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Finnish 15-year olds have been among the top overall performers in international student assessment studies during the last decade; metaphors like 'miracle' and 'paradox' have emerged, especially related to school mathematics. The goal of this article is to situate the good results in the Finnish educational policy in the 1990s, as well as in accounts from five Finnish Swedish-speaking mathematics teachers in a teacher training school who set out to restructure their teaching and learning practices.

Introduction

In the 1990s descriptions on how mathematics teaching should be arranged and assessed were widespread, including in Finland (Kupari & Haapasalo, 1993). As a research field, mathematics education was strongly focused on constructing and implementing new models of mathematics teaching as well as researching the cognitive development of individuals, both teachers and students (see e.g. Fennema & Scott Nelson, 1997; Goldin, 1990). Teachers were described as agents of change (Leder, 1989) and in processes of transition (Fennema & Scott Nelson, 1997) where new forms of mathematical practice were to be constructed by the teachers. The role of assessment in learning was heavily emphasized. The core argument was 'what is assessed is what really counts', that is, what gets assessed and how it gets assessed sends clear signals to students about what is regarded as important by the educational system (Clarke & Stephens, 1996; Morgan, 2000; Webb & Coxford, 1993).

The case study presented in this article addresses how five Finnish mathematics teachers, colleagues in a Swedish-speaking teacher training school, talked about on-going restructuring of their teaching and learning practices in terms of experiences and expectations five months into an action research process that they initiated in the early 1990s. In this action research the teachers were the agents of change (Leder, 1989); I joined the process as an outsider researcher.

The being a teacher at a teacher training school means higher professional staff requirements and an active role in

pursuing research and development. As an outsider in the action research I was intrigued by what these teachers saw as important in the restructuring process. Why did these presumably excellent teachers see their practices in need of restructuring and how could their talk about restructuring practice be interpreted in relation to the national educational policy?

Global Contextual Frame

Pasi Sahlberg (2011) argues that there is a positive connection between the evolution of educational policies in Finland during the 1990s and the Finnish results in international comparisons during the last decade. As Director General at the Finnish Ministry of Education and Culture, Sahlberg concludes that "it is important to note that any effects that teaching may have had on the results in a given education system primarily reflect the influence of education policies and reforms implemented in the 1990s – not the most recent education reforms" (p. 52). In the following section I introduce traditional methods of mathematics teaching in grades 7 to 9 in Finland, and the politically supported curricular changes that were implemented during the 1990s. More details on the Finnish educational system and on the educational tasks of school mathematics are available elsewhere (e.g. Pehkonen, Ahtee & Lavonen, 2007; Sahlberg, 2011).

Traditional Mathematics Teaching

In Finland mathematics teaching in grades 7 to 9 has traditionally been *teacher-centred*. Teachers relied to a high degree on demonstrations, explanations and whole-class communication to convey content, and on students' learning by listening and participating in call-and-response interactions. During lessons students practised the recently familiarized content individually and at their own pace, while teachers walked around in the classroom to help them if needed. Practise was primarily done with textbook tasks, seldom with teacher-made tasks, and with one textbook per school year as a rule.

There was no formalised grouping of students according to mathematical ability, but the teacher often differentiated student work by assigning learning tasks to students according to presumed difficulty and complexity of the task. Thus some students would go deeper into the learning content than others. All students did home assignments regularly and their work was usually checked and commented on in the following lesson. Generally mathematics teachers tended to see the textbook as representing the core learning content to be addressed during the school year. (Norris, Aspland, MacDonald, Schostak & Zamorski, 1996; Pehkonen, et. al., 2007)

Politically Supported Transition

During the 1990s a more open and *student-centred* approach to schooling started to slowly find its way into the Finnish mathematics classrooms (Pehkonen & Seppälä, 2007). In the early 1990s such changes were argued for in the national educational policy, and were codified in 1994 by the Finnish

government in a new national core curriculum for basic education in grades 1 to 9 (NBE, 1994). Co-operative learning approaches were emphasized. The development of students' mathematical thinking and a deep understanding of the subject were emphasized. Problem-solving was set as the leading teaching principle along with mathematical-logical requirements motivated by empirical and 'hands-on' learning experiences. Furthermore, a more dynamic approach to assessment was argued for, where the students' development of mathematical thinking was to be continuously evaluated with versatile methods, informally as well as verbally, alongside conventional achievement tests. Through this continuous assessment of learning outcomes a teacher was to obtain information not only about improved student performances, but also about each individual student's motivation for learning.

New Demands on Teachers

When implementing the new curriculum, the teachers in each school were expected to (1) discuss and interpret the values and goals expressed in the core curriculum for each school subject, (2) formulate their interpretations in a more detailed school-based curriculum, and (3) explore together how to attain and maintain values and goals in terms of teaching and learning practices. The processes of implementing the new demands were allowed to vary from school to school as well as within schools. There was, however, more pressure on the teacher training schools than on other schools to keep up with research within the educational field and changes in the national curriculum. Furthermore, in Finland the teachers in the teacher training schools were expected to take part in small-scale research projects together with teacher education staff from universities. The next section illuminates one such small-scale research project: an example of action research initiated by mathematics teachers themselves.

Local Contextual Frame

The School

The school is a training site for pre-service teachers that operates in close connection to the department of teacher education of Åbo Akademi University. It is an inner city school comprising classes from kindergarten to grade 12, with around 800 students and 75 teachers. The language of instruction is Swedish. The social atmosphere is relaxed and calm with fairly close and caring relationships between students and teachers. In grades 1 to 9 the students are organized by age and grouped in heterogeneous, rather small groups. There are usually around 15, and normally less than 25 students per group.

Implementation of 1994 Curriculum through Action Research

In the early 1990s and in the spirit of the 1994 curriculum described above, some mathematics teachers in the school initiated a reform of their teaching practices. The reform was conceptualized as a project focused on "learning processes and assessment" and as emerging from a constructivist

view of knowledge development (Hagman, 1994). In 1994 the informal enquiries of the teachers were formalised into an action research process which lasted for three years.

Action research is defined as "a form of self-reflective enquiry undertaken by participants in social situations to improve the rationality and justice of their own practices, and the situations in which the practices are carried out" and as "a way of participating in decision-making about development" (Carr & Kemmis, 1986/1994, p. 162). Educational action research often operates in cycles within cycles of planning, enacting, observing, reflecting and re-planning, often as collaboration between teacher-researchers and outsider researchers (Elliot, 1991; Raymond & Leinenbach, 2000).

The action research process was initiated by the teachers themselves, and supported economically by the Finnish National Board of Education. It was organized under the supervision of the department of teacher education at the university. In the early 1990s I worked as a mathematics teacher for grades 7 to 9 in another school, but was now involved in the action research as an outsider researcher.

The research group comprised five teachers and two mathematics educators from the department, including myself. The group met for action research meetings outside school hours, mostly on the department premises. The minutes I wrote of each formal meeting were sent for comments to the teachers. In between the formal meetings the teachers came together on the school premises for informal meetings in which I did not take part.

Each teacher's experiences were discussed at the formal action research meetings. These discussions were based on the teachers' narratives of trying out various teaching and assessment strategies. They focused on ways to restructure students' learning practices with the help of more problem-solving and mathematical investigations, and on developing new strategies for continuous assessment of learning outcomes. For instance, the teachers described 'How do you think here?' as a common question in their classrooms. More comprehensive insights into assessment, individualization and problem-solving aspects of the action research can be found in the writings of two of the teacher-researchers (see Burman, 1994, 1996, and Burman and Röj, 1997).

The teachers' goals in the action research process can be summarized as:

(1) increase the amount and quality of interactions in the classroom;
(2) spend more teaching time on problem-solving and strategies for problem-solving;
(3) make the students more aware of their own responsibility for learning;
(4) be more sensitive to the mathematical thinking of individual students;
(5) broaden the range of learning/ assessment tools; and
(6) develop continuous assessment and support of students' learning.

Methodology and Methods

Traditional educational research methodology aims to keep a researcher apart from the phenomena being studied (Amit & Fried, 2002). Such an assumption was not realistic in this case study. I had the role of an outsider in the action research and I did not participate in the research process with any explicit intention to restructure my own teaching. However I simultaneously acted as an integral and active part of the action research process itself. I am a mathematics teacher and I was well aware of the demands set on the teachers by the 1994 curriculum. Hence, it was natural for me to consider all kinds of issues related to schooling and mathematics education both in informal discussions and during action research meetings.

I had what Miriam Amit and Michael Fried describe as the important "intelligent grasp of the content of the discussions" (p. 379). Therefore, when I wanted to deepen my own understanding of the restructuring processes and learn about how the teacher-researchers conceived the ongoing restructuring of teaching and learning practices, the most sensible alternative for coming to know about these issues was to discuss them with each teacher. If you want to understand how people you know conceive of something, why not ask them about it?

I met each teacher individually for a semi-structured discussion five months after the start of the action research process. Up to the time of the discussions four formal action research meetings had been held. In the discussions we explored each teacher's personal reasons for involvement in restructuring school mathematical practices, as well as experiences and expectations of teaching and assessment strategies and the action research process. The five audio-taped discussions (approx. 60 min each) were later transcribed verbatim by the author and printed for further analyses.

The discussions were in Swedish. For use in this paper I have translated the teachers' words into English. The problems inherent in transcribing and translating into another language cannot be addressed here due to limited space (see for example Bucholtz, 2007).

Analytic Procedure

When I began the analysis of the interviews, I drew on my professional understanding of good school mathematical practices as an initial analytic lens. I was also familiar with the national educational policies and theoretical underpinnings of the action research process. With this significant pre-understanding I ran the obvious risk of becoming one of those "researchers who fails to listen adequately to feedback from the field, especially to stories that contradict their own definitions" (LeCompte, 1993, p. 11). I did not want to state how things related to the restructuring process *should or might be* seen; I wanted to capture and understand how things *were* seen from the teachers' points of view at the time of the discussion.

One way to approach this complexity was to refrain from doing a content

analysis based on an explicit analytical frame and on categories for coding in advance of the analysis (Bryman, 2001, p. 190). In order to allow aspects that appeared significant from the teachers' viewpoints to emerge, I decided to use a grounded analysis of their conversations. By reading the transcripts over and over again and by simultaneously comparing and contrasting statements, four broader themes emerged. These were:

- *Insufficiency and safety of the known;*
- *Hope and disbelief related to a student-centred practice;*
- *Hope and disbelief related to assessment;* and
- *Effects of research and collaboration.*

Furthermore, as a result of my close reading of the transcripts, I was sensitized to the teachers' frequent use of metaphorical expressions. Metaphors were frequently used by the teachers to make sense of perceived demands related to the action research process as well as to the curricular requirements.

According to the Finnish educational policy in the early 1990s a restructured practice should afford each student a fair chance and equal educational opportunities to grow in mathematical talent, and to continue his or her studies in mathematics at the next school level (Pehkonen, et. al., 2007). In the teachers' discussions the implementation of the requirements was visible in metaphorical expressions, for instance the teachers talked about their need for "tools" to help them "feed the students" and "lift weak students up". George Lakoff and Mark Johnson (1980) say "the essence of metaphor is understanding and experiencing one kind of thing in terms of another" (p. 5); they argue that metaphors are "pervasive in everyday life, not just in language but in thought and action" (p. 3).

Statements with metaphorical expressions in the transcripts were collected and explicitly focused on in the analysis to deepen my understanding of how the ongoing restructuring of the teaching and learning practices was perceived by the teachers. Two epistemologically deep and interlinked metaphors were constructed by comparing and contrasting the metaphorical expressions (Hellspong, 2006).

I noticed that teachers often used expressions that I could associate with a *transport-track* metaphor. In relation to *actions on their students* the teachers used expressions such as to "guide students step by step", to "lift students up" and to "stop students from falling behind" In relation to *aspects that supported or hampered the restructuring process* the teachers used expressions like to "be trapped in patterns", to "walk in the same old wheel-tracks" and to "follow a flow".

The other significant deep metaphor I was able to construct was a *commodity-container* metaphor. In their talk the teachers framed both themselves and their students as having a mind that could be in various stages of openness and from where "answers" could be "pulled out". The inside of the mind

could be "empty" or more or less "filled" with knowledge. Knowledge was represented as "tools" and "ideas" and the teachers' actions on students' minds as "filling" or noticing "gaps" or "white spots" in the knowledge with various methods.

At the time of the audio-taped discussions I was not aware of how metaphors may frame meaning assigned to events and, as argued by others (Chapman, 1997, Mellin-Olsen, 1991; Yero, 2010), provide structure to a teachers' educational actions. Thus there was no intent to elaborate on the meaning of metaphors either in the discussions with the teachers or at the previous action research meetings. However, my understanding of how metaphors structured the teachers' narratives of trying out various teaching and assessment strategies increased. As a consequence, reflections in the action research group deepened, and more elaborate teaching and assessment strategies were articulated in the subsequent formal action research meetings.

Results

In the first section of results I present a narrative constructed out of the discussions with the teachers that describes the *transport-track* and *commodity-container* metaphors. The narrative has a double function. First, it acts as a window to the local mathematical practice, or, in the words of James Stigler and James Hiebert (1999), to the local "cultural script" made visible by the teachers in their talk. A cultural script is defined as general knowledge about teaching events that resides in the minds of participants in the culture. This script is so widely shared and familiar that it becomes nearly invisible to the participants. Second, the narrative is intended as a frame for the aforementioned four themes that emerged out of analysing the teacher-researchers' conversations.

The transport-track and commodity-container metaphors

A mathematics teacher is responsible for transporting every student across the grade levels, through the school year, from one form to another and from one school to the next or into life outside school. During this process, the teacher selects different strategies and teaching styles, or tracks, in order to help each student acquire a certain amount and type of mathematical knowledge. A teacher should change tracks, use several tracks simultaneously and speed up or slow down the transport according to the needs of a student and the social situation in the classroom.

Some students keenly follow the teacher along a more mathematically demanding track while some need to be pushed, pulled or lead by the hand along a track because they might have a different goal for the transport from that of the teacher. Teachers want useful mathematical ideas to accumulate in each student in various ways and in various configurations depending on the quality and type of the track they follow. A student "with a mathematical eye" might actively discover the

mathematical content the teacher thinks should be stored. In a teachers' words, "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".

There might also be negotiations between the teacher and student about the amount and structure of the selected mathematical content, as well as the pace of the transport. "Mathematics teaching should be more student-friendly, I mean, useful mathematics should be student-friendly. I think students desire variation in teaching methods." However the teacher must have the last word. It is the teacher who is responsible for making the students ready for taking in the conveyed knowledge and for learning; a teacher should "connect the brains" of the students. One participant noted, "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".

It is the teacher who decides which type and amount of mathematical content is to be stored when the students leave grade 9. When deciding about the transport and the track, it is an advantage if the teacher knows under what circumstances the student will need the stored mathematics. The teacher should be informed about the mathematical demands of the next school and of life in general. It is also an advantage to know how to adjust the transport and the track according to the ability, interest and motivation of each student. When the students are transported to the next school or out in the real life, they need their minds to be filled with "a rich store of mathematical tools". For instance, a student aiming at an upper secondary school should know the basics in mathematics by heart otherwise the student will probably confront problems later when learning conceptually more advanced mathematics and reaching higher levels of understanding. But all students should have more mathematical tools stored in their minds when they leave grade 9 than they will need later on. "You should demand that most of the students learn more than they need".

On some tracks the students are offered responsibility for deciding on, and for filling their own mathematical content as well as that of their friends. "I transfer part of the responsibility to them; they must be responsible for their friends in the group". Yet without a teacher by their side, students are not always motivated or interested. "I said, like, read this, do that, look at those examples and at the tasks … no one did anything, when I came back they had been sitting for an hour doing nothing." Students might as well be allowed to do the filling together or together with their parents, or decide about the content all alone.

Sometimes students copy the work of others and could be considered 'freeloaders'. Some students need to be put on remedial transport with another

teacher, which makes it more difficult for the regular teacher to conduct or supervise the filling of their minds. It may be that a student is neither aware of nor interested in which transport he or she is on, nor is the student interested in what knowledge items should go into his or her mind. “There are students who are not aware that they need this type of knowledge”. Some students have a tendency to fall off the transport and some have holes in their minds which complicate the filling process.

Theme 1: Insufficiency and safety of the known

A common ground and a shared reason to be involved in the restructuring process was the view that traditional mathematics teaching was considered insufficient. From a teacher’s perspective the traditional teaching approach was like “walking in the same old wheel-tracks”. From a student’s perspective the approach was described as “too theoretical” and as “boring” with far “too little realistic mathematics” and far too much “bumping around with rules”, “too little time to think” and with “too much reliance on conventional tests”. The learning content should, the teachers argued, include more than mathematics. It should also include norms related to how a student is expected to act in the mathematics classroom both socially and mathematically. As a teacher reported:

> 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. The teacher should be the answering party who should be quiet most of the time in class.

The expressed intentions of the teachers closely followed the intentions of the Finnish national core curriculum from 1994. The teachers wanted to become better listeners along with a stronger focus on exploring the mathematical thinking of individual students and nurturing students' responsibility for their learning. In their discussions they described students’ teacher-dependency and lack of perseverance. The teachers clearly expected the restructuring to result in a transfer of the locus of knowledge responsibility to the students. Students “have been far too passive when they leave grade 9” and should be “taught how to be responsible for their own knowledge”. A major insufficiency of the traditional teaching practice was that it turned learners into passive thinkers “unable to read mathematical textbooks on their own”.

Every teacher expressed various degrees of disaffection towards their “old” teaching and assessment strategies but leaving the familiar classroom routines was hard. There was also a feeling of safety of the known. The teachers described teaching and learning as a “journey”, where both the teacher and the students are driving according to how they think mathematical teaching and learning should be. But now, as one teacher described the situation, “a cross-road on the journey was reached”. The teachers experienced the paradox of being simultaneously safe and trapped in the instructional patterns built up over the years; patterns that students were content with.

One teacher stated that if he "slips back into teaching as usual" his students would "start to look well-fed because [he] acts the way they are used to". This teacher described himself as a very professional teacher who had constantly improved and renewed his practices over the years. Yet as he expected the students to want him to act in the same way as usual, it was also very easy for him to find motives to follow "the simpler road". Pedagogically this would mean that he gave students the well-formulated explanations they expected and refrained from involving the students in their own learning, especially as he considered himself to be "empty of new teaching ideas".

Theme 2: Hope and disbelief related to a restructured practice

Discussing expectations of the effects of restructuring revealed a tendency to perceive a restructured practice as "all this other stuff" that in some sense constrained the teaching of "normal topics". Two types of teaching practices were found in the teachers' conversations: the restructured "something else"-practices, and the traditional practices with their usual routines and participant roles. A restructured practice was nevertheless referred to in positive terms, especially when the teachers talked about school mathematics from the students' point of view.

The teachers expected the restructured practice to afford them new and better tools for addressing academic and motivational heterogeneity in the groups of students. They talked about the nice sense of success they had experienced as a result of giving the students more time to think and devoting more time to whole-class discussions. Boys in particular, they argued, were given a more authentic opportunity to show their mathematical talent within a student-centred approach, including a system of continuous assessment of students' learning; more boys were innovative and active in the whole-class discussions than was usually the case.

Conversations about achieving a different learning behaviour clearly indicate that the teachers expected to increase the amount and quality of students' mathematical thinking and communication in their classroom. They expected each student to explain his or her mathematical thinking, try to make sense of other students' thinking, and base the explanations on proper mathematical understanding. Some strategies described by the teachers to support thinking and student talk were: resisting the temptation to answer students' questions too quickly, patiently give the students more time to think, and asking students for different mathematical arguments and explanations. One teacher described explicitly how he had empowered the students by asking them to work in pairs and explore the mathematical learning content together.

However, obstacles were perceived in the process of restructuring. As expressed in the quotation below, a teacher easily slips back into a teacher-centred practice when she or he feels the pressure to deliver set mathematical content in conjunction with a lack of

teaching time and perceived personal pedagogical shortcomings.

> In the beginning I thought more of the process and how to get the students to talk mathematics and find out the answers by themselves. But there is lack of time and I notice how I slip back to my old teaching style. I have never been really didactic in my teaching but, yet, I think I am not patient enough to pull out the answers from the students, I don't give them the time to think, to think things through.

The teachers described their struggle to increase the amount and quality of student talk in the classroom by opening up the classroom for more students contributing to whole-class discussions. Some students did not endorse the new norms for interaction that the teacher expected to emerge in the classroom: they were not "playing the game". From the teacher's point of view the students who played the game did so because of their motivation to participate in productive activities together with the teacher. "Some students are playing the game. This is expected, these students are motivated. Then there are others who might tear the situation down. If there are enough of these pupils in a classroom all teaching gets difficult."

The general sense of success with regard to some students' access to learning was accompanied by a distressing feeling of not being able to capture and maintain the interest of every student and motivate each student to contribute mathematically to the whole-class discussions. Each teacher described tensions involved in linking teaching a whole class with scaffolding the learning of individual students. The mathematical correctness of each student's thinking was unanimously conceived of as a core teaching goal. However, in a community of practice where students expect "to get the mathematics explained" by the teacher, and the teacher expects the students "to do and learn those things that they know are evaluated", too much scaffolding of the students could also result in "a kind of surface level knowledge when a student knows things just for the moment". In such a situation the focus of a student's attention is more on how to satisfy the teacher by delivering an acceptable response than on understanding the mathematical content of the problem.

Even though the teachers did not expect problems as those mentioned above to be directly related to the process of restructuring, there seemed to be connections. The teachers expected the "good" and "motivated" students to work well within any teaching approach and with any learning content. Within the restructuring process the levels of thinking and understanding of these "good" students were expected to rise even more than within a traditional practice. A common concern was that good students will be "the winners" and that "the gap" between "the low achievers" and "the high achievers" could be widening. There were also strong concerns among the teachers that "the low achievers", "the unmotivated students" -- those students who needed to be "pushed", "forced" or "pulled" by the teacher -- would not get to practise

enough mathematics, and mathematics that is useful for them, within a restructured practice. Some teachers asked themselves if a teaching practice with a clear focus on "the basics" of the mathematical content perhaps would enhance these students' learning more than the "other stuff" which the restructured practice brought with it.

Theme 3: Hope and disbelief related to assessment

The teachers expected the continuous assessment of students' learning -- also an expectation of the 1994 curriculum -- to be a long-term key to success in changing students' learning behaviour. Their expectations were thus clearly aligned with the contemporary argument that what gets assessed is what counts. New assessment strategies like "a new test structure, project work, monthly problems, written assessment of homework", were supposed to have the highest feasibility and to be a lasting outcome of the restructuring process. The new assessment strategies were described as having "the strongest foothold" in the restructuring process. The quotation below illustrates the teachers' firm conviction that a changed assessment policy will inevitably be followed by a change in the learning behaviour of the students.

> Students do those things that they know are used for assessment. It is as simple as that. If you say that this will appear in the test, whatever type of test, this is what they learn. That's the way students function.

But the new assessment strategies did came to the fore in critical comments too. Supplementing everyday instructional work with continuous assessment was problematic and time-consuming. Assessment was described as "quite heavy" and narrowed down the teacher's pedagogical space. This was a drawback of the agreement to use the same achievement tests and assignments according to a timetable set in the beginning of the school-year. This uniformity created a certain personal space for a teacher, as finding good assessment tasks is a slow process and work could be divided. However the agreement had a detrimental influence on the teacher's ability to react to the needs of the students and to act on the spur of the moment: there was limited space for doing those "odd things a teacher sometimes wants to do" and a pressure to teach the mathematical content at the same pace in each teacher-researcher's classroom.

What solutions could there then be to pedagogical dilemmas such as those described above? Some solutions suggested by the teachers related to the perceived needs of the students and to the teacher's judgment of each student's level of mathematical ability. One teacher suggested the introduction of two types of assignments with divergent criteria for high marks: one type for students "who need to practise the basics" and another type for students "who are high achievers". Then, this teacher argued, it would be reasonable to guide a student who aims at higher grades to an assignment "where finding mathematical connections and patterns" is a learning goal, and to guide "those

that are satisfied with lower grades" to an assignment "where you work with something basic". This suggestion makes visible an assumption that one group of students needs to be directed to what Morgan (2000) describes as a "foundational curriculum" rather than to move on to more advanced mathematics.

Another suggested solution was to form two or three so called "ability groups", and then afford students the opportunity to choose between these groups, at least occasionally. Such a solution, this teacher argued, would benefit both "the very weakest" and "the best" students. Now, in the heterogeneous groups, he said he concentrated his scaffolding on those students that he classified as "weak"; a pedagogical solution he expected to be at the expense of the learning of his "best students".

Theme 4: Effects of research and collaboration

Combining the complexities of teaching and the analytic reasoning of action research was referred to as problematic. In the quotation below, a teacher describes this difficulty as related to the situated nature of his reasoning while teaching. He describes his pedagogical thinking as integrated within the moments of classroom discourse and finds it difficult to stop the discourse momentarily to evaluate and reflect.

> I don't think before I implement things, I mean, I think when I implement, I mean, when I am faced with a problem the answers come up, I don't sit and think in a vacuum and create solutions, they come up when they are needed.

All the teachers talked in positive terms about the collaborative dimension of action research. To work closely with colleagues was considered a supportive basis for the restructuring process. The teachers' discussions indicate a *zoom-in effect* related to the collaborative dimension: when a teacher is aware that meetings with colleagues are coming up, where agreed-upon issues will be discussed, the teacher is more sensitive and aware of aspects of these issues as they appear in the classroom and in research meetings. The research meetings were social platforms which gave each teacher the possibility, as one teacher put it, to "formulate things as thoughts that you perhaps would not have formulated otherwise, you would just go on".

To meet with other teachers and be afforded the possibility to learn from the experiences of colleagues was important, especially to the newcomers in the research community. However, the old-timer/newcomer relationship also included a power component that possibly had a silencing and sidetracking effect on a newcomer in the community. For one newcomer teacher the action research meant "jumping right into the middle" of pedagogical arrangements he felt pressed to align with, including the assessment strategies. He described a practice influenced by his loyalty to the decisions made within the research group as well as by his sensitivity to the needs of his students. On the one hand he did not

want to criticize what he described as "the system" and "to be bossy right away" within the research process; on the other hand he experienced a need to "take more liberties". He wanted to attend to issues concerning his "weak class" in a manner that "the system" did not allow him to.

Discussion

Mathematics teaching can be seen as a cultural activity, and thus teachers and researchers alike may be blind to some of the significant features that characterize teaching in their own culture, the so-called cultural script (Stigler & Hiebert, 1999). These features are taken for granted as the way things are or ought to be, rather than choices that can be re-examined. The deep *transport-track* and *commodity-container* metaphors described in this study resemble those in studies on teacher thinking (see for example Mellin-Olsen, 1991). They make transparent some features of the cultural script within which the educators in this study, myself included, worked. There is ample evidence that fundamental changes in teaching and learning do not emerge simply by adjusting the teachers' pedagogical strategies bit by bit: a change is also needed in beliefs, values and understanding; in the pervasive metaphors that ground and shape the pedagogical practice itself (Amit & Fried, 2001; Fennema & Scott Nelson, 1997; Yero, 2010).

Consider how the teachers in this study used metaphors like being "trapped in patterns" to describe classroom routines that were not adequately serving some students' mathematical learning, but which nevertheless were described as supported by students' expectations, and partly by the teachers themselves asking whether a restructured practice might lose sight of "the basics" of the learning content. Collaboration with, and learning from the experiences of colleagues within action research may provide a good platform for resolving this paradox. There is a need to explore how the "pattern" metaphor relates to learning content and participation structure of teacher and students in the classroom.

Changing one's teaching and learning practices, however, is an endeavour with complexities that rational plan-act-reflect-change processes, which are accepted by most proponents of action research, do not account for. A teacher's decision-making in the classroom is influenced by simultaneously existing, mutually competing motives and, as indicated by the teachers in this study, all participants in a classroom are not "playing the game". Decisions have to be rapid and related to classroom management as well as to the social and cognitive needs of individual students. The social and cognitive complexities of classroom work make it difficult for a teacher-researcher to maintain focus and reflect only on certain aspects of the classroom processes while leaving others aside. The thinking and conscious reflection supposed to be present in action research may come afterwards, but by then new problems demanding the teacher's attention might already have entered the scene.

As shown in this study, teachers feel safe within a cultural script that all parties concerned have become used to. When teachers begin to move to new forms of teaching and learning practices, they have to cope with a greater degree of ambiguity and uncertainty in their professional lives; they have to be able to leave the safety of the known. Also shown is how disparity between a teacher's intentions and experienced classroom routines often becomes a source of discomfort. Not being able to teach consistently in the way you would like is frustrating. The additional experience of students expecting the teacher to act in the usual way may provide a reason for the teacher to stay "trapped by the taken-as-shared beliefs and practices of the tradition" (Gregg 1995, 464) and refrain from implementing any fundamental changes.

The restructuring of the teachers' beliefs, values and understandings that relate to new forms of teaching and learning practices need continuous support from colleagues and from the educational community as a whole in order to be sustained. Sharing one's work with others may be vital for this process of restructuring. As concluded by the evaluators of the Finnish 1994 curricular reform, "peer appraisal may offer a valuable way forward for teacher evaluation and development in a period of change and experimentation" (Norris, et. al. 1996, p. 74). However, as this study indicates, collegiality can also act as a subtle barrier that makes an innovative teacher retreat to the safety of the known and to routines that are socially endorsed within the familiar cultural script.

The results presented in this article are based on interpretations of teacher-researchers' discussion about restructuring practice. This is an important limitation of the study because talking *about* practice and talking *within* practice are different. To paraphrase John Elliott (1991), if the participants in action research restrict themselves to talk about practice, the process runs the risk of facing a major problem typical for cultural innovation *from within*: the failure of the innovators to free themselves from the fundamental beliefs and values embedded in the culture they want to change. The core of the dilemma is that teachers look at teaching and learning through metaphors that keep the instructional habits alive. On one hand it is necessary for each teacher who wants to undergo change to open up, scrutinize and make these metaphors visible, if possible together with colleagues. On the other hand the impetus for this process is that teachers have already revealed the essence of the cultural script, that is, the fundamental beliefs and values that sustain the metaphors. Sharing video studies of classroom work within the action research might be a way to tackle this dilemma.

This article has offered the reader a window to the Finnish educational policy as well as to an example of a policy-related but local process of educational change. It has shown how five mathematics teachers in a teacher training school set out to restructure their teaching and learning practices,

and how their talk about restructuring was related to the expectations expressed in Finnish educational policy in the 1990s. The local character of the study offers a limited basis for answering the question of why Finnish students are among the top performers in international comparisons. The study can however be interpreted as an example of contextual frames supporting such success.

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