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Mathematics Teaching in Swedish-speaking lower and upper Secondary Schools in Finland - What do the teachers tell us? Initial presentation of a research-study.

1. Background

There are two scopes of interest in the background of this project:

Firstly, the teachers' use of problem solving and assessment, as stated for instance in Principles and Standards (2000). Information about the Swedish teachers' use of problem solving and assessment methods and also about their willingness to change their instructional practice in these respects will be used as a preliminary analysis within another research done by Lars Burman. *At Pre-ICME in Växjö Lars Burman is presenting this part of the research in a separate paper.*

A second aim is to get a "still photo" of the mathematics education in the Swedish lower and upper secondary schools in Finland seen from the teachers' point of view. What do the mathematics teachers in the Swedish-speaking lower and upper secondary schools tell us about teaching and learning?

- Can we find dimensions that are important factors in their personal theories about teaching and learning? (here I include the concepts 'conceptions, beliefs and attitudes' in the broad concept 'personal theory' and I don't discuss existing aspects of these concepts)
- Are there differences between groups of teachers, e.g. teachers belonging to different age groups; gender differences; differences between teachers at lower and upper secondary level?
- What do the teachers find important in mathematics education and in being a mathematics teacher? Can we from the stories teachers tell us find out how they value their subject, the teaching of it and themselves as mathematics teachers, and hereby add information to the discussion about the Finnish success in the PISA study? For instance, what do the teachers at the lower secondary level tell about how they manage to teach the entire age cohort?

Results from a previous survey showed an interesting polarisation among the teachers concerning the last group of questions. The survey included only mathematics teachers at Swedish lower secondary level and was focused on textbooks and curriculum. According to the opinions that the teachers expressed a dichotomy was found. On the one hand there were teachers who wanted a textbook that would help them concentrate on the core of mathematics, on rules and strategies, on drill and individual practice. On the other hand there were teachers who asked for textbooks where mathematics is put in a cultural, realistic and meaningful context and that support inventions and communicative methods of teaching. (Røj-Lindberg, 1999, p. 77).

2. Framework of the research

Several personal and qualitatively different theories of teaching have been found in teachers' answers to questions about teaching in general and about mathematics teaching in particular. There are also research-based indications of how these personal theories affect what the teachers teach, how they teach it and how the teaching affect the learning behaviour of the students. The results of a study done with nearly 500 secondary students in Australia may serve as an example. When teachers focused strongly on actively engaging students and creating a supportive environment all students focused on student-centred aspects of the class. In contrast, when traditional expository teaching methods were used all students focused on transmission and reproduction (Campbell, Smith, Boulton-Lewis, Brownlee, Burnett, Carrington & Purdie, 2001).

Scardamalia & Bereiter (1989) discuss differences between expert and non-expert teachers associated with four expressed theories of teaching: teaching as cultural transmission, teaching as skills training, teaching as fostering natural development and teaching as promoting conceptual change. A strikingly similar template of theories as those of Scardamalia & Bereiter was earlier found by Fox (1983) in responses to the question "What do you mean by teaching?" In the teachers' responses Fox found four basic theories of teaching and expressed these as metaphorical concepts: the transfer theory, the shaping theory, the travelling theory and the growing theory.

Different personal theories of teaching like those presented by Fox and Scardamalia & Bereiter have also been discussed extensively in relation to mathematics education (see e.g. Thompson, 1992).

An example of this is presented by Jakubowski who, with a group of teachers, analyzed the teachers' beliefs about teaching mathematics. They found four metaphors that described their work: the teacher as a policeman, the teacher as a mother hen, the teacher as an entertainer and the teacher as a gardener. These metaphors acted as their personal theories of teaching and created a ground which influenced their decisions and actions in the classrooms (Jakubowski, in Presmeg, 1997).

Andrews and Hatch identified five perspectives on mathematics teaching among secondary teachers. Mathematics teaching was conceived as process-oriented, as skills-oriented, as a cooperative and collaborative act, as focused on the individual child and as connected to a mathematically enriched classroom environment (1999).

In 1995 I realized semi-structured interviews with six mathematics teachers at a Swedish lower secondary school in Finland. In the interviews the teachers were asked to reflect on teaching methods, assessment and other issues related to the action-research project these teachers were involved in. From the teachers arguments about teaching and learning I was able to extract two pairs of metaphors: the transport-track and the commodity-container metaphors (Røj-Lindberg, 2002).

From a study that involved 44 Finnish mathematics teachers at lower secondary level, Pehkonen concludes that the teachers had very different views on optimal learning. Some teachers made statements about learning that were compatible with a behaviouristic view of learning, whereas some teachers very actively discussed learning situations from the view point of students (Pehkonen, 1998)

Research has also clearly shown that theories of teaching are influenced by the teacher's conception of mathematics as a subject. For instance Battista concludes that those teachers who conceptualise mathematics as rule-learning, view teaching as telling students how to perform set procedures (1994). Mathematics as rule learning is only one theory about mathematics that have been observed in teaching (the instrumentalist view), others are mathematics as a static body of knowledge that is discovered by the learner (the Platonist view) and mathematics as an ever expanding cultural product where the learners are involved in the invention of this unfinished product (the problem-solving view) (Ernest, 1989).

There is reason to believe that teachers' personal theories about mathematics and its teaching and learning play an important role in the formation of instructional practices characteristic of their teaching. There is also reason to believe that many mathematics teachers are very well aware of their personal theories and, also, both the shortcomings that these theories might include and the reasons for change in the instructional practice. In fact research has shown that teachers with differing beliefs about mathematics may exhibit similar classrooms behaviours as a consequence of contextual constraints and demands (Lerman, 1986, cited by Andrew & Hatch, 1999)

So, what will the teachers tell us in the on-going study? Are the theories of a pragmatic and practical character concerning the curriculum, classroom dynamics and the students' capacities winning over those that include the characteristics of an innovative mathematics teacher? A serious caveat to take into account is that written statements may not be the best source when trying to unveil teachers' theories of teaching. Some theories may lurk beyond ready articulation.

2. Method

2.1 Questionnaire

The main instrument in this survey is a questionnaire to the teachers of mathematics at the lower, comprehensive, and upper secondary levels in Swedish-speaking schools in Finland. Advice given by Cohen, Manion and Morrison (2000) about structure and lay-out were followed in planning the questionnaire. For a reliable result from a survey it is important to get a high response level. The length of the questionnaire is often thought of as a hindrance, but according to Cohen et. al. it is more important to focus on issues with which the respondents are familiar. This is especially true for a group of sophisticated respondents such as teachers. Even though some doubts were expressed about mathematics teachers' willingness to write answers to open questions (!), it was considered important to use both closed and open-ended questions in the questionnaire. According to Cohen et.al it is "the open-ended responses that might contain the 'gems' of information that otherwise might not have been caught" (p. 255).

The questionnaire comprises six pages and consists of two parts, one part where background facts about the respondent and the school is collected (gender, age, years of service as mathematics teacher, present employment, amount of students in school, amount of studies in mathematics, amount of in-service training, number of students in the school) and one part with items divided into six sections according to the following:

- A) questions about how mathematics teaching is organized and about teaching material (separate for lower and upper secondary level),

- B) questions about evaluation and assessment (separate for lower and upper secondary level)
- C) 31 statements about teaching and learning where the respondent is asked to indicate the degree of agreement (scale 1-5, from don't agree at all to totally agree),
- D) eleven statements about problem solving, investigations, evaluation and assessment where the respondent is asked to indicate the degree of agreement (separate for lower and upper secondary level) (scale 1-5, from don't agree at all to totally agree),
- E) sentence-completion; six indicated beginnings to complete
- F) respondent's autobiography written from the perspective of a good friend

In the covering letter the respondent was asked to indicate his or her interest in a follow-up study by writing down the telephone-number. In the planned follow-up study the validity of the results from the survey will be checked by deep-interviews with a small number of respondents.

To increase the reliability and validity the questionnaire was pre-tested by the mathematics teachers at the teacher training school. These teachers were then excluded from the sample. The teachers at the teacher training school were chosen as pilots since their professional situation is remarkably different from the situation of other mathematics teachers due to their teacher training responsibilities. By excluding them from the sample possible distortions of the results stemming from their position as teacher trainers were avoided.

2.2 Sample

The participants in this survey were, in November 2002, registered as members of the Swedish Teachers' Union in Finland (Finlands Svenska Lärarförbund, FSL) and at the same time registered as mathematics teachers at the lower or upper secondary school level. Finding the addresses to the participants through the FSL was considered to be a fast and reliable procedure as the degree of belonging to the teachers' union is close to 100%.

The target group consisted of 223 teachers (mathematics teachers at the teacher training school not included). On January 22nd questionnaires including a covering letter were sent out by post to 155 members of FSL registered as mathematics teachers in lower secondary schools and 68 members of FSL registered as mathematics teachers in upper secondary schools. In the covering letter the teachers were asked to return the questionnaire in an accompanying, stamped and addressed envelope by February 10th. All questionnaires returned within the time were included in a draw for ten books.

The initial mailing resulted in a total of 82 returned questionnaires (37%). On February 11th a follow-up letter was sent out and one week later a reminder was published in the membership paper of FSL. No further copy of the questionnaire was sent out. As a result of the reminders the amount of responses increased by 50 to a total of 132 (59%). With only one follow-up letter to the questionnaire the return rate must be considered very satisfactory (Cohen, Manion & Morrison, 2000).

Seven of the returned questionnaires were empty mostly because the respondent had recently left teaching because of retirement or other duties and thus did not want to take part in the survey. Roughly 30 respondents indicated interest in taking part in a deep-interview within the planned follow-up study.

In table 1 below the distribution of the remaining 125 respondents (56 women, 69 men) in the sample according to level of teaching is shown.

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	Frequency	Percent	Valid Percent	Cumulative Percent
Valid ak 1-6	1	,8	,8	,8
ak 7-9	67	53,6	53,6	54,4
gymnasiet	44	35,2	35,2	89,6
annan skolform	1	,8	,8	90,4
ak 1-9 och gymnasiet	2	1,6	1,6	92,0
ak 7-9 och gymnasiet	8	6,4	6,4	98,4
ak 1-9	2	1,6	1,6	100,0
Total	125	100,0	100,0	

Table 1. Distribution of the respondents according to level of teaching

3. Some very, very initial results

The few results that will be reported at PICME10 are very preliminary and are based upon the sections C, E and F of the questionnaire.

The 31 items in section C have been subjected to factor analysis using the software SPSS for statistical analysis. Because the Cronbach alpha reliability test yielded a factor 0.5 (0.7 would represent good reliability) a systematic removal of some items might be needed. This has not been done so far.

A factor analyse is an analytical tool that can be used to identify latent variables or factors that underlie a set of items and thus explain the answering behaviour of the respondents. When determining the numbers of factors to extract, those factors that have eigen values in excess of 1 are accepted. Here I include only the six first factors given by the factor analysis out of a total of 12 factors with an eigen value in excess of 1. Only those items with loadings in excess of 0.4 have been accepted as valid contributors to a factor.

The six factors shown in table 2 are extracted from answers from those 108 respondents that have answered all 31 items. These six factors explain not more than 44 % of the variance but are rather robust.

Some differences between lower and upper secondary teachers can be found.

In table 3 the answers from the lower secondary teachers are included. The six first factors explain 50% of the variance.

In table 4 answers from the upper secondary teachers are included. The first six factors explain 55% of the variance.

In analyzing the answers from sections E and F the NVivo software for qualitative analysis will be used. In NVivo the texts written by the respondents can be coded. The coding process can be open or done according to a pre-determined set of categories. At this stage I am still reflecting on the coding process, that has just begun, and at PICME10 I will present and discuss some of the answers from twelve of the respondents very briefly.

Mathematics is best taught in homogeneous groups	0.792		
Groupings according to ability support mathematics learning	0.778		
All students learn more mathematics with setting	0.770		
A big variation between students is a hindrance in teaching	0.762		
Mathematics should be taught in mixed-ability groups through comprehensive school	-0.735		
It is important that the students are involved in decisions about teaching methods	0.741		
It is important that the students formulate their own tasks.	0.637		
Gender differences in mathematics are results of teaching	0.600		
It is the teacher's duty to give the students mathematical models	0.724		
In mathematics it is the teacher who selects the methods of teaching	0.627		
There are problem-solving strategies that the students must learn.	0.467		0.428
School mathematics is useful in life		0.740	
Mathematical skills are appreciated by the society		0.705	
Variation in teaching supports the learning of mathematics.		0.488	
My picture of a good mathematics teacher was mostly formed during the school and study years			0.881
My picture of a god mathematics teacher was mostly formed during my teacher years			-0.872
Discussion is necessary in learning mathematics			0.673
Mathematical ability comes natural			0.604

Table 2. Details of the factor analysis showing the weightings on each item. All respondents included.

Mathematics is best taught in homogeneous groups	0.847		
Groupings according to ability support mathematics learning	0.803		
All students learn more mathematics with setting	0.776		
Mathematics should be taught in mixed-ability groups through comprehensive school	-0.773		
A big variation between students is a hindrance in teaching	0.740		
In mathematics teaching the teacher selects the method of teaching	0.400		
As a teacher of mathematics I also teach values	0.780		
Variation in teaching supports the learning of mathematics.	0.587		
The creativity of the students is developed by mathematics teaching	0.571		
Enough consideration is taken of mathematical thinking ability in assessing the students	0.477		
Mathematical ability comes natural		0.725	
The students' questions are important in mathematics teaching		0.693	
School mathematics is useful in life		0.441	
My picture of a good mathematics teacher was mostly formed during my teacher years			0.900
My picture of a good mathematics teacher was mostly formed during the school and study years			-0.875
Discussions are necessary in learning mathematics			0.784
Whole-class instruction using the board is an effective teaching method in mathematics			0.687
There are problem-solving strategies that the students must learn.			0.517
Expectations must in mathematics be high of all students			0.787
The textbook is governing the etching of mathematics			-0.587
It is the teachers duty to give the students mathematical models			0.564

Table 3. Details of the factor analysis showing the weightings on each item. Lower secondary teachers included.

Groupings according to ability			
support the learning of mathematics	0.799		
Mathematics should be taught in mixed-ability groups through comprehensive school	-0.777		
Mathematics is best taught in homogeneous groups	0.739		
A big variation between students is a hindrance in teaching	0.713		
All students learn more mathematics with setting	0.682	0.424	
Expectations must in mathematics teaching be high of all students.	-0.563	-0.466	
Mathematical skills are appreciated by the society	0.754		
School mathematics is useful in life	0.706		
The approach of the teacher can affect the students' attitudes	0.704		
There are problem-solving strategies that the students must learn.	-0.543		0.416
The curriculum is an important governing authority		0.897	
Enough consideration is taken of mathematical thinking ability in assessing the students	0.445	0.675	
Working individually is the best way to reach the learning goals		0.415	
As a teacher of mathematics I also teach values		0.833	
National evaluations are important in my teaching		0.637	
The creativity of the students is developed by mathematics teaching		0.571	
My picture of a good mathematics teacher was mostly formed during the school and study years		0.833	
My picture of a good mathematics teacher was mostly formed during my teacher years		-0.818	
It is the teacher's duty to give the students mathematical models			0.564
Variation in teaching supports the learning if mathematics	0.509		0.535

Table 4. Details of the factor analysis showing the weightings on each item. Upper secondary teachers included.

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