



MATHEMATICS AND MULTILINGUALISM – WHERE IMMIGRANT PUPILS SUCCEED

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Abstract: Children of foreign origin are increasingly failing in mathematics in Swedish compulsory schools. This article analyses the didactics at a school proven very successful in teaching mathematics to all children including the 70 % of children of foreign origin. The situation at the studied school is compared to research of the Swedish school system through the concepts creation of meaning, intercultural leadership and linguistic approach. The environment at the school is signified by: 1) a linguistic approach to mathematics 2) interplay in classrooms of mathematics between visual and practical materials and problem solving rarely focusing on textbooks 3) a learning and problem solving organization where “Swedishness” (that is to say the Swedish way) is not the norm by which students are judged, including a positive approach to multilingualism 4) high expectations towards pupils and 5) teachers and the school leadership holding an inclusive approach to pupils who need support in learning compulsory school mathematics. Supplementary teacher training has proven to be one factor of great importance in classrooms of mathematics. The studied school shows signs of being a learning organization where one teacher takes on the part of a knowledge activist – provoking new ways of thinking (Jacobssen & Thorsvik 2008).

Key words: multilingual, mathematics, intercultural leadership

Introduction

During the past decade the compulsory education in Sweden is facing a new challenge as the learning-gap between students of different socio economic backgrounds is increasing. According to PISA (Programme for International Student Assessment) 2009 this gap is today larger than the OECD (Organisation for Economic Cooperation and Development) average (Skolverket 2010:b:28). One group of students which is increasingly facing problems is children of foreign origin. According to the Swedish National Agency for Education, 10 % of students with parents born within Sweden lack grades sufficient to proceed to high school. For students of foreign background as many as 25 % fail (Skolverket 2010:a:58). In comparison to 2006 the share of students of foreign background failing has increased by 2 % (Skolverket 2006:a:62).

Many students fail in mathematics. Since 1998, 20 % of students of foreign background constantly fail in math. This fact should be put in contrast to the evaluation of immigrants’ success according to PISA 2003 where immigrants have a high motivation and strive to study mathematics. In several countries such as Canada, Macao-China, Australia and New Zealand immigrant students reach similar results to “native” students. OECD points out that the reason for lower results can be explained by immigrants’ language and background but can also be connected to the attitude of the recipient country (Norén 2010:21f). The disadvantages of students of foreign background within the Swedish school system have been explained by Hansson as an effect of social and pedagogical segregation often going hand in hand (Hansson 2011).

Although the overall results of students of foreign background seem discouraging in Sweden some schools show contrary results. This paper aims to investigate and analyze practices in such a school where pupils have been known to succeed in mathematics. Here 95,7 % of pupils in grade five succeed in mathematics as compared to the average Swedish school which reaches only 88 %. The school is situated in a suburban and segregated area outside a major city where pupils come from mainly limited

socio-economic backgrounds. The rate of second language learners are 70 % of all pupils in this school.

The study focuses on a qualitative analysis of a school environment which reaches high results according to official statistics by the National Agency for Education. To investigate “best practice” is in line with the ethical aspects of research within the Humanities and Social sciences of the Swedish Research Council (Vetenskapsrådet 2002).

Pre-study

In preparation for the main study a minor field study was executed. Here attitudes of school leadership within three different schools in the same municipality were investigated. The results show that the school reaching outstanding results in mathematics has 70 % second language learners and uses a clear linguistic approach to teaching. Two other schools with 40 % and 20 % second language learners do not reach equivalent results in math and their approach is linguistic to a minor extent. Consequently linguistic theory became an important tool to shaping the theoretical framework of the study.

Aim and questions

The aim of the study is to map out the didactics in mathematics and the culture of the selected school. The analysis is based on a socio-political viewpoint that power is relational and reflected within schools. According to this idea the interplay between schools/teachers and the families/students can either support or resist the support of minority groups. The didactics of mathematics are studied through concepts such as, creation of meaning, intercultural leadership and scaffolding. The questions in focus are: 1) what is emphasized as functional didactics in mathematics for pupils of foreign origin? 2) What materials are used? 3) What attitudes are held towards bilingualism and how is the teaching of mother tongue organized? 4) Which expectations are nurtured towards pupils and 5) how are children in need of support cared for?

Method

By using ethnographic methods, mainly interviews and participant observation, data was collected in four mathematics classrooms which corresponded to consecutive ages of education. The data include field notes and observation of artifacts in the environment as well as interviews and informal conversations with teachers and school leadership. Information from the school website, Swedish National Agency for Education and the municipality were also used.

Creating meaning in mathematics – a Swedish background

Jean Piagét as well as Lev Vygotskij both stressed the importance of activities and experience as a foundation for children to build upon for developing knowledge – constructivism. Individuals should actively seek meaning in order to learn. While Piagét focuses the explorative part of learning Vygotskij stresses the importance of language and interaction as a medium to convey meaning.

Swedish school Curriculums has since the 1960's increasingly pointed out the importance of engaging pupils in mathematical discussions and explorative mathematics (Whyndham, Riesbeck & Shoultz 2000:48). The most recent curriculum of 2011 avoids pointing out how teachers should work but rephrases the constructivist aims as abilities which pupils should meet, i.e. communicative skills to argue for and explain mathematical questions, calculations and conclusions (Lgr 11). Despite official aims to create explorative interplay and communication in classrooms of mathematics, research shows that pupils in general are left to individual calculating and an outdated epistemological attitude among teachers of mathematics (Skolverket 2003:24).

As explained by Schoenfeldt mathematics can be understood in different ways. At the one end of the spectrum knowing mathematics is to master facts and procedures dealing with quantities, magnitudes, and forms. At the other end of the spectrum, mathematics is conceptualized as a "science of patterns" based on empirical evidence (Shoenfeldt 1992:3). The different ways of conceptualizing mathematics would inevitably lead to different kinds of teaching where Shoenfeldt advocates the latter approach leading to a practical understanding of mathematics as a science.

From a historical point of view, however, the aim of Swedish school mathematics has never been to create an understanding of mathematics as a science according to recent research by Lundin. He points out that the role of Swedish school mathematics has been to sort out students and to keep them disciplined (Lundin 2011:373). Although Swedish curriculums during the past 60 years have been pointing out the need to communicate and experiment in order to reach an understanding of mathematics as a science, the long tradition of understanding math as mastering facts and procedures lingers on. The difficulties to change practice in Swedish classrooms can be explained by the fact that mathematics as well as language is a carrier of values (Rönnerbergs & Rönnerberg 2006:1:5ff). Another reason could be the lack of training among teachers (Sterner & Lundberg).

How math should be taught has been formulated in several studies. The successful teacher holds discussions at different levels coupled with individual reflection according to Clarke & Clarke while Stiegler & Stevansson stresses that lessons should contain reflection around few problems and the teachers tone kept considerate (according to Emanuelsson & Doverberg 2006). McIntosh discusses the need for children to communicate around practical challenges and problems in practical experiments (McIntosh 2008:3). This strategy is in accordance with Malmer and Kruse who underline the need of experiments to create an “inner archive of images” within the pupil, as a basis for making generalizations and developing mathematical understanding. Anderberg & Källgården stresses a balance between creative activities and knowledge of mathematical concepts, methods and expressions. They also focus on seeing different ways to problem-solving, choosing method, verifying results and written as well as oral accounting (Anderberg & Källgården 2007:6).

The study aims at mapping out in what way teachers create meaning in classrooms of mathematics in the chosen school.

Intercultural leadership and multilingualism

As formulated by Charles Taylor our identities are developed through interplay with other human beings and the society around us. Should the image which is reflected present a narrow or degrading image of us, this could lead to severe damage forcing us into a corrupted existence (Taylor 1994). The intercultural concept focuses aspects of inclusion of minority groups mainly from an ethnic and multilingual point of view. Through this focus is investigated the ability of the school to present an attitude towards pupils of foreign origin which enhances their opportunities to succeed despite cultural and linguistic differences.

Intercultural leadership is defined by Lahdenperä and includes many different aspects within the organization as well as in the classroom. Through the empirical data some of these aspects are investigated. One focus is the consciousness of teachers referring to their awareness culturally and their ability to reflect upon themselves in relation to expectations towards the pupils.

Another factor of importance is an inclusive approach (Lahdenperä 2008:56). Swedish special needs education and support teaching has historically been organized through logic of “segregated integration” where children through expertise judgment were singled out from their original environment to optimize learning. This way of organizing has of late been questioned and the attitude has changed towards logic of “inclusive integration” where recourses should come to the pupils within their home environment. The inclusive approach focused social training and the building of fellowship as well as a democratic participation of all children in the group (Haug 1998:23).

Supplementary training of teachers and the ability of the organization to learning and problem solving are other aspects of intercultural leadership as stressed by Lahdenperä. It involves how the organization safeguards and utilizes learning. This could include transforming quiet knowledge of co-workers into explicit knowledge in written or oral form. But it can also focus on how explicit knowledge is transformed into quiet knowledge through making a synthesis of supplementary training.

Second language learners have much to gain from mastering their mother tongue and the intercultural leadership encourages students to take part in such studies. The cognitive advantages first formulated by Cummins in 1979 have been a great inspiration to international research during the past three decades leading to a unanimous research community supporting education in favor of pupil learning

their mother tongue (Nygren-Junkin, 2011). The Swedish National Agency for Education supports multilingualism while schools face organizational problems and minority groups have problems arguing their individual rights to support teaching.

All these aspects are described in the study within the concept of intercultural leadership.

Linguistic approach and Scaffolding

In order to improve opportunities for children of foreign origin Jim Cummins argues that they must be encouraged to read and write extensively. He underlines the need for a “learning-community” in the class room where everyone can make their voice heard. In order for children to reach past a basic interpersonal communication skill (BICS) to a cognitive academic language proficiency (CALP) subjects should be taught in a linguistic way (Cummins 1996:91).

Pauline Gibbons develops her thoughts around scaffolding as a central theme in a linguistic approach to teaching. The scaffolding concept originates from Wood, Bruner and Ross referring to the way parents and small children bring about conversation. Gibbons interpretation refers to the ability of the teacher to help the pupil to reach new abilities, new concepts or new levels of understanding through temporary help or temporary limitations (Gibbons 2010:29).

In order to enhance understanding of mathematical concepts for second language learners Mohan and Cummins encourages using other representations than verbal or symbolic (Rönnerberg & Rönnerberg 2001:25, Cummins 1996:77). This is in line with The Swedish National Agency for Education where Löwing & Kihlborn argues that the aim of teaching mathematics should be for the learners to absorb certain mathematical concepts and models step by step. They advocate a route starting in the simple and concrete end moving towards abstraction and increased complexity (Löwing & Kihlborn 2008:125). This route is consistent with teaching methods aiming at reaching all children including those with other difficulties than language where the visual and multisensory aspects play an important part (Malmer 2010, Kruse 2010, Sterner & Lundberg 2002).

Results and analysis – main differences

Expectations and support teaching in mathematics

Observations show that expectations on pupils are held high and the importance of high expectations is stressed by the teachers during interviews. To keep high but realistic expectations towards pupils coincides with the attitude of successful teachers of mathematics (Clarke & Clarke 2006). This differs in comparison to the general attitude in Swedish schools where children of foreign origin are often segregated pedagogically due to their cultural or language background as found by Hansson (Hansson 2011). To segregate pupils due to a specific difficulty can lead to lowered expectations on the group with a negative self-image as a result (Haug 1998:56).

All pupils at the observed school are getting support within the classroom from their mathematics teacher rather than being singled out to receive support elsewhere. Should the pupil need extra lessons the teacher could temporarily also give him/her that in order for all students to reach a proper understanding of a topic in mathematics. Support is given within the classroom as teachers spend more time with pupils in need. This indicates that support teaching is practiced with an inclusive approach which is also stressed by Lahdenperä as significant for intercultural leadership (Lahdenperä 2008).

Interviews show that the teachers do not doubt the pupils’ abilities. They focus on their own teaching as the main instrument to making pupils’ understand. They also make individual arrangements for pupils with certain difficulties and take time to discuss these questions with the class in order for the other pupils to understand and respect such arrangements.

Visual and practical material in mathematics

When observing the classrooms it is obvious that practical and visual materials are often used when teaching mathematics. Pupils are given numerous opportunities by the teachers to verbalizing mathematics in connection to viewing experiments, drawings or objects in connection to mathematical

problems. According to research this is essential for second language learners who generally get few opportunities to verbalizing academic language (Ivory m.fl. in Rönnerberg & Rönnerberg 2001:70, Cummins1996:91).

Didactics are more practical in lower ages and continuously increase in complexity and abstraction. Textbooks are used only to a limited extent which is a significant difference compared to the average Swedish classroom. Here one of the teachers seems to be the inspiration of the others. She is also the teacher who has undergone supplementary training which convinced her to “give up the book”.

Interviews as well as observations show that the observed school has developed new ways of teaching in order to meet the needs of second language learners. This indicates that the school seems to function as a learning and problem solving organization. In the group of mathematics teachers one teacher takes on the part of a knowledge activist – provoking new ways of thinking (Jacobssen & Thorsvik 2008). To be a learning organization with the ability to solve upcoming problems is also a significant part of intercultural leadership according to Lahdenperä (Lahdenperä 2008).

Linguistic approach

Interviews as well as observations show that the linguistic approach is a central method with school leadership, teachers and everyone working here. The overall aim to teaching pupils a context independent language seems to be an important ingredient in welding the culture of the school. When teachers of mathematics here focus their lessons on language it also means that they focus their teaching on the understanding of mathematical concepts. The linguistic approach as practiced in the observed classrooms of mathematics coincides with a focus on conceptual understanding which has been demanded in Swedish classrooms of mathematics (Stenhag 2010).

Group size is a dilemma raised by the teacher acting as a “knowledge activist” at the investigated school. She is skeptical to sizes of groups increasing as she experiences the urgent need for pupils to communicate mathematics. She is aware that some research in classrooms of mathematics does not stress group size as an important factor (Clarke & Clarke 2006:54). However group size can be a relevant question according to research focusing immigrant students which stresses the need for pupils to verbalize academic language (Ivory in Rönnerberg & Rönnerberg 2008:70, Long in Axelsson 2003:141). Group size in the investigated school is generally less than 20 pupils. Among the youngest children math groups are even smaller. During observations among six year olds’ these were taught in half class groups of 5-10 children.

All observations in classrooms of mathematics presented rich opportunities for children to communicate mathematics among themselves as well as with the teacher. All observations in classrooms of mathematics also showed that teachers were skilled in creating a “learning culture” where all pupils could make their voices heard.

Multilingualism

At the school 85 % of second language learners today study their mother tongue. This is a great increase as compared to 2005 when only 38 % took part (Skolverkets utbildningsinspektion 2005:a). Teachers as well as school leadership seem well aware of the advantages of pupils learning their mother tongue even though they claim to encourage such studies to different degrees.

Teachers at the investigated school stress two reasons for pupils to pursue studies of their mother tongue. The first reason mentioned is that it enhances parent-children relations making it possible for parents to govern their children as they grow. The second reason mentioned is the cognitive gains reached by understanding concepts in different languages.

Interviews as well as observations show that teachers are positive to pupils’ language and culture manifesting themselves during lessons. The school also has locally employed teachers of mother tongue and such lessons as well as multilingual support teaching seems well organized. All these facts reflect intercultural leadership as formulated by Lahdenperä (Lahdenperä 2008).

Interviews as well as official documents and information on the school web site indicate a clear and transparent organization of pupils’ rights to support teaching in their mother tongue. However, interviews also reflect the fact that teachers must be the advocates of pupil’s rights (rather than

parents). All teachers are well aware of the costs and feel that they have problems giving enough support to newly arrived immigrants.

Conclusion

The findings indicate that a focus on linguistic dimensions in mathematics through the interplay between visual and practical experience builds up a didactic of a social-constructivist nature that has long been sought after in Swedish mathematics classrooms. This correlates with recent research which couples the linguistic approach to the building of a communicative reform-oriented discourse in school mathematics (Norén 2011). The environment at the school is signified by:

- 1) a linguistic approach to mathematics;
- 2) interplay in classrooms of mathematics between visual and practical materials and problem solving rarely focusing on textbooks, bringing about a didactics of a functional social-constructivist nature;
- 3) a learning and problem solving organization where “Swedishness” (that is to say the Swedish way) is not the norm by which students are judged, including a positive approach to multilingualism;
- 4) high expectations towards pupils;
- 5) teachers and the school leadership holding an inclusive approach to pupils who need support in learning compulsory school mathematics.

Supplementary teacher training has proven to be one factor of great importance in classrooms of mathematics. The studied school shows signs of being a learning organization where one teacher takes on the part of a knowledge activist – provoking new ways of thinking (Jacobssen & Thorsvik 2008).

Innovations within the field of didactics have often arisen through developing methods for children facing specific challenges. There is reason to believe that the linguistic approach which has been developed for children facing challenges as second language learners can be a functional method to teaching mathematics to all children.

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