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***I WAS TRAPPED IN A PATTERN -  
Dilemmas, tensions and metaphors expressed by mathematics  
teachers in transition***

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This chapter gives an account of six mathematics teachers' reasoning about their teaching in the beginning of an action research process at the lower secondary level of a teacher training school in Finland. The teachers described their mathematics teaching, their beliefs about learning, reasons and attitudes to changes in teaching strategies, successes and shortcomings and how they conceived their roles within the collaborative action research process. The interviews revealed that insights from a long teacher career can act as a safe but professionally alienating pattern. Further, two main metaphors of teaching and learning emerged: the "commodity – container" metaphor and the "transport – track" metaphor.

*Key words:* mathematics teaching, teacher change, action research, metaphor.

## PROLOGUE

One day a professor from the Faculty of Education rang me and asked: Would you like to leave your job as a mathematics teacher for half a year and find out what the PUMA-project is all about? For two reasons I did not hesitate. Firstly this was a good opportunity for me to get my postgraduate studies started and secondly my curiosity woke: a PUMA in the mathematics classroom must mean a very active and different teaching approach! This took place quite a few years back. Since my engagement later turned into a research study, eventually I never went back to my job as a teacher in mathematics, physics and chemistry at a lower secondary school. In parallel to the teachers' story I tell you in this chapter, runs my own story of experiential learning to become a researcher of mathematics education. Even though my personal story of development is not explicitly visible in the written text below it was part and parcel of the process.

## INTRODUCTION

In this chapter I present six mathematics teachers' reasoning about their teaching, while involved in a three-year action research process at the lower secondary level of a Swedish-speaking teacher training school<sup>1</sup> in Finland. The action research was initiated by the teachers themselves and by them given the acronym PUMA (in Swedish Process och Utvärdering i MAtematikundervisningen = Process and Assessment in Mathematics Teaching) which reflected the overall aim of the reform process: to make improvements based on a constructivist philosophy in the processes of teaching, learning and assessment. The action research process of the teachers was observed by me and other personnel from the Faculty of Education. My role unfolded in two directions: to act as a co-manager of the process and to act as a researcher. In parallel to the action research process I collected data from interviews and informal discussions with participating teachers, from interviews with students, from visits in classrooms, from assessments and reports of students, and from teachers' self-reports in between and during action research meetings. Here I present dilemmas, tensions and metaphors that arose from interviews I did with the teachers six months after the beginning of the action-research.

## CONTEXT OF THE STUDY

The PUMA action research process involved a group of six mathematics teachers teaching at the lower secondary level. At the time of the interviews the participating teachers (here I will use the pseudonyms Tom, Per, Kaj, Ove, Leif, Alf) represented a wide range, from two years to 24 years of experience, of teaching mathematics. All the teachers were male. No female teacher was teaching mathematics in the school at that time. According to the regulations, the teachers at the teacher training schools are imposed to supervise teacher students in their teaching practice and can thus generally be considered more skilled in discussing epistemological and pedagogical issues than average mathematics teachers. Consequently I can state that these six teachers were no ordinary mathematics teachers. Furthermore, the teachers at the teacher training schools are all expected to actively develop their teaching.

In Finland, as in numerous countries all around the world, classroom instruction in mathematics has tended to rely heavily on teacher demonstrations and routine drill and practice (e.g. Boaler 2000, Bodin & Capponi 1996, Fennema & Nelson 1997, Kupari 1999, Røj-Lindberg 1999). A more progressive, open and student-active approach to learning is very rarely taken, even though evidence of its positive implications has been verified by research (e.g. Boaler 1997, Kupari

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<sup>1</sup> "Teacher training school" is a translation from the Swedish expression "övningsskola". A more verbatim translation would be "the school where you practice to become a teacher".

1999, Røj-Lindberg 2001). Hence, Tom's description of a general style of teaching as teacher-centred, including a mainly passive student role and the teacher dominating the conversation, was by no means exceptional from an international perspective. In the interview Tom stated: *in our school the teacher is the talking party, the students are, at the very most, the answering party. In the change-process we try to reverse this situation, and it is difficult.* He referred to the students' prevalent view of studying mathematics, especially at the upper secondary level, as: *you don't read mathematics; you listen to it and write it down.* Working collaboratively on improvement within an action research process, he and his five colleagues wanted to develop the assessment of students' learning and to expand their repertoire of teaching strategies with more problem solving and individual investigations by the students. Furthermore, they wanted to enhance mathematical discussions and the students' awareness and responsibility of learning. In short, they aimed at moving from what Fox (1983) describes as simple theories of learning to more developed theories of learning.

The global goals of the action research process were expressed by the teachers themselves at the beginning at the action research process. Furthermore, the goals were in line with the requirements of the national mathematics curriculum. In other words, the teachers had reached a critical juncture in their professional lives as mathematics teachers, a situation which according to Raymond & Leinenbach (2000, p. 305) often act as a starting point for action research.

*Teachers who engage in action research are generally teachers who are at a critical juncture in their teaching practice and are in a state of mind where they are open to change. The state of mind might be that one's philosophy of teaching may be in a state of disequilibrium or perhaps the teacher is faced with a dilemma.*

The desired mathematics classroom was to be different from the one familiar to the teachers and the students (see also Tom's comments above) and, hence, there was a demand for transition not only in the teachers' beliefs and understanding of the teaching and learning process, but also in the tacit agreement, also called "the didactical contract"<sup>2</sup>, about how the teachers and the students were supposed to act in the classroom. Many studies of mathematics teaching have shown that these changes are very hard to accomplish (see e.g. Bodin & Capponi 1996, Ernest 1989, Franke, Fennema & Carpenter 1997) and that the teachers' beliefs, views and preferences about mathematics and its teaching play a significant, albeit subtle, role in shaping the classroom behaviour of both the teachers (see e.g. Andrews & Hatch 1999, Manouchehri & Goodman 1998, Thompson 1984) and the students (see e.g. Boaler 2000, Campbell, Smith,

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<sup>2</sup> Brousseau has coined the concept "didactical contract" to describe the invisible agreement that exists in the classroom and deals with what the teachers and the students are supposed to do. (Brousseau 1990).

Boulton-Lewis, Brownlee, Burnett, Carrington & Purdie 2001, Nardi & Steward 2003).

The participating teachers focused their action research on the teaching of six mixed-ability groups at grades 7 and 8 with between 13 and 22 students in each group: Kaj, Leif, Per and Ove were teaching one group each, Alf taught one group in each grade. Tom, who had been very active in establishing the action research process, was appointed principal and did not teach any class at the lower secondary level at the time of the interviews.

The action research followed a model presented by Kemmis & McTaggart (1988) with cycles of planning, enacting, observing, reflecting and replanning. In this process the teachers met regularly for both formal action research sessions called together by personnel from the Faculty of Education and for informal small-group meetings. Four formal and more than 10 informal action research meetings were held prior to the teacher interviews. Kemmis & Taggart (1988, p. 5) provide the following definition of action research, which emphasises its participatory, collaborative and self-reflective nature and locates it as a form of social action oriented towards improvement.

*Action research is a form of collective self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of these practices and the situations in which these practices are carried out.*

Teaching strategies and methods of assessment were presented and discussed by the teachers during the action research meetings. Each teacher tried the agreed teaching strategies in his classroom, in conjunction with using the ordinary textbook. Among the new assessment components, the teacher-initiated project-works differed most from the former routines and they were the most time-consuming for both teachers and students. The project-works were handed out to the students as individual homework to be completed over a period of two weeks. During the term before the interviews one project-work each was completed by the students in both grade 7 and 8: in grade 7 the project dealt with number theory and in grade 8 with functions. Another totally new assessment component called “explanation-tasks” was added to the formal tests. Written explanations of how to solve problems were considered to reflect the student’s level of conceptual knowing (Hiebert & Lefevre, 1986).

## COLLECTION AND PROCESSING OF DATA

I conducted semi-structured individual interviews with the mathematics teachers participating in PUMA midway into the first year of action research, with an intention to get a deeper insight into each teacher's beliefs of teaching and learning of mathematics and commitment to change. The main discussion themes were the following: What dilemmas and personal feelings did the teacher face in his teaching? What made the teacher become involved in the action research process? How had his involvement in PUMA affected his teaching, his role as a teacher and the learning of his students? In the interviews I started out with the same questions to every teacher and asked follow-up questions to go deeper into issues that were raised as important.

The interviews lasted approximately 30 minutes each and were transcribed verbatim comprising a total of 76 pages of text. In analyzing the interviews I implemented a process of comparing and contrasting the data from each individual teacher (Strauss & Corbin, 1994). A number of broader themes and particular issues emerged, issues that the teachers described as significant to their personal commitment to the PUMA-project and to their beliefs about mathematics teaching and learning.

It is important to note here, that my close interpretation of the teacher interviews followed after the full completion of the three-year action research process. Hence, the interpretations and statements I make in the following text are necessarily affected by additional insights accumulated after the interviews.

## RESULTS

### *Insufficiency, monotony and safety of the known*

The teachers considered their "old" teaching practice as insufficient and all six teachers expressed various degrees of disaffection towards their traditional teaching strategies. But leaving the old teaching habits was considered to be hard: there was also a feeling of safety of the known. The teachers described their professional life as a journey, where the teacher is driving according to his beliefs about teaching and learning. Now they had reached a cross-road on their journey. On one hand the teachers wanted to become better teachers and expressed a need for more knowledge about innovative approaches to teaching. They wanted to reorient and restructure their teaching by taking small steps towards a constructivist teaching approach with support from professional colleagues and without leaving what they considered to be good aspects of the old curriculum. On the other hand the teachers were worried about negative reactions from their students, from non-participating colleagues and worried about disadvantageous effects on learning, especially for the mathematically low achievers.

When we were talking about grounds for changing teaching practice the teachers referred to the monotony of the traditional teaching approach and to the unwanted effects of this approach both for themselves and for the students. Some of them described their teaching strategy as *walking in the same old wheel-tracks*, and considered the teaching as being too *theoretical* and *boring*. *Bumping around with rules, too little time to think for the students and too much reliance on traditional tests*, were other statements about their teaching practice. The teachers also referred to bad learning results, to the many uninterested and passive students with no or very little ability to think mathematically and to students with a limited ability to put their mathematical knowing and understanding into words and to be independent learners. One teacher exemplified the teacher-dependency by referring to students' inability to read mathematical textbooks on their own. Another teacher expressed his wish to *connect the students' brains*.

When a teacher has used the same pedagogical approach for years, it has become very self-explanatory and convenient to follow. The teacher feels safe in the instructional pattern he has built during the years, a pattern that the students also have become used to. The words of Leif, as we were discussing changes in his role as teacher, give a flavour of the well-established and unreflecting routine he wanted to break.

*Before you took the book, went into the classroom without thinking, especially in grade 7, you gave the answers to keep the students satisfied.*

Tom described his feeling of meeting an impasse after over 20 years of teaching, saying that he had come to a point where he felt he was stuck and trapped in patterns that he didn't find successful. He considered himself to be a very professional teacher, but even though he had constantly improved and renewed his teaching during the years, he felt that he was empty of new ideas and he was repeating himself. But, again, as the students obviously wanted him to act in the same way as usual, it was also easy for Tom to find motives to stop the struggle for changes in his instruction.

*The students want teacher-centred teaching. That is what they want and that is what I am good at, I am such a person who is good at explaining and it is the most convenient way for the students, to get it explained by me, they understand and it goes well and it is a simple way to take. As soon as I slipped back into my old teaching style they (students) started to look well fed because I acted the way they were used to.*

The impact of collegiality on the change process was clearly expressed by Leif, who said: *there are those that criticize all instructional development no matter what it is all about, those teachers that like to continue in the same old rut and feel threatened and jealous. Maybe they don't have the strength or ability themselves, they just want to criticize others.* Leif's statement opens up a very important issue, namely in order to understand teacher change, one has to look at the whole educational culture wherein the individual teacher is just one of the components. Impact of colleagues and other school professionals, especially leaders, on teachers involved in a change processes, can at best be very supportive. But the collegiality can also act as a subtle brake-block that make an innovative teacher retreat back to the safety of the known and to the culturally accepted routines (Boaler 1997, Edwards 2000, Manouchehri & Goodman 1998). That is, to improve the quality of educational experiences for students, account need to be taken also of the organisations in which the pedagogical practices occur (Grundy 1994, Kemmis & McTaggart 1988).

### *Beliefs and doubts, successes and shortcomings*

Since development of the assessment of students' learning was one of the aims of the PUMA-project, it was no surprise that the belief in assessment as a key device in changing students' working and learning habits was very explicitly expressed by the teachers<sup>3</sup>. Especially Tom was very clear in his stated belief: if you change the objectives of the assessment this will inevitably be followed by a predestined change in student learning:

*In the long run I think that it is the assessment, the pieces of evaluation that are important, because it is through them we can change the behaviour of the students. They do those things that they know are evaluated... it is as simple as that. If you say that this will appear in the test, whatever type of test, that is what they learn. That's the way they function.*

The new components of assessment were also thought of as having the highest viability and to be one of the lasting outcomes of the action research project. As Alf reflected on what eventually could be a lasting effect, he stated that:

*When PUMA ends, I think the assessment components, like the new test-structure, the projects, the monthly problems, perhaps the written home-work assessment, will stay in some form, but I am not sure to which extent, these are as we know quite heavy now, but I think they could be something that perhaps have got the strongest foothold.*

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<sup>3</sup> How the modes of assessment steer the actions of persons involved is described in literature about educational reform, see e.g. Resnick & Resnick 1991.

The strong focus on assessment was nevertheless focus for critical reflection by the teachers as can be noticed also in the excerpt from the interview with Alf. He describes the assessment structure as “*quite heavy*”. Integrating the assessment into the everyday instructional work was further described as problematic and time-consuming. The teachers commented on effects of the PUMA project on their teaching in ways that made me notice a tendency to see the new teaching strategies as well as the assessment components as external “bits and pieces”. Those disturbed the delivery of the ordinary content. Obviously there was still in the minds of the teachers a division of the mathematics teaching into two types. On one hand there was the PUMA-teaching including its new assessment components and on the other hand there was the teacher’s ordinary mathematics teaching with its usual routines and roles of teacher and students. This is exemplified in the following excerpt from the interview with Kaj:

*Kaj: You have to be a little bit careful not to split up the normal topics, they might fall apart by all this other stuff.*

*A-S: What do you mean with normal topics?*

*Kaj: If we take, say, calculation of percentages, and you are working with that, and then, in the middle, you jump out and do something else*

Before the part of the interview quoted above, Kaj was commenting on possible negative side-effects of project-work, especially for the low achievers. According to him traditional teaching and a stronger concentration on basics would enhance their learning more than the “*other stuff*”. Obviously one solution to this dilemma, from Kaj’s point of view, would be to integrate the project-work into the normal curriculum and hence have the projects subordinated to the pace of the textbook, instead of having them separated and done by the students outside ordinary lessons.

When we discussed the teaching strategies that were used to implement the goals of the PUMA project, the teachers talked about the nice sense of success from giving the students more time to think and from devoting more time to class-discussions. According to one of the teachers this also gave the boys a more honest chance because many boys are innovative and active in discussions but don’t succeed so well in the formal tests. But the teachers’ sense of success was whittled down by a devastating feeling of not being able to gain and hold the student interest and getting all the students motivated to contribute to the teacher-led class-discussions.

Besides student motivation, another area of concern was how to cope with the academic and motivational heterogeneity among students. The teachers felt quite strong tensions between their concern for scaffolding the learning of individual

students and managing the whole class. Even though these problems were not new and not directly outcomes of the new teaching components, there seemed to be connections. A common opinion among the teachers was that the good students were the winners and that the gap between low- and high achievers was widening. Good students work well within any teaching approach and now the many project-works, problem-solving sessions, class-discussions etc. raised their standard of knowing and thinking more than ever before. There were concerns among the teachers that the low achievers and unmotivated students did not get to practice those things they needed. Traditional teaching, where the teacher is pushing the low achieving student to practice one, preferably practical, task at a time would perhaps be better. One teacher suggested the introduction of two types of project-works, one for those who need to practice the basics and another type for those who are high achievers. He could then direct the low achievers to the former type where: *you more work with something and where the mathematical connections and patterns and such is not a salient feature*. Students, who wanted to achieve more and get higher grades, could be directed to project-works where finding connections and patterns was a goal. Another type of solution suggested by some of the teachers was to form two or three homogeneous groups according to ability, and then give the students an opportunity to choose between the ability groups, at least occasionally. Leif's thought was that:

*It would be ok to let the students choose according to ability, in my class two groups of students suffer, the very best and the very weakest. And I think the best students suffer most as I have so many weak students in my class, so I concentrate on them [here Leif refers to the weak students].*

Finally, when I looked at how the teachers described their teaching situation I found a lot of metaphorical expressions with an essence that the teacher is a kind of coach, whose duty is to stop students from falling behind and to lift weak students up, to lift all students to certain knowledge levels and to guide the students or to lead them step by step. The teachers described helping, forcing, whipping, pushing, pulling, steering and paving the way for students learning and to make the students work, discover or think. Some teachers expressed concerns about white spots or big gaps in the students' mathematical knowledge and talked about the need of giving tools to the students, about tracking the thoughts of students and students tracking the thoughts of the teacher.

Moreover, the teachers also used metaphors to describe and define their professional reality. In this connection they used phrases like to take a simpler road, to follow the stream, to be trapped in patterns, to be in ten fathoms of water, to walk in the same old wheel-tracks, to drive according to your beliefs, to jump on something that moves and to switch on the brakes. As I continued to read the interviews over and over again and compared and contrasted texts in

order to understand and find meanings behind the statements, I found two main metaphors emerging out of the teachers' stories: mathematics teaching as transport along tracks and mathematical ideas as commodities stored in individual containers.

*The transport-track and commodity-container metaphors*

Two main metaphors emerged out of the teachers' reasoning about teaching, learning and change: the transport-track metaphor and the commodity-container metaphor. Teaching was described as transports along tracks and mathematical ideas as commodities that are stored in individual containers during the teaching and learning process.

The mathematics teacher is responsible for the transport of every student from the beginning to the end of lessons, through the school year, from one form to another and from one school to the next or into the life outside school. During the transport the teacher selects different strategies and teaching styles, tracks, in order to help individual students to get a certain amount and type of mathematical knowledge. The students' minds are seen as containers where the knowledge is stored. The teachers should change track, use several tracks simultaneously and speed up or slow down the transport according to the needs of the students and the social situation in the classroom. Some students follow keenly the teacher along a more demanding track while some students need to be pushed, pulled or lead by the hand along the track because these students might have another goal for the transport than the one the teacher has.

The teachers store the mathematical ideas in each student's container in various ways and in various compositions depending on the quality and type of the track they follow. The students themselves might be active to find out what items the teacher thinks should be stored in each student's container.

*New methods, like inductive methods, give the students possibilities to discover the new, you reason your way through it but the students come up with the final statements... they will remember more... you give them a more mathematical eye. (Per)*

Also, there might be some negotiation between the teacher and the student about the amount and structure of the selected content and the pace of the transport.

*Mathematics teaching should be more student-friendly, I mean, useful mathematics, student-friendly also in the sense that that they are the ones who should have much to say about the pace, I think they want variation in*

*the methods of teaching, that makes teaching more student-friendly, compared to being one-sided. (Ove)*

But it is the teacher who has the last say. It is the teacher who has the responsibility to open up all the individual containers, to connect them to the system and make them ready for the transport and who also should decide which type of content each individual container should have when it leaves the school.

*I always try to get the students to connect their brains, to think for themselves, but this doesn't always happen, especially not with all of the students. The most effective way to do the connection, to start their thinking about a task, is to walk around in the classroom. (Kaj)*

When deciding about the transport and the track, it is an advantage for the teacher to know under which circumstances the student will need the stored mathematics (demands of the next school and of life). It is also an advantage to know how to adjust the transport and the track according to the types and capacities of the different containers (ability, interest, motivation of student). When the students are transported to the next school or out in the real life, they need their containers to be filled with “*a rich store of mathematical tools*”. For instance, a student aiming at upper secondary must know the basic rules by heart, otherwise he will get problems later to get his container filled with more sophisticated mathematical stuff and to reach higher levels of understanding. But all students should have more mathematical tools stored in their containers than they will need later on. *You should demand that most of the students learn more than they need. (Alf)*

On some tracks the students are offered responsibility for filling up and also deciding on the content of their own containers as well as the containers of their friends. *I transfer a part of the responsibility to them, that they must be responsible for their friends in the group. (Ove)* But without the teacher by their side, the students don't always have motivation or interest in doing this. *I said, like, read this, do that, look at those examples and to the tasks ... no one did anything, when I came they had been sitting for an hour doing nothing, I think it is really too bad. (Tom)*

Students might also fill their containers together and decide about the content all by themselves or together with their parents. Sometimes students copy work of others and are thus some kind of freeloaders. Some students need be put on remedial transport with some other teacher and this makes it more difficult for the ordinary teacher to do or supervise the filling of the container of these students. It happens, that a student is neither aware of or interested in which transport he is on, nor is he interested in what type of ideas he should get into his

container. *There are students who are not aware of that they need this type of knowledge.* (Ove) Some students have a tendency to fall off the transport and some have holes in their containers.

## COMMENTS ON THE ACTION RESEARCH

In the interviews all teachers emphasized the collaborative dimension of the action research process, as being the most valuable. The meetings were also platforms where the teachers had the possibility to *formulate things as thoughts that you perhaps wouldn't have formulated otherwise, you would just go on.* (Kaj) These words point at what I want to call the *zoom in - effect* of the collaborative dimension: knowing that you will meet colleagues and discuss certain issues with them, makes you more sensitive and aware of components in relation to these issues as they appear in the classroom.

To work with colleagues and learn from their experience was of very great value especially to the younger teachers. This even though the apprentice-mentor relationship also seems to have included a power component that possibly put a check on some critical points during the first action research cycle. This is reflected in the discussion with Leif, when he tells me that to him, joining something that was already settled by some of his colleagues (Leif joined the action research group in a later stage than the other teachers), meant following a plan without any overt critical reflection.

A-S: *Is there something you miss?*

Leif: *Yes, maybe freedom, I have felt rather tied up. We have discussed, I mean taken a week at a time, and this system makes you rather tied up...*

A-S: *How has this affected you?*

Leif: *I don't know... maybe you haven't done things the way you would have wanted to. Sometimes you want to do an odd thing. With a good class it would have been ok to do the odd things anyhow, but I have a rather weak class, they are completely busy doing this even though they have all the time. Actually they would need more time, I have decided not to feel tied up during the spring, I will try do take more freedom... perhaps the freedom has suffered because you had to come on now and jump right into the middle of this type of project, and you perhaps didn't want to be bossy right away... And this is not only PUMA, this is if you plan to have the same tests ...rather tied up systems.*

The PUMA classes wrote the same tests and did the same project-works according to a timetable that was set in the beginning of the autumn. From the teachers' point of view this uniformity saved time but as we can see from the

above excerpt it might have had a detrimental influence on other goals of the project. This type of uniformity does reflect a tacit agreement that the same teaching-content is delivered at the same pace in all classrooms and doesn't give enough room for class-bound solutions and the needs of individual students. The commodity-container metaphor discussed earlier helps us to further understand this facet of the instructional practice.

The PUMA project was a process of improvement that focused upon individual teachers and their restructuring of the pedagogical practices in certain classrooms. From the point of view of the teachers, this situation created some kind of a professional schizophrenia. Stepping into a PUMA class meant taking on a PUMA teacher role while being the ordinary mathematics teacher in other classes. This tendency was enhanced by the strong emphasis on special instructional techniques like project-works and other assessment components that were implemented only in the PUMA classes. The action research format did provide a strategy for the pedagogical improvement but the research dimension of the process was a difficult endeavour. The complexity of the classroom context made it difficult for the teachers to sustain concentration and reflect upon only certain aspects of the class-room processes leaving others aside. In the instructional flow the decisions of the teacher are rapid, pragmatic and related to the totality of the classroom situation. In a problem solving moment the teacher acts upon his experience from similar situations and upon his knowledge about the individual students. The thinking and conscious reflection may come afterwards, but then new problems might already have entered on the scene demanding the teacher's attention. The teacher's decision making in the mathematics classroom is influenced by the simultaneous existence of mutually competing motives. For instance, in the PUMA project more student talk about mathematical issues was an important principle but managerial priorities often made the teachers put constraints on the students' communication in the actual practice.

## EPILOGUE

From my own experience as a mathematics teacher and from listening to Tom, Leif, Kaj, Per, Alf and Ove I can assert that improvement and change of mathematics teaching is not easily done by a cyclical plan-act-reflect-evaluate process. Mathematics teaching, as all teaching, can be compared to a chaotic situation where many disparate demands are hanging over its executors. Dispirited, uninterested, anxious or confused students spell management problems. An "uncovered" curriculum might spell negative reactions from colleagues in the team and on the next level of schooling. It might perhaps also spell official and parental disapproval.

The teacher feels safe in a classroom culture with an instructional pattern and a division of labour between the teacher and the students that all parties concerned have become used to, including parents and colleagues. Even though the teacher might be disappointed with its effects, breaking the pattern means leaving the safety of known and coping with new dilemmas. The action research format can act as a framework for the support structure needed for sustained change, firstly if the individual teachers themselves are willing to take the risk and responsibility in leaving old patterns of instruction and, secondly if they are parts of a supportive community. In addition to the changes that have to occur in the individual teachers' own beliefs, in his understandings and in his style of mathematics teaching, there also has to be a continuous support from colleagues and from the school community as a whole as well as from the research community.

According to Goldsmith & Schifter (1997) teachers cannot realize the new insights of a school mathematics reform by themselves. Neither can they succeed in transforming their teaching by simply adjusting a bit of practice here and there. Breaking the old patterns of teaching can perhaps be understood as shifting one pedagogical paradigm to another. This shift requires that the individual teacher undergoes a personal paradigmatic revolution where his change efforts must win over deep-rooted habits and beliefs that are products of an old curriculum and of a pedagogical culture including language, mathematical activities, social relationships and organisational practices wherein the teacher has grown to be the teacher he is.

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