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INTERACTION AND GENDER – FINDINGS OF A MICROETHNOGRAPHICAL APPROACH TO CLASSROOM DISCOURSE

ABSTRACT. The aim of the present study is to reconstruct teacher–student acting to find out whether there are gender-specific methods of managing classroom situations and gender-related patterns of interaction. The findings reveal that over the long run the gender of the participants is immaterial. There are, however, gender-related modifications of the ordinary interaction patterns. They result from gender-specific practices on the part of the students and from the corresponding actions on the part of the teachers. Five types of gender-related modifications have been reconstructed. The methods which enable students to participate successfully in the interaction process have become more common for the boys than for the girls. Therefore the boys appear more mathematically competent than the girls.

BACKGROUND OF THE PRESENT STUDY

The interaction pattern in the mathematics classroom is an important factor in the examination of gender-related differences in attitudes towards mathematics and mathematics achievement (cf. Armstrong, 1982; Boswell, 1985; Brush, 1985; Fennema and Sherman, 1977, 1978; Hanna, 1988; Joffe and Foxman, 1988). There are numerous studies that deal with interaction in the math classroom. The aim of these studies is to compare the frequency of specific types of teacher interactions with females and males (Becker, 1981; Fennema and Reyes, 1981; Frasch and Wagner, 1982; Leinhardt, Seewald and Engel, 1979; Öhler, 1989; Parsons et al., 1980; Stallings, 1979).

For example, in Becker's analysis of ten high school geometry courses (each with an equal male-female ratio), teachers asked males more questions, particularly more process questions, gave them more feedback after a partially incorrect answer, initiated more non-academic contacts with males, and directed about two thirds of their encouraging comments to males. The female students received nearly all of the non-encouraging or discouraging comments that the teachers made. Observation of the students' behaviour showed that males called out answers more often than females and were much more active in initiating informal contacts with the teacher. Females tended to ask more public questions than males.

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Because of their differing observation categories and designs, other studies have achieved other results . . . in detail. On the whole, however, the findings come to the same thing (apart from the study of Parsons et al., 1980): in nearly every observation category teacher-male interactions are more frequent than teacher-female interactions.

These studies provide insight into the interaction processes in the mathematics classroom, but nevertheless leave several areas unexplored. First, the observations generally concentrate on the behaviour of the teachers; there are few findings about the behaviour of the students. Second, the behaviour of the teachers is not related to the behaviour of the students and vice versa. The behaviour of one is analyzed in isolation from the behaviour of the other. Therefore the development of the interaction cannot be revealed. For example, we don't learn how students actually solve a problem guided by the teacher. What clues does the teacher give? How do the students interpret and make use of them? To which helps does the teacher feels compelled by the reactions of the students? And how do the students react to this help? We do not see whether girls and boys participate in problem solving differently, and if they do how is the teacher-female interaction structured in comparison with the teacher-male interaction.

Relevant questions with regard to the development of the students' relation to mathematics are not answered in these studies: for instance, how students and the teacher manage problem-solving so that it is successful on the whole despite incorrect answers on the part of the students.

Some Typical Features of Interaction Analysis with Respect to Gender

The shortcomings of the cited research become clear when the backgrounds of thinking about the research object are considered.

First, the analysis of interactions is based on a particular concept about the way the interaction contributes to gender-related differences in the relation to mathematics. The concept is the "differential socialization" model (cf. Schenk, 1979). According to this model girls and boys are treated differently in various respects by their socialization agents and therefore acquire different attitudes and modes of behaviour. Thus gender-related differences in the realm of mathematics are due to the gender-differentiated treatment children experience in the context of mathematics learning. The majority of the researchers suggest that girls get too little attention and too little support in the mathematics classroom to develop a lasting interest in mathematics. As a consequence of using this model, one observes mainly the behaviour of the teachers.

Second, these studies are based on a certain understanding of mathematics education and mathematical knowledge. This understanding contributes to the focus on teacher behaviour and the omission of the interaction between the students and the teacher. Implicit in the model is the assumption that an objective mathematical knowledge exists and that the learning of this knowledge is guided by the teacher. It may be that the "socratic method" of asking questions (cf. Voigt, 1989b) is considered the norm by the researchers. In any case the teacher's direction towards "true" knowledge through the use of questions, clues, and appropriate feedback is important.

This model of mathematics instruction is embedded in a certain concept of social interaction. Everything that happens in a social interaction is determined by the behaviour of the individual participants, especially by that of the dominating participants. The behaviour itself is determined by intrapersonal and or external factors (attitudes, needs, social norms, or role expectations). The interaction is only the social "place" in which the true determinants operate. What happens is the "sum" of the behaviour of the individual participants respectively the sum of its determining factors. Therefore the behaviour of different persons may be analyzed separately. In this model of interaction there is no assumption that the participants in an interaction interpret the actions of the vis-a-vis as well as the whole situation, and design their own actions on the basis of these interpretations. Without this assumption it makes sense to fix the observation categories before the observation starts and it is possible to assign the observed modes of behaviour to the categories. To illustrate, it does not come into mind that a student could interpret a "process question" not as a request for explaining the calculation, or giving reasons for its correctness, but as a call for repeating the technical procedure, and that the teacher could nevertheless appreciate the student's answer and thereby confirm the new status of the question as a "product question".

In sum it seems that interaction analysis based on this background can hardly gain insights into the microstructures of interaction in the math classroom, structures that might be particularly relevant to understanding the distanced attitude of women towards mathematics. There is some evidence that mere *quantitative* differences in teacher behaviour according to the gender of the student the teacher interacts with are not enough to account for the differences in student attitudes or achievements. Instead, the *quality* of the interaction seems to play an important role (Eccles and Blumenfeld, 1985; Schatz-Koehler, 1985). This leads some researchers to suggest a broadening of the theoretical basis of the interaction research and an application of new methods: "Thicker description with more attention to qualitative aspects of classroom events is also needed. Research using the Brophy-Good dyadic interaction coding system and similar systems for low-inference recording of discrete behaviors that occur frequently in classrooms have produced useful information . . . but they do not allow for capturing the subleties and qualitative aspects of classroom events that are important for studying gender-related issues" (Brophy, 1985, p. 137).

The study[1] tries to do away with these shortcomings. The aim is to reconstruct the acting of the teacher and the acting of the students in their mutual relation. This means that a new path is being taken in the analysis of gender-specific aspects of interaction in the mathematics classroom.

DESIGN OF THE PRESENT STUDY

Theoretical Background

This study relies on microsociological approaches stemming from constructivist scientific theory: symbolic interactionism and ethnomethodology (Blumer, 1969; Bergmann, 1981; Garfinkel, 1967; Goffman, 1959; Wilson, 1970). These are based on the following assumptions: People construct subjective meanings for things, but nevertheless arrive at a common reality and at a knowledge which is experienced as universally valid. The commonly accepted valid meanings are the result of social negotiation processes. As a consequence, social interaction establishes the reality to be analyzed.

From this point of view mathematics education is a negotiation of meaning too. On the basis of this approach interaction in the mathematics classroom has successfully been analyzed for some years now (Bauersfeld, 1985, 1987; Bauersfeld, Krummheuer and Voigt, 1988; Cobb, 1988; Krummheuer, 1982, 1983; Voigt, 1984, 1985, 1989a, 1989b).

Aims

The theoretical approaches developed in the course of research on mathematics teaching lead to the following research questions:

- Do teachers and students have gender-specific practices for mastering the classroom situations?
- Are there gender-specific schemata of interpretations of themes and situations?
- Do the interactions, female teacher-girls, female teacher-boys, male teacher-girls, male teacher-boys, show typical patterns?

The starting point of the analysis is the gender of the participants. Actions and interpretations reconstructed on the part of one gender are classified as typical for that gender without regard to correspondence of the findings with the gender-role stereotypes.

In the present study a further theoretical assumption is made. Within the interaction process, not only the official mathematical knowledge is constituted but also images of how "good" a student is at mathematics. All participants in the interaction, the teacher and the students, contribute through their actions to the result – whether the students successfully or unsuccessfully manage the classroom situation. In other words: mathematical competence on the part of the students is established in the interaction. The question of gender-related differences in this respect is investigated as well.

Method

The aim and the methods of any study result from the underlying theoretical concepts. In this study the analysis consists of the reconstruction of aspects of the reality constructed by the participants of the interaction. In the reconstruction the attempt is made to see, on the one hand, the events from the participants' point of view. On the other hand, the aim is to show patterns in the actions, and in the structure of the interaction, that cannot be gained from the participants' interpretations only. In a manner analogous to the constructions of the participants in the interaction, the reconstruction is based on the interpretations of the researchers.

The basic data involved in this analysis are audio and video recordings from three to five successive mathematics lessons in eleven Austrian grammar school classes. The grades range from five to twelve and are, of course, co-educational. Transcripts of the lessons recorded build the basis for the interpretation. This follows the orientations developed in the research on mathematics teaching (cf. Bauersfeld, Krummheuer and Voigt, 1988; Voigt, 1984). The results are gained by applying interpretation hypotheses developed at singular interaction sequences to other comparable sequences. These are, in turn, transformed into final interpretations.

As the extent of the data shows the present study is not only a case study. However, general validity of the results is not demanded. Such a demand would not correspond with the theoretical basis stemming from constructivism and interactionism, as could be shown in a detailed epistemological analysis. According to the underlying concepts the inter-subjectivity of the results is a product of negotiations too.

RESULTS: GENDER-RELATED MODIFICATIONS OF INTERACTION SEQUENCES

The present analysis confirms the result of many other investigations (cf. Hoethker and Ahlbrand, 1969; Hopf, 1980) that mathematics lessons are usually organized in the form of conversations following the tripartite elicitation-response-evaluation scheme: the teacher asks a question, a student answers and the teacher evaluates the answer (cf. Streeck, 1979). Thus the teacher doesn't hold a lecture but forces the students into active participation in the lesson. Analyses of the microstructure of the interaction have shown that there are several recurring patterns of interaction in mathematics lessons organized in this form (Voigt, 1984, 1985, 1989a, 1989b).

In the observed lessons, episodes where new concepts or problems are introduced as well as episodes where exercises are done or definite solutions are repeated are organized in this manner. Over long periods the gender of the participants doesn't play a role. Both female and male teachers and girls and boys act so that the typical patterns are established.

There are, however, modifications of the ordinary interaction patterns. These differ according to the gender of the participating students. The gender of the teacher doesn't matter. This latter result is in accord with other findings about the behaviour of female and male teachers which maintain that there are only a few differences between female and male teachers. In short, female teachers tend to be more student-centred, indirect and supportive of students than male teachers. In general, however, female and male teachers are much more similar to each other than different (cf. Brophy, 1985). The modifications of the typical patterns result from gender-specific student practices. The modifications also result from the actions of the teachers in correspondence to the students' actions. Teachers have gender-specific practices that they use only in (certain) interactions with girls respectively with boys.

Modifications in the interaction between the teacher and the boys can be regarded as variations of the ordinary patterns because the basic structure, "one adjusting to the other," of the tripartite sequences is maintained. Modifications established in the interaction between the teacher and the girls, however, can be interpreted as clear deviations from these patterns because the adjusting process fails; the smooth running of the interaction process is obstructed or interrupted.

Five types of gender-related changes of interaction sequences have been reconstructed. Except for the second type which is related to a certain topic appearing only in four classes, all the types of modifications could be reconstructed in all eleven classes.

The five types are:

- the "blocking the task-constitution" in the teacher-girls interaction
- the "blocking the reference to knowledge outside mathematics" in the teacher-girls interaction
- the "too complete description" established in the teacher-girls interaction
- modifications of the managing of failure: the "concealing of failure" in the teacher-boys interaction and the "emerging of failure" in the teacher-girls interaction
- modifications of "establishing a desired answer": the "argumentative insistence on the desired answer" in the teacher-boys interaction and the "authoritative insistence" in the teacher-girls interaction

In the following paragraphs an outline of these types is given.

The "Blocking the Task-Constitution" in the Teacher-Girls Interaction

In periods where new mathematical concepts are introduced or new tasks are solved, specific patterns of interaction have been reconstructed (Voigt, 1984). One of them is the "elicitation pattern." At its beginning, that is, in the phase the actual task is constituted in, the teacher presents an ambiguous task and the students offer answers based on the trial-and-error-method. For example: During the teaching of statistics in a class of grade eleven students (aged about 17) the concept "representative sample" is introduced. The introductory problem runs as follows: "An inquiry of 2463 secondary-school graduates showed that 182 graduates want to study mathematics, 225 physics, and 316 chemistry. How many students can we expect in these subjects if there are 72000 secondary-school graduates all together?" The teacher's first question aims at the presuppositions for the solution of this problem. For experienced mathematicians it is obvious that the teacher has the representativity of the sample in mind. From the students' perspective, however, this question is ambiguous. One can make other, additional assumptions too and the teacher does not give the students any clue. The students make various suggestions. For instance one student assumes that every secondary-school graduate will take up a study. This is a natural though not necessarily correct assumption.

The findings reveal that such suggestions come mainly from the boys. The more ambiguous a question is, the more students have to rely on trial and error, the less girls actively participate in the interaction. Their typical reaction to such questions appears to be waiting and saying nothing. The task-constitution is established rather in teacher-boys interactions.

The "Blocking the Reference to Knowledge Outside Mathematics" in the Teacher-Girls Interaction

After the solution of application problems several times in four of the classes, the extra-mathematical field of the application was thematized. In such episodes two typical structures have been reconstructed (cf. Jungwirth, 1990b).

The first can be called the "eliciting general knowledge through asking questions." General knowledge is knowledge which is based on the everyday experience of the students outside school on the one hand, and the scientific knowledge gained at school in subjects other than mathematics on the other hand. For instance, in a grade ten class the teacher talks about the social implications of depreciation following the calculation of depreciation based on a given rate of price increase. In a dialogue with the students, using the tripartite scheme, the teacher develops the argument that counter-measures to a decrease in the purchasing power of money lie in wage increases and the rate of interest being above the inflation rate. The structure of the interaction here is similar to that one in introduction periods. Again girls tend to say nothing when the teacher poses ambiguous questions. They tend to keep silent, too, when the questions become more pointed.

The second way of thematizing general knowledge can be named "demonstrating the general knowledge at your disposal." In this context general knowledge is everyday knowledge, for which experience outside school is relevant. An example of this is the episode in a class of grade eight students (aged about 14) that happened after the solution of this problem: "Mrs Sweet wants to get some strawberries from a strawberry field. In the one nearest to her home the strawberries cost 16 schillings a kilo, in one further away they cost 14.50. It costs 30 schillings to get to the second one, that is, 12 schillings more than to the first one. Ask a question and answer it by solving an inequality." After solving the problem the teacher talks about the everyday situation. He asks about criteria in daily life for the choice of where to buy strawberries. Several students take part and name various criteria, for example, the taste of the strawberries, the transport of the perishable fruit, the pollution of the strawberry field, or the time needed to go to the field and back home. The linguistic structure of the utterances shows that the students are offering suggestions which are not necessarily their own opinions. The participation method of the students may be called "making a show of opinions." They do not refer to the contributions of the others; only the teacher comments on their suggestions, however without channelling them to any predetermined point. He aims rather at collecting several possible answers.

The girls tend not to participate in such a demonstration of everyday knowledge. In the "buying strawberries" episode the girls don't participate at all, although it can be assumed that girls are as familiar with the topic as boys. This indicates that the "blocking" phenomenon in the teacher-girls interaction is at least partly due to the way a topic is treated in the classroom.

The "Too Complete Description" Established in the Teacher-Girls Interaction

Within the problem solving that follows the tripartite scheme of elicitation-response-evaluation students usually offer fragmentary answers; they use the routine of verbal reduction (Voigt, 1984).

The findings indicate that answering in this manner is more routine for boys than for girls. In several episodes it has been observed that girls use a different practice. They give complete answers, that is, answers in which they describe all the main aspects of the problem. With this practice the girls depart from the usual way of answering. Their acting doesn't include the obligation for the teacher to elicit the missing aspects by further questioning. In spite of this, the teacher routinely asks about the aspects already presented. The reaction can be called an "undoing" of the complete answer. It is an attempt to re-establish the turn-by-turn development of solutions that the girl has disturbed. Through the "undoing" and the subsequent "putting together" the girl's original answer becomes a "too complete description."

The following transcript illustrates this modification. The translation of the dialogues spoken in the Austrian dialect tries to preserve the meaning and the structure of the spoken language as well as to use English idioms (original transcript in Jungwirth, 1990a; for the rules of transcription see appendix).

A Typical Example of a "Too Complete Description"

Context: A grade eight class has been shown the method of getting an approximate value of pi by drawing polygons in and around a circle. Now they repeat this method.

15 Teacher: how must we how can we approximate to pi
16 *more* and *more*. [Frank ↑, Joe ↑, Ursula↑]
17 [2 sec p] Ursula.
18 Ursula: well, the more corners [Frank ↓, Joe ↓] the
19 polygon has got the nearer, we are well the
20 nearer it is well the more accurate is the
21 approximate value. and when it has got at last a
22 million corners then it is almost like a circle
23 but it is still lacking a bit. [She speaks lower
24 Teacher: yes –
25 and lower]
26 Teacher: do you think that you can distinguish between
27 a milliongon and a circle. with the naked eye –
28 Ursula: no certainly not.
29 Teacher: no longer.
30 Ursula: you can't draw it any more can you
31 Teacher: unless it is very *large*' but [2 sec p] in
32 those dimensions we can draw on the board
33 we'd hardly see any difference. but does
34 some difference exist after all. Mary. between
35 a milliongon and a circle. [Dora ↑, Frank ↑]
36 Mary: yes. [low]
37 Teacher: yes –
38 Mary: sure. [nods, Dora ↓, Frank ↓]
39 Teacher: thus can we rely on measuring with the eye –
40 Mary: no.
41 Teacher: can we always rely on visualization in
42 mathematics.
43 Mary: no. Not always. [low, smiles]
44 Teacher: no. [2 sec p] that certainly looks like
45 a circle but actually is no circle, okay.

The teacher asks about the method that leads to an approximate value of pi (lines 15–16). The answer of the girl, Ursula, consists of two parts. The first part (lines 18–21) is directly related to the teacher's question, although Ursula doesn't describe the procedure the teacher asked about but states the finding that results from it. In the second part (lines 21–23) Ursula explains the relation between the circle and the approximating polygon by the example milliongon. This is a complete answer because the statement includes the two contradictory aspects of such an approximation: to come nearer and nearer and never to coincide. Now the undoing of her answer begins. The teacher reacts first by taking up one aspect (lines 26–33) and then turning to the other (lines 33–38). The second aspect is expanded to the problem of the reliability of visualization in mathematics (lines 39–44). In his final utterance (lines 44–45) the teacher repeats in his own words the statement Ursula has already made a short time ago.

Modifications of the Managing of Failure

In the case when students show a lack of (official) knowledge or understanding the teacher usually draws the students' attention to this and then tries to direct them to the "right" answer. Turn by turn the teacher and the students come to an agreement as to what the valid result is. That is the basis for continuing the problem solving.

The Modification in the Teacher-Boys Interaction: "The Concealing of Failure"

In the course of teacher-boys interactions, episodes have been reconstructed in which the failure becomes a little mistake, a mere error or a sudden lack of concentration.

One practice the boys use to conceal a failure is to show an immediate understanding of the teacher's stating or correcting the wrong answer. Their utterances demonstrate that they realize the correctness of the teacher's statement. A second practice is to show intellectual exertion in the form of pondering, or recalling steps of the procedure or commenting on steps or on previous suggestions. These reactions pretend, at least, that the wrong answer cannot be due to a serious failure. The teacher contributes to this concealment of failure by giving clues and information to help the boy in the subsequent course of the interaction. It looks, however, as if the teacher is just expressing aloud the idea the boy himself has in mind.

The Modification in the Teacher-Girls Interaction: "The Emerging of Failure"

Within the teacher-girls interactions, however, episodes have been reconstructed in which the failure emerges and becomes bigger and bigger during the course of the interaction.

The practice on the part of the girls that leads to the emergence of a lack of knowledge or understanding is adhering to a problem-solving approach of persisting in the underlying concepts without taking notice of the teacher's suggestions and hints. If a concept has been denied too clearly to hold on to any longer, the girls tend to say nothing instead of turning to the teacher's way. The teacher contributes to the "emerging of a failure" because she or he also adheres to the way of solution she or he has figured out at the beginning. The routines of direction don't work in this case; the teacher doesn't succeed in changing the girl's approach. Teacher and girl fail to adjust to each other. The typical pattern of elicitation breaks down.

Modifications of Establishing a Desired Answer

Teachers have several routines of rejecting student answers or suggestions that are correct in principle but nevertheless unwelcome (cf. Voigt, 1984). The following modes of defence and direction have been reconstructed.

The Modification in the Teacher-Boys Interaction: The "Argumentative Insistence on the Desired Answer"

Within the teacher-boys interactions there are episodes in which the defence of an awkward contribution and the (simultaneous) direction towards the desired answer is managed in an argumentative form. The teacher evaluates the boy's contribution as correct in principle, but, in spite of this, confirms by an argument her or his own suggestion. Through argument the boy is given an opportunity to reply. He makes use of this opportunity and shows his agreement with the teacher's utterance. Even though there is not a full-fledged argument, the desired answer is established by negotiation.

The Modification in the Teacher-Girls Interaction: The "Authoritative Insistence on the Desired Answer"

In those cases of teacher-girls interaction in which no ordinary defence pattern is found, an authoritative form of defence and direction has been reconstructed. Once more the teacher classifies the student's contribution as correct in principle but nevertheless confronts the girl with the solution she or he has figured out previously. Because of the authority of the teacher, this becomes the valid answer. The teacher avoids an argument. The girl is not involved in making the decision nor initiates a participation by herself. In these episodes the principle of establishing a result within a dialogue, which we can find in the ordinary forms of defence and in the other modification, is violated.

The modifications of the managing of failure and of the establishing the desired answer are illustrated by short scenes. These scenes have been chosen to show both types of modifications. (These two types of gender-related changes of interaction sequences are usually not linked together.)

A Typical Example for the "Concealing of Failure" and for the "Argumentative Insistence on the Desired Answer"

Context: A class of grade eight students (aged about 14) reflects upon the formula for the area of a circle. It has been deduced that a duplication of the radius quadruples the area. The teacher asks, "Someone wants only to double the area. What must he do with the radius?" A boy named Ralf calls out, "times square root of two". The teacher calls upon him to deduce $A(\sqrt{2} \cdot r) = 2A(r)$ at the blackboard.

Teacher: begin again with A of r'
Ralf: A of r equals r squared times pi. so.
[writes $A(r = r^2\pi$]
Teacher: yes the second bracket is still missing.
Ralf: oh sorry. that's what I always forget. well now
we have said well when we so what must what do we need
in order to get the *half* area – we'd have
Teacher: yes'
Ralf: to say then well –
Teacher: not the *half* the *double* area isnt it'
Ralf: oh I see, the double area. of course. wed have
to write this down the other way round I
think' thus say r of *two* A' [writes $r(2A)$]
Teacher: no you have [Ralf wipes off $r(2A)$] you have
argued' well if you multiply it with the square
Ralf: A of r of course.
Teacher: root of two the double must result from it.
try it' let's do the area A of'
Ralf: A of square root of two'
Teacher: square root times r'
Ralf: times r yes. [3 sec p] equals'
Teacher: let's fill in. thats also a way.

The teacher directs Ralf to the – in his opinion – proper starting point of the deduction, to the formula for the area of a circle $A(r) = r^2\pi$ (line 4). Ralf writes down this formula, "forgetting" however to make a bracket behind the r (line 6). The teacher points out that the bracket is missing (line 7). His sober utterance indicates that he considers Ralf's action as mere carelessness. It could, however, also be argued that Ralf doesn't know the mathematical meaning of the expression $A(r)$ and only translates words into signs ("of" is a bracket). By his comment "Oh sorry, that's what I always forget" (line 8), he, in any case, cleverly conceals possible problems of understanding. It seems that just his forgetfulness plays a trick on him again. There is also no unique interpretation of his slip of the tongue, "what do we need to get the half area?" (lines 9–10). It might be that Ralf has the previous problem in mind. If one starts with quadrupling, now the half area is asked about. By his remark, "oh I see the double area, of course" (line 14), he again looks as if he has just made a small mistake. His suggestion to begin with $r(2A)$ and the comment "the other way round" (line 15), however, indicate that he in fact starts from the previous problem (there was deduced $A(2r) = 4A(r)$). But it is idle to speculate on how Ralf would solve the task on his own because he has no opportunity to carry out his plan. To begin with $r(2A)$ would be correct in principle too, but the teacher rejects his suggestion (line 17). Ralf reacts promptly and wipes off $r(2A)$ immediately after the teacher says no. The defence happens in an argumentative mode. The teacher argues that Ralf had already aimed at the desired procedure (lines 17–20). Ralf makes use of the opportunity to reply and turns to the desired procedure immediately. By "A of r of course" (line 19) he looks as if he has remembered this previous suggestion and comes back to the proper starting-point. The teacher explicitly invites him to go that way and at the same time gives him a clue (line 21). In a dialogue the correct starting point emerges. Again Ralf looks as if it were obvious to him (line 24). Then the teacher gives him a hint again (line 25). By his final comment ("that's also a way," line 25) the teacher marks the actual procedure as one of several possible ones. This means that Ralf's original procedure is characterized as a practicable one too.

A Typical Example for the "Emerging of Failure" and for the "Authoritative Insistence on the Desired Answer"

Context: Tenth graders (aged about 16) are solving application problems for the geometric sequence. Just before this scene the following problem was solved at the board by the teacher with the participation of the students: "How much does the value of the money go down in one year if there is a rate of price increase of 6%? How much of its original value has a certain sum of money got after 5, 10 or 20 years if prices rise steadily?" The whole solution is still on the blackboard. Now the following problem is going to be solved: "How much is the rate of price increase if in five years purchasing power decreases by half?" The girl Wilma volunteers to solve this problem at the board.

Teacher: how shall we [3 sec p, Wilma comes to the
board] let's see. what must we do'
Wilma: I don't know *this*. [points to the denominator
of the formula for the purchasing power $(1/1.06)^n$,
which is still on the board]
Teacher: yes or I can say I call the whole fraction q.
[3 sec p Wilma doesn't write] yes' I can do
this can't I'
*N*Boy: (can you?)
Wilma: yes. [Shrugs her shoulders]
Teacher: well you must have q to the' [2 sec p] well
how many years have we had'
Wilma: the n I know that is five years'
Teacher: five', and what must
that be *approximately*' the half means'
Wilma: zero zero point five.
Teacher: zero point five. and therefore q is' [3 sec p
Wilma writes $q^5 = 0.5$]
Wilma: well the fifth root of the (.). [Writes $q =$]
Teacher: the fifth root of zero point
five and this I will calculate for you.
[2 sec p] so point five' [4 sec p] and that is
zero point eighty seven zero six' [2 sec p, Wilma
completes $q = 0.8706$] so which rate of price
increase have we got *approximately* –
Wilma: well [Coughs, 3 sec p]
Teacher: how much is the rate of price increase now.
*N*Boy: eighty-seven percent –
Teacher: no.
Wilma: no. [Shakes her head.] well this is p divided
by a hundred – [Looks to the teacher]
Teacher: you can read it off cant you.

43 Wilma: and this is then –
44 Teacher: yes' [4 sec p] so the zero point [3 sec p, he
45 takes the chalk from Wilma's hand]

By utterance "how shall we" (line 11) the teacher gives a hint of his approach to the problem: it might be continued with "call the unknown quantity." But with his open question he then returns to the very beginning of the problem solving. Wilma starts with stating what is unknown (line 13). In that she refers to the problem solved just before; one doesn't know the denominator of the formula for the purchasing power drawn up a short time ago. Obviously Wilma is about to introduce her procedure. The teacher, however, doesn't give her the opportunity to do so. After expressing his agreement he presents his alternative, one that he has already indicated at the beginning of the scene ("yes or I can say that I call the whole fraction *q*," lines 16–17). By the linguistic construction "or" Wilma's approach remains a correct one. Nevertheless it is rejected by the teacher without a reason. It might be that he has not yet understood it when he changes it to the way he has figured out. Wilma obviously hesitates to continue writing (line 17). By that it appears as if she could not follow the teacher's suggestion. Simultaneously she forces the teacher to refer to the shared knowledge with regard to abbreviations (lines 17–18). Her following "yes" (line 20) accompanied by a shrugging of her shoulders shows that she agrees with the teacher as for the abbreviation but doesn't know how to solve the problem from this starting point. The teacher now has his way by strictly directing the solution process (lines 21–22). He doesn't succeed, however, in dissuading her from her original procedure. Her answer "the *n* I know" (line 23) to his question shows that she still adheres to her concept: an *n* appears only in the formula for the purchasing power, not in the teacher's utterance. The teacher undertakes the necessary calculation (lines 31–34) because Wilma, as she stated before this transcript starts, doesn't have a pocket calculator. At this moment in the solution process it is impossible to read off the value of the rate of price increase. Thus Wilma can't answer the questions referring to this (lines 34–35, 37), but she doesn't try to do so either. She still muses over her original procedure; both the teacher and the student go their own ways. Wilma appears to develop her concept to get a term from which she could draw the value of the rate ("well this is *p* divided by a hundred," lines 40–41, "and this is then," line 43). Alone she doesn't succeed, however; and the teacher doesn't take notice of her attempts. Finally the teacher himself carries out the necessary transformation.

What Happens Simultaneously: *Staging of Mathematical* (*In*)*competence*

In the “concealing of failure” and in the “argumentative insistence” boys seem to be judicious students who can realize the correctness of the teacher’s statements. In the interaction, relative mathematical competence on the part of the boys is staged. In the “emerging of failure” as well as in the “authoritative insistence” the girls do not look judicious to such an extent; on the contrary, in these interaction episodes a relative incompetence on their part is established. These results – competence and incompetence – are due to the modes of participation of the boys and the girls and to the corresponding practices of the teacher.

The other gender-related changes of interaction sequences also show that boys manage the discourse in the mathematics classroom following the tripartite scheme more successfully than girls. Generally speaking, to say nothing is considered as a failure. As in introduction periods the essential ideas hidden in the presented subject shall be found out by the students, the “blocking the task-constitution” especially suggests that girls have difficulty grasping the essentials – in everyday understanding probably “the” feature of genuine mathematical talent. By their “blocking the reference to knowledge outside mathematics” girls present themselves in a way that leads to the image that girls are good rote learners without any interest in a broad view of the subject. High mathematical competence doesn’t result from a “too complete description” either, although in the example the girl does very well. It looks as if she gave an answer that might be essentially correct, but, was not able to make herself understood.

I would like to emphasize that from my point of view the mathematical incompetence on the part of the girls is constituted in the interaction. All participants, in particular the girls themselves, contribute to it. The feminist explanation (cf. Enders-Dragässer and Fuchs, 1988) that such an impression is the result of teachers’ discriminatory practices cannot be maintained here. Girls do not generally use those practices and routines that establish a smooth course of interaction, practices that are a token of success in managing the negotiation process. Instead they use practices which obstruct or interrupt the smooth course. Acting in this way is inconsistent with gender-role stereotypes. According to these the ability to adjust is typical for females whereas it is typical for males to resist and to be obstinate. This contradiction would be a problem if results concerning the acting of females and males had to conform with gender-role expectancies in order to be valid.

The greater mathematical competence staged by the boys in the interactions also offers an explanation of the different descriptions teachers give of the academic performances of girls and boys. According to several studies (cf. Jungwirth, 1990a; Walkerdine, 1989) teachers tend to use such terms as "natural ability" or "flair" much more often to describe boys whereas they tend to call even high-ranking girls "hard-working." Since boys are better in managing interactions following the tripartite scheme it is not surprising that teachers get the impression that boys "know" and girls "learn."

One possible explanation for the boys' superiority in managing these interactions can be drawn from the work of Maltz and Borker (1982). They argue that girls and boys learn to do specific things with language within their gender-segregated peer groups. In their social world the girls mainly learn to establish relationships of equality and closeness, to criticize without seeming harsh, and to read the cues indicating the actual quality of relationships to other girls. The social world of boys, on the contrary, "is one of posturing and counterposturing . . . . Storytelling, joke telling, and other narrative performance events are common features . . . . The storyteller is frequently faced with mockery, challenges and side comments on his story. A major sociolinguistic skill which a boy must apparently learn in interacting with his peers is to ride this series of challenges" (Maltz and Borker, 1982, pp. 207–208). Accordingly the methods of successful participation in the classroom discourse following the tripartite scheme (guessing answers, immediately adjusting to the actual turns and new questions of the teacher, etc.) seem to be more related to the conversational routines of the boys than those of the girls.

CONCLUSIONS

Finally, I would like to turn to the practical consequences that can be drawn from the present study. Unless it is enough just to take note of the gap in competency between boys and girls, the question arises of how to change the status quo. As all participants in the actual interaction contribute to the establishing of mathematical (in)competence, changes on the level of interactions demand changes in the practices of the teachers as well as those of the students. According to the theoretical background the present study is based on, the problem of actually changing practices can't be solved by drawing up a list of the "proper" practices and training teachers and students to use them. Such a suggestion would not be compatible with the interactionistic perspective; and, besides, such a technical approach has turned out to be inappropriate in initiating new developments in everyday teaching and learning (Ebbutt and Elliott, 1985; Schön, 1983). It is necessary to turn to another direction – towards a greater sensibility to what happens in interactions and a higher capacity of reflecting upon interactional processes. This may then lead the participants to develop their own modes of managing the interactions. Two aspects are important. Obviously teachers (and students) should become aware of the gender-related patterns of participation in the mathematics classroom. But that isn't enough. The typical form of tripartite sequences and its ordinary patterns of interaction must be reflected upon; because this form is the implicit norm for forming an opinion about the gender-related modifications. To achieve the desired aim there arise new and challenging tasks for future pre- and in-service teacher education.

APPENDIX

N	non-identified female or male student
NN	two or more non-identified female or male students
*N*Boy	non-identified boy
*N*Girl	non-identified girl
,	very short pause (max. 1 sec)
[a sec p]	pause lasting a seconds
.	lowering the voice
–	maintaining the pitch
’	raising the voice
exact	emphasizing
exact	drawling
(.) (. .)	inarticulate utterance lasting 1 or 2 seconds
(*a* sec)	inarticulate utterance lasting a seconds (for $a > 3$)
(one?)	inarticulate; supposed wording
[laughter]	characterizing environmental events and processes
↑, ↓	raising the hand, putting down the hand
A: let us begin *B*: but we want	simultaneous utterances
A: let us begin *B*: but we want	*B* partly speaks simultaneously with *A*
A: let us begin *B*: but we want	*B* interrupts *A*

NOTE

[1] In this paper selected findings of a research project ordered by the Austrian Federal Ministery of Education are presented (cf. Jungwirth, 1990a, 1990b, 1990c).

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