichtsgeschehen - Fragestellungen, Verfahren und Beispiele. In H. Maier, J. Voigt (Eds.), *Interpretative Unterrichtsforschung* (pp. 117-151). Köln: Aulis.
- MÖRCHEN, U. & MÜNZINGER, W. & VOIGT, J. (1991). Die geöffnete Klassentür. Zeitrechnung im Mathematikunterricht. *Praxis Schule*, 2, (1), 49-53.
- SCHOEN, D. A. (1983). *The reflective practitioner*. London: Temple Smith.
- SORGER, P. & WIECHMANN, B. & WOLLRING, B. (1994). Qualitative empirische Studien - Evaluation der Arbeitsformen eines von Studierenden mitgetragenen Forschungsprojektes. In K. P. Müller (Ed.), *Beiträge zum Mathematikunterricht* (pp. 358-361). Hildesheim: Franzbecker.

- STEINBRING, H. (1997). Epistemological investigation of classroom interaction in elementary mathematics teaching. *Educational Studies in Mathematics*, 32 (1), 49-92.
- VOIGT, J. (1995). Thematic patterns of interaction and sociomathematical norms. In P. COBB & H. BAUERSFELD (Eds.), *The emergence of mathematical meaning - Interaction in classroom cultures* (pp. 163-201). Hillsdale: Lawrence Erlbaum.
- VOIGT, J. (1993). Die Rolltreppenaufgabe - Lehrern gestellt. In K. Krainer et al. (Eds.) *Erklären, Verstehen, Mißverstehen von Chemie und Mathematik* (pp. 146-152). Kassel: Hessisches Institut für Lehrerfortbildung.
- VOIGT, J. (1991). Die mikroethnographische Erkundung von Mathematikunterricht - Interpretative Methoden in der Interaktionsanalyse. In H. Maier & J. Voigt (Eds.), *Interpretative Unterrichtsforschung* (pp. 152-175). Köln: Aulis.
- WOLLRING, B. (1994). Fallstudien zu frequentistischen Kompetenzen von Grundschulkindern in stochastischen Situationen - Kinder rekonstruieren verdeckte Glücksräder. In H. MAIER & J. VOIGT (Eds.), *Verstehen und Verständigung* (pp. 144-181). Köln: Aulis.

Dr. Helga Jungwirth  
Universität Linz  
Abteilung für Didaktik der Mathematik  
Altenberger Str. 69, A-4040 Linz

Prof. Dr. Heinz Steinbring  
Universität Dortmund  
Fachbereich Mathematik  
Vogelpothsweg 87, 44227 Dortmund  
heinz.steinbring@mathematik.uni-dortmund.de

Prof. Dr. Jörg Voigt  
Westfälische Wilhelms-Universität Münster  
Institut für Didaktik der Mathematik  
Einsteinstr. 62, 48149 Münster  
jvoigt@math.uni-muenster.de

Prof. Dr. Bernd Wollring  
Universität Gesamthochschule Kassel  
Fachbereich 17 - Mathematik / Informatik  
Heinrich-Plett-Str. 40, 34132 Kassel  
Wollring@mathematik.uni-kassel.de