Mother-tongue of teaching mathematics project

Eva Norén
Department of education in mathematics and science
Stockholm University, Sweden
Email: eva.noren@umn.su.se

This paper gives examples from a bilingual mathematics teaching project which was run in five multicultural schools in Sweden. In the project bilingual mathematics teachers seemed to promote mathematical learning and engagement in the classroom by using two languages in mathematical discourses. Pupils and teachers communicated mathematics in different ways and the interplay between mathematics and language often became obvious. Bilingual pupils participating in the project said they were able to learn more and they felt secure with the ways of using languages and talking mathematics. Participating in the project gave many of the pupils a confidence in their mathematics competence.

Key words: Bilingual, teaching, concepts, mathematics, experience

Introduction

This papers' objective is to describe and give examples from a qualitative evaluation of a mathematics teaching project in multicultural environments. In Stockholm, Sweden, and its suburban schools there is approximately 35 % minority or migrant pupils, in some schools up to 98 %. Their origins are from different countries and together they speak more than 100 diverse languages. During the last years a lot of new pupils arrive to school from Iraq and Somalia.

Five suburban schools in Stockholm, dealing with migrant pupils between the ages of nine, and sixteen participated in the *Mother-tongue of teaching mathematics* project. The project was in progress for two full school years, 2004 - 2006. The project focused on migrant pupils, who had recently arrived to Sweden, but also on migrant pupils who have been in Sweden for a long time. The five schools had classes teaching mathematics in both Swedish, and either Arabic, or Somali. The main aims of the project were to enable pupils to develop their mathematical knowledge, to get higher levels and grades in mathematics, and to use and develop their bilingualism in a mathematical learning environment. Seven bilingual teachers and about 60 pupils participated in the project. Three different organisational models were used for teaching mathematics:

1• all instruction by a bilingual teacher

2• the students had half their lessons in Swedish and half in their mother tongue

0• mother-tongue teaching involved extended time and is in addition to the regular teaching, which took place in only Swedish

Even though seven teachers taught bilingual in the project, examples in this paper derives from three of them teaching mathematics in three different schools. Their bilingual students had all their mathematics lessons in a bilingual classroom. Two of these three teachers had several years of experience in teaching mathematics monolingual in Swedish in the same schools as they did teach bilingual within the project. Before the project started the third teacher referred to in this paper used to teach Somali, as a language, to Somali speaking pupils.

The *Mother-tongue of teaching mathematics* project was qualitatively evaluated by me (Norén 2007).

Background to the project

Lately studies around the western world show that minority students with different linguistic and cultural backgrounds achieve poorer results in mathematics than majority students (Secada 1992, Skolverket 1997, 2007). National studies in Sweden, as well as PISA and TIMSS[1] studies have shown that several immigrant pupils in Sweden don't reach the lowest curriculum objectives in mathematics. Pupils' differences in mathematics achievement have become wider and there are concerns about minority students' marginal performance in mathematics in Swedish mathematics classrooms (OECD 2006). Often students' low performances in mathematic refer to deficiencies that call for remediation in the students, in their languages or cultural backgrounds. One example is their "lack of Swedish ness" (Parszyk 1999, Runfors 2003).

Migration enforces teachers to take into account that mathematics and mathematics education are very much dependent on language and culture, as minority students often do not succeed in school mathematics (Skolverket 1997, 2007). Barwell, Barton & Setati (2007) argue for the great importance of recognising that "language and multilingualism in particular, interacts with learning mathematics" (p 115). Moschkovich (2007) says that early studies of bilingual students learning mathematics often focused on word problems, translating from the language of instruction to mathematical symbols. Students' vocabulary and reading skills in the language of instruction were also focused on. Most studies until recently have been upon bilingual or second language learner students participating in monolingual instruction mathematics classrooms. Results have shown that it is a complicated task to learn mathematics in a second language one not is academic proficient in and to develop mathematics skills and mathematics communicative capacity at the same time. Adler (2001) focused three dimensions in multilingual mathematics classrooms: pupils' access to the language of instruction, pupils' access to specific mathematical discourses and ways of talking in school and classrooms.

An earlier Swedish study by Parszyk (1999) showed that the more diversity between students' and Swedish culture the harder it was for students to solve text problems in Swedish mathematics national tests. As both instruction and national tests were based on western main stream perspectives it made it difficult for students to achieve good results as their earlier experiences were not the same. Parszyk also gave evidence for minority students' believing that school was not for them but for others, they did not feel included in the classroom discourse.

[1] International OECD studies concerning students results in school

In Sweden the objectives given by the Riksdag [the Parliament] for national language policy are four. The fourth objective is:

> Everyone is to have a right to language: to develop and learn Swedish, to develop and use their own mother tongue or national minority language and to have the opportunity to learn foreign languages (p. 20).

Theoretical perspective in the evaluation

Within the evaluation sociocultural influences were important as I regard mathematics as socially, culturally and historically constructed (1978, 1987, Rogoff 2003). By using a sociocultural perspective it is possible to view the languages and cultural backgrounds of the teachers and pupils as resources for teaching and learning mathematics and as a potential for the pupils future lives (Moschkovich 2007). Languages is then looked upon as cultural mediating artefacts (Vygotskij 1978) and learning mathematics occurs collaboratively in the context of shared events and as each ones experiences (Dewey 1980), languages and cultural backgrounds were valued as resources – students became empowered (Cummins 2000).

Methods for the evaluation

Ethnographic methods (Hammersley & Atkinson 2007) were used to collect data for the evaluation. I was a participant observer during two years, doing more than 60 observations, in the bilingual mathematics classrooms within the project. I was observing the mathematical activities and the interaction, in which teachers and pupils used the languages Swedish and Arabic or Swedish and Somali. Furthermore I participated in the bilingual teachers' network, established by the bilingual mathematics teacher from the five schools, Swedish speaking mathematics teachers and two project coordinators. I interviewed and had informal conversations with teachers, students, school principles and official clerks.

Mathematics curriculum, mathematical discourse

Swedish curriculum promotes mathematics teachers to vary teaching in a conceptual discourse, including ways of communicating mathematics in classrooms and using problem solving as a base for understanding. Even so, in Swedish mathematics classrooms a procedural or calculational[2] (Cobb 1988, 2000) discourse is common as pupils often work by themselves trying to construct their own knowledge by following instructions from text books (Skolverket 2003, 2004). In the *mother-tongue teaching of mathematics* project classrooms a conceptual discourse[3] were more often found. Contrary to earlier results, within the project, students communicated; teachers taught, instructed and guided their pupils. The bilingual teachers seemed to inspire their students and promote mathematical learning by a rather conceptual and communicative mathematical discourse. Lone individual work in mathematics textbooks successively became less common as the project was running on. The mathematical discourse changed from a procedural to a more conceptual discourse.

Often pupils participating in the *mother-tongue of mathematics teaching* project took initiative to communicate mathematics concepts. Frequently they asked their bilingual

[2] Mathematics has its own mode of discourse and register, to "talk mathematics" involves calculational or procedural ways how to "do" mathematics, focusing on rules and procedures; how to calculate

[3] Reasons for calculating in particular ways are discussed

teachers to explain further and to give more examples on the white board to the whole group of students. The pupils did not work much by themselves in their text books. Teachers often let the students themselves take part in writing and drawing on the whiteboard and try to explain certain areas of mathematics to their fellow students. For example how you can find the heights in different triangles and why there are three heights in a triangle. As a girl in eight grade explained pointing to her drawings on the whiteboard using Swedish and once in a while hesitating, the teacher told some concepts' words in Arabic and gave an explanation to what a triangle *base* [bas] is in Arabic. Together, in Arabic and Swedish, the teacher and the girl, by drawing 90° angles, connected the bases in an acute-angled triangle to the heights in it.

It seemed to be possible for the bilingual teachers to promote pupils engagement in mathematical thinking, by using two languages. Some teachers also stimulated meaningful discussions in mathematics by using their earlier experiences as pupils themselves in their country of origin, then reflecting diverse traditions of instruction. One example is when an Arabic speaking teacher beside 3,14 introduced $\frac{22}{7}$ as an approximation for Π. She said it was common in her country of origin (Iraq) to use both of them. An interesting discussion aroused among the students in ninth grade as they found other ways of looking at the constant relations between radius of a circle, circumferences and areas of circles. This discussion deepened the students' conceptual understanding of these phenomenons. In Swedish mathematical textbooks the approximation $\frac{22}{7}$ is sometimes used in historical texts about Π.

Textbooks and text problems

Pre-produced textbooks domination is influencing Swedish mainstream mathematics teaching. The textbooks also influenced the bilingual teaching in the project. The bilingual teachers had no choice but to use the books or other types of materials that already was used in the schools participating in the project. It might indicate that Swedish mathematics teacher's have implicit preferential rights of interpretation, making multilingual teachers feeling obliged to follow the same script (Stigler & Hiebert 2000) as they do. Power relations did not seem to bee equal as Swedish mathematics teachers chose the written material the students worked with during mathematics class. This may perhaps be a sign of monolingual Swedish speaking teachers' interpretation of students' low achievement as failures within the students' personalities, backgrounds, experiences and culture rather than the teaching. These issues indicate that mathematics education designed for multilingual students includes more to deal with than switching languages of instruction. Sometimes it was not enough just to translate text problems from Swedish to the pupils' mother tongue. Text problems in mathematics, written in Swedish often connect to Swedish, or at least western, cultural phenomena. These text problems sometimes seemed to cause worries for pupils with cultural backgrounds other than Swedish

One example of this is when two Somali speaking boys in fifth grade tried to solve text problems. Their Somali speaking teacher translated the text tasks from Swedish to Somali, but the translation did not appear be a help to them, especially not with the problems like this one, derived from the fairy tale of 'The Princess on the Pea':

> In the fairy tale the princess on the pea had 20 mattresses. Each mattress was 10 cm. Her bed was 50 cm high. Did the princess fit on top of the bed if her bedroom was 280 cm from floor to ceiling?[4]

The two boys said that the context in the written task was not familiar to them. They got no image of what the bed would look like as they had never heard the fairy tale. It made it difficult for them to make the arithmetic calculations even though they should not be complicated for pupils eleven years of age. The boys even had problems imagining what one mattress would look like. Their Somali speaking teacher tried to tell them in Somali and Swedish but it ended up with the teacher drawing pictures of the bed, the mattresses and the room. In a discussion on Somali and Swedish between the three of them, the boys at last solved the task. There was 30 cm to go for the princess they said and their answer was that she would fit in as she was thin. Along with the written task was a picture of a girl sleeping in a bed. You could see her eyes closed and her hands on top of a blanket. The bed with all the mattresses was not shown in the picture. The experiences of the boys were not taken into the choice of mathematical text problems to work with. It was a Swedish speaking mathematics teacher who had chosen the problem. The boys could not contextualize the mathematical task.

As a teacher one can assume that these two Somali boys lacked experiences of having been told common Swedish or Western fairy tales, they didn't know much mathematics or they didn't know Swedish good enough to understand the text problem. Various interpretations give different answers how to go on with the boys' education in mathematics. A sociocultural perspective in the mathematics classroom, with a view on the these students as bilingual and second language learners with resources and experiences to learn mathematics, and an emphasize on the their participation in discourse practices could empower them, as well as enrich views on the relationship between language and learning mathematics. As Moschkovich (2007) writes.

> … a sociocultural perspective shifts away from deficiency models of bilingual learners and instead focus on describing the resources bilingual students use to communicate mathematically. Without this shift we will have a limited view of these learners and we will design instruction that neglects the competencies they bring to mathematics classrooms (p 90).

Classroom discourse

Pupils participating in the project said they felt included and secure with the ways of talking in the bilingual mathematics classroom, or, expressed in another way, in the classroom discourse. In interviews and informal conversations pupils articulated their feelings of participation and involvement in the mathematics classroom. Many of the pupils, not recently arrived, had earlier experiences of only Swedish mathematics teaching. Some of them expressed that it sometimes had been difficult for them to answer questions and it had been even harder for them to ask questions to teachers and to ask them for help in an "only Swedish" teaching classroom. They said the situation changed when they were able to use their mother- tongue and had a bilingual mathematics teacher teaching them. They talked about feeling included and secure within the frames of the project. One pupil, representative, in eight grade said:

[4] My translation, the text is formulated by Forsbäck & Olsson (20xx) in Swedish

> It was fun with the unity when everybody spoke the same languages and … like that … you come close to each other. … No one was left behind or left alone.[5]

Many pupils enjoyed and appreciated to be able talk and use both their languages when learning mathematics. If they did not know "the words" in one language, they could say it in the other language, their teacher or a school mate could tell them. Often they learned to communicate and use words in both languages for mathematic concepts even though the bilingual teachers often focused on the Swedish words for concepts as Swedish were used in their text books. Swedish is also the language of instruction in all other school subjects. In the future, after compulsory school, the students would probably not have the opportunity to go on learning mathematics in a bilingual environment. Because of that fact the bilingual teachers found it necessary to focus the Swedish words for important concepts, for example as in geometry *circumference* [omkrets], *area* [area], *diameter* [diameter], *radius* [radie].

The bilingual teachers mostly used mother-tongues for explaining while using vernacular expressions used in daily life. One example comes from a repetition lesson about how to add, subtract, multiply and divide *fractions* [bråk]. One of the bilingual Arabic and Swedish speaking teacher used the Swedish words for *numerator* [täljare], *denominator* [nämnare], ***lowest common denominator*** [minsta gemensamma nämnare], *shorten* [förkorta] och *extend* [förlänga]. Almost all the rest of the teaching review was in Arabic. The teacher was well aware of her code switching to focus, as she said, the important words for the concepts in Swedish, but also to relate to the experiences pupils have in their daily life when they frequently speak their mother-tongue. In the bilingual mathematics classrooms the interplay between mathematics and language often became obvious. One Somali and Swedish speaking teacher sometimes spoke Somali while writing on the white board in Swedish. He was also well aware of his way of code switching to focus, as he said, the connection between the two languages according to mathematics concepts and to get his pupils to understand mathematics better. One girl, age 13, said in an interview that before she had not understood anything in mathematics, but "now when I have it in Somali it is a lot easier, I understand a lot".

Teachers with earlier experiences of teaching monolingual in Swedish, then participating in the bilingual project, stated that the pupils communicated more often and asked more questions when they were able to use both languages, in the same way as they often do between friends when not in class, and within their families.

It seemed as though the bilingual teachers, as one could expect, considered students first languages as resources for constructing mathematical knowledge and communicating mathematically. As the teachers, had immigrant backgrounds themselves, most of their own education are from their countries of origin, but also schooling in Sweden, it might be natural or come by an awareness of how complex the situation can be, when someone has to learn in a language not ones first. As the teachers had the same language and cultural background as their pupils, they were able to draw on their own and students earlier experiences, and to use code-switching and ethnomathematics (D'Ambrosio 1997) perspectives, as tools for teaching and learning mathematics. The teachers or the students could have said the same thing as Setati (Barwell & Setati 2005) expressed, in a dialogue with Barwell, by saying "Whenever I bump into some mathematics that does not make sense to me I draw on my social, cultural and linguistic resources to make sense of it" (p. 22).

[5] My translation

At the start of the project there were doubts about it from different directions and persons involved. One example comes from a headmaster, in one of the five project participating schools. He points to an important fact. He had objections and his main concern was that he wasn't sure a bilingual teaching mathematics project would benefit the pupils learning of Swedish. At the end of the project he said that when he realised pupils "could get grades in mathematics without knowing much Swedish" all anxieties of the kind disappeared. He said he realised that pupils' ability to show and expand their knowledge in mathematics strengthened them and made them proud of themselves. That influenced the whole situation for particularly the newly arrived pupils in school, to the better, he said.

Conclusion

The students who seemed to achieve most within the project were recently arrivals to Sweden, age 14-15. They would reach the final classes in Swedish compulsory school within a year or two after their arrival. If they had not been in the bilingual teaching mathematics project they would have had all their instruction in Swedish, in a preparation group, struggling learning basic conversational fluency, and probably not getting the same chance to reach mathematical progress.

For a second language learner it is difficult to use communication skills and achieve cognitive creativity to solve problems, at the same level as a first language learner, as he/she has not yet required the same level or stage in Swedish language development (when it is the language of instruction). There will be a language barrier. In bilingual mathematics teaching the bilingual students get access to languages of instruction, the language barrier falls and the students are learning as well in their first as in their second language.

Minority pupils' access to study mathematics is of great importance and seems to increase while they have possibilities to use their first language as a language for learning mathematics alongside Swedish. Teachers have to depend on what pupils bring with them into the mathematics classroom and to what their earlier experiences are. The bilingual teachers participating in the project considered students first languages and cultural backgrounds as resources for constructing mathematical knowledge. Some of them considered ethnomathematics perspectives, according to their own and pupils' earlier experiences, as in the above mentioned example of Π. Some of them saw also the pupils' lives and their environments of today, as resources for developing mathematics concepts.

Teaching is a cultural activity (Hiebert and Stigler 1999) signifying that teaching is learned through participation over long periods of time. One example; in Swedish mathematics classrooms, it is often more customary to concentrate on decimal numbers than fractions. In some other countries, Somalia for instance, it is more common to work a lot on fractions. Apparently the bilingual teachers in different ways had to struggle with the only Swedish speaking teachers about power – who was to choose materials and content to work with in the mathematics classrooms? A move towards comparison between differences and use of countries diverse subject content and ways of teaching could have been an area of cooperation connecting the bilingual and the Swedish speaking mathematics teachers.

When pupils, through their mother tongue get access to mathematics discourse, which have a high amount of symbolic capital (Bourdieu 1991) in Swedish society at large, it seems as though the status of students' first languages enhance. Symbolic capital is added to the mother-tongue. *My language is good enough for learning mathematics* is a thought expressed

within some of the pupils' and bilingual teachers' ways of speaking about mathematics and language. Some pupils seem to develop a deeper interest in mathematics and also got better results in tests.

As Sjögren (1997) wrote: "In Sweden the principle of home-language[6] teaching as a way to provide students with an academically sound bilingualism has been accepted for more than twenty years, but still has great difficulties in becoming incorporated as a basic element into the school curriculum." (p. 7). Since 1997 the view on pupils' home-languages or mother tongues has changed. There has also been a shift in official policy which language to use for instruction in mathematics education. The *Mother-tongue teaching of mathematics* project is a result of the change of attitudes towards bilingual or/and mother tongue instruction. But still there are hesitations among teachers, politicians and administrators. Sjögren (2002) says:

> It's not so much Swedes themselves who are 'Swedish,' but institutions-the Swedish schools, parliament, police, press, and so on. And being institutions, they are extremely slow to change. They support the existing ideology and way of thinking (p 16).

There seem to be a lot to gain when bilingual teachers' and pupils' first languages are used for teaching and learning mathematics, in Swedish mathematics classrooms. To be able to communicate in a mathematical learning situation, pupils need to use their language(s) of thinking, their cultural and social backgrounds as tools for mediation, to be able to develop new concepts and ways of understanding. It can mean a lot to pupils' confidence in themselves to be "good at" mathematics in school, in a society like Sweden.

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[6] Before 1997 the word home-language was used, after 1997 the word mother-tongue is used for the same phenomenon

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