ON GIVING MEANING TO SOCIAL SCIENCE STUDENTS. A CASE FROM SWEDEN

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ABSTRACT

Compulsory mathematics for social science students is problematic. We discuss the case of a group of students in Sweden who met a mathematics course inspired on the ideas of critical mathematics education and ethnomathematics. The evidence collected about studentsôexperiences on this course indicate that opening a space for agency and linking mathematics to their foregrounds can be the basis for a more meaningful mathematical experience. Such as experience has the potential of contributing to the process of studentsô subjectification.

Keywords: Critical mathematics education, ethnomathematics, mathematics for social science students, meaning, agency, foreground, subjectification.

INTRODUCTION

That students have troubles with mathematics is not any news. Some countries and particular educational institutions believe on all the good reasons to teach all students mathematics, including those who, beyond basic compulsory education, have chosen study paths that do not in a direct way involve mathematics. That is the case of, for example, students who have chosen a humanistic or social science path in high school and who will probably join further studies where mathematics is not required. The political or administrative decision of offering advanced high school mathematics for all is far from being problematic since it forces mathematics teachers to instruct students who are highly unmotivated to engage in the learning of mathematics. From the part of many students, who either define themselves as ñmath hatersò, or just see it

studying a subject that they do not like, it is difficult to understand why they have to invest energy in a subject that they will never use for anything in their future lives. For both teachers and students the decision is problematic.

There are few studies and experiences in the international research literature addressing this problem. Still, there are many youngsters in the world who face a meaningless engagement with mathematics, dictated from higher national policy levels. In this paper we examine this situation for the case of Sweden, a Nordic country that has explicitly made the decision for compulsory mathematics in all the different paths of high school[1]. In particular we inquire why mathematics education seems to be lacking meaning for the many students engaged in the social science line in Sweden. With inspiration in Critical Mathematics Education and the Ethnomathematics Program, we propose possible understandings of the issue of the meaningfulness of mathematics education in relation to the social science students in Sweden. We then analyze an experiment that Annica Andersson introduced in a mathematics class of social science students in Sweden. We conclude with a discussion of a central idea for this case ð but arguably for many other cases of other students who struggle to make sense of their mathematical experienceð : a mathematics education that allows students to construct their own project of subjectification has a chance of being meaningful in deep ways.

MATHEMATICS FOR SOCIAL SCIENCE STUDENTS: PROBLEMS AND DILEMMAS

In 2008 in Sweden there were a total of 93.000 students taking the 3-year social science program in upper secondary schools. Of them 32.000 students were in

[1] Compared to the organization of high school in Colombia where all students have all the same compulsory subjects in upper secondary school, in many European countries there is a policy of study path which students can make. Normally students in a scientific path will have to deal with many mathematics courses preparing them for scientific or engineering studies in higher education. Students choosing a humanity or social science line are not required to study mathematics. In Sweden, however, the choice has been made that all students have to complete different mathematics courses of different levels of difficulty and complexity.

mpulsory Mathematics A-course. There are two closely connected study programmes: the social science media programme with 6.600 in their first year and the social science arts programme with 8.300 in their first year. This means that each year there are about 47.000 students, only in Sweden, taking the compulsory Mathematics A course on the social science programs at high school (Skolverket, 2008).

The Mathematics A course is a course covering elementary mathematical content such as arithmetic, geometry, algebra, statistics and basic-level functions. The course is on the borderline to more advanced mathematics studies. The problem with this course is that the mathematics content is not connected to other subjects on the studentsô chosen study path in social sciences. A large part of the course content is recognised by students as topics already studied in primary school; however, the new mathematical content introduced is a lot more advanced than what they have met before. Therefore, those who have achieved highly in mathematics earlier see it as being very boring; while those who have failed see it as an experience that confronts them with problems, contradictions and dilemmas. In any case, students struggle though the course. The question that emerges is: *How can mathematics education get to be meaningful for students on social science programs in upper secondary schools?*

THE NOTION OF MEANINGFUL MATHEMATICS EDUCATION

The meaning that students ascribe to mathematics education as a whole experience is to be seen in relation to studentsô intentions to engage in the activity of learning, where their agency is fundamental. The intentionality for learning is also related to the studentsôforegrounds (Alrø et al., 2009). Thus, the notion of meaning in mathematics education is not only connected to the mathematical conceptual meaning, as supposed by most of the literature in mathematics education (Skovsmose, 2005). Alrø et al. (2009) define a studentô s foreground as referring ò to a personôs interpretation of his or her learning possibilities and ólifeôopportunities, in relation to what the socio-political context seems to make acceptable for and available to the personò (p. 17).

program are a diverse group of students with different cultural foregrounds and backgrounds, different interests and with different experiences of prior mathematics education. However, they have in common their choice of study program and their interest in social science, and a possible foreground for them is to study or work in areas connected to the social sciences. The relation between the notions of agency, foreground and creation of meaning is explained by Alrø et al. (2009) in this way:

> A condition for a person making the decision of engaging in the act of learning is that the activity makes sense, that is, that the person finds and constructs a meaning. [é] The notion of foreground highlights the fact that meaning is not only a function of what the student has already cognized, but also and especially of the studentôs dreams, illusions, aspirations and perceived realistic possibilities for his or her future life. (p. 18)

From the point of view of the individual, the sense that is given to the engagement in the learning of mathematics is connected to the studentsô possibilities of acting and to their foregrounds. For social science students, this idea can be a possibility for exploring how to make mathematics education more meaningful.

Furthermore, we have found inspiration in the philosophical framework proposed by Biesta (2005, 2009) where he argues that there are three main functions for education in our societies nowadays. The first reason is for students to get *qualification*; that is knowledge, skills, understandings and forms judgements that allow students to act and do. The second reason is the *socialisation* function where ñstudents become members of and part of particular social, cultural and political ordersò (2009). The socialisation reason plays an important role in the continuation of both desired and undesired reproduction of culture and traditions. The third reason relates to the students gaining *subjectification*. As Biesta points out, whether all education actually contributes to subjectifying students is debatable. But ñany education worthy of its name should always contribute to processes of subjectification that allow those educated to become more autonomous and independent in their thinking

nework allows us thinking in the function of mathematics education, in general, and in its function to the particular group of social science students in particular. It also opens possibilities to highlight goals in education without constructing the social science students as a group with ñspecific problemsò or ñspecial needsò in the classroom. Instead Biestaôs framework allows us to think what mathematics education has to offer these students as ñmainstreamò students who have to take compulsory mathematics courses, independently of whether they want it or not.

In this paper we start by considering critical mathematics education and ethnomathematics as fruitful ways to develop mathematics education for social science students and to make it meaningful both in relation to their possible foregrounds and to their chosen study program. We describe some of the theoretical foundations of these two trends in mathematics education. We then proceed to relate these ideas to active citizenship education and the aims of the Swedish mathematics curriculum. We then introduce the setting of a teaching sequence and describe its design for creating meaning for social students. We finalize with an analysis of the sequence in terms of how it addresses possibilities for the students to engage in processes of subjectification.

Why Critical Mathematics Education?

Critical mathematics education, philosophically described by Skovsmose (1994), is a mathematics education raising issues as social justice, democracy, equity and political issues in mathematics classrooms. Different people have developed educational practices with these concerns (e.g., Frankenstein, 1999; Gutstein, 2006). They use mathematical projects, tasks and assignments to teach students to ñread the world with mathematicsò (Gutstein, 2008). Critical mathematics education is context-bound (Skovsmose, 2005). To give some examples Gutstein (2006) develops practice in inner-city Hispanic communities in Chicago and Knijnik (1999) in the camps of the Brazilian Landless Peoples Movement. For Skovsmose (in press) it is important that mathematics education addresses both the critical position of mathematics education and that of mathematics. Skovsmose states that problem-based and project-organised

ion are ways of realising critical mathematics education. ñthe problems should emerge from real-life situations, while the project organisation should ensure that students become owners of their learning processesò(p. 1).

In our research work we are starting to see that critical mathematics education, if giving opportunity to students of experiencing meaning and agency, might be strongly connected to their process of subjectification (e.g., García et al., 2009). But if the mathematical activities just are a new set of tasks created by the teacher with real life situations not recognized by the students, we could risk loosing the opportunity to pursue the subjectification goal.

Why the Ethnomathematical Program?

Ethnomathematics can be seen as a concept, a research field and/or an educational discourse (Andersson, 2007). The concept was defined by DøAmbrosio (1985) as the mathematics you find in different identified culture groups. In 1994 DøAmbrosio developed the concept of ethnomathematics further by dividing it into *ethno-mathema-tics*. *Mathema* refers to understanding and coping with reality, *tics* refers to techniques and art and together with the prefix *ethno* it comes to mean the culturally embedded techniques of understanding. In this way the definition includes more than first understood as ethnomathematics (DøAmbrosio, 2006). The ethnomathematical research area defined by Gerdes (1996) as ò the cultural anthropology of mathematics and mathematical educationòdescribes the research field as a field ò n its own right, a field that reflects an acceptance and a consciousness of the existence of many forms of mathematics, each particular in its own way to a certain (sub) cultureò(p.915). DøAmbrosio's arguments for mathematics in identified groups and Gerdes ethnomathematical implications for research gives possibilities in research to address social science students as an group who could have its own mathematical practices and with its own special objectives in mathematics education.

The context in an ethnomathematical educational discourse often becomes

imulate students to reflect on societal issues (Gerdes, 1996). Ethnomathematical educational discourses have also been described as ways to bring discussions about global fairness and justice issues into the mathematical classroom (Archer, 1998).

Both critical mathematics education and ethnomathematics discourses are ways of seeing mathematics education with a concern to address environmental, equity, global and local social issues within mathematics teaching. Since social science students might have possibilities to connect these issues to other social science subjects in school and might have foregrounds with interest relating to these issues, then critical mathematics education and ethnomathematics might be approaches that suit these students particularly well. But, we want to stress the fact that we believe *every student* could benefit from critical mathematics education or ethnomathematics education, especially as it relates to the intentions of active citizenship education, now addressed and stated important in several (Western) curricula.

Citizenship education and the Swedish mathematics curriculum

The Swedish upper secondary school is committed to offering an education that, with all its subjects, contributes strongly to the construction of citizenship. One of the aims in mathematics teaching is stated in the Swedish curriculum as ÒThe subject aims at pupils being able to *analyse, critically assess and solve problems* in order to be able to *independently* determine their views on *issues important both for themselves and society, covering areas such as ethics and the environment.*" (Utbildningsdepartementet, 2000, my italics). One main goal in the compulsory Mathematics A course states that ÒPupils should be able to *formulate, analyse and solve mathematical problems of importance for everyday life* and their chosen study orientationÒ (Utbildningsdepartementet, 2000, my italics). Our interpretation of the role for mathematics teaching in upper secondary schools is that it has to give students mathematical knowledge and competence for taking well-grounded decisions in everyday life, to interpret the flow of information and, thereby, follow, understand and participate in political discussions in society. Since the goals in the Swedish mathematics

ed with words such as ñdemocracyò, ñcritically analysedò, ñsocietyò, ñethicsò and ñthe environmentò we see obvious possibilities for making mathematics education an education for citizenship and democracy. We argue that mathematics education could have a strong potential for education for an active citizenship. Ross (2008) states that three major elements can be distinguished in any effective citizen education programme: values and dispositions, skills and competences, and knowledge and understanding (p. 495). Mathematics ought to be an obvious subject for students gaining knowledge, skills and competencies to become active citizens in society. Vithal (2004, p. 227) also points out that ñhard evidence to support or counter theoretical propositions and associated practices seeking to realise notions of empowerment, emancipation, democracy, social justice, equity and so on through mathematics education is still rather thinò and thus gives the research presented in this paper both significance and relevance. We conclude that bringing citizenship education and mathematics education goals together ought to be an important continuation in the development of both mathematics education and active citizen education.

In the litterature on critical mathematics education and ethnomathematics the importance of answering the questions ñwhyò and ñwhat is the meaningò of mathematics teaching and learning in a particular context are highlighted. A teacher engaging in critical mathematics education and/or ethnomathematics need pedagogic content knowledge as well as abilities to deal with the development of studentsô reasoning skills. The focus of teaching concerns the mathematical contents, skills and competences, as well as the ethical and political dimensions in the tasks, in the teaching situation and in the studentsô learning activity. The activities have to be owned by the students and be authentic for them. In the following pages we present the characteristics of a teaching sequence designed and implemented by Annica Andersson. We together analyse this experience in relation to the issue of meaning and subjectification.

E

In an upper secondary school in southern Sweden 30 social science students participated in a compulsory Mathematics A course during two school semesters. The curriculum for the Mathematics A course was followed in detail but how the different parts of the curriculum and different topics were addressed differed from ñtraditionalò mathematics teaching. The parts of the that changed were designed with inspiration from Critical Mathematics Education and Ethnomathematics. They will be described in detail in the next section. The topics chosen related to issues raised in current debates in Sweden. The remaining topics in the course curriculum were taught in a more traditional way with introductions to the mathematical topic by the teacher followed by counting exercises on work sheets or in the mathematics textbook. The Swedish ethical guidelines (Vetenskapsrådet, 1990) were all followed and addressed during the research process.

As the teacher, Annica, developed tasks for the social science students that connected to the Swedish context. Annica wanted to establish in the classroom a type of interaction where students experienced a high level of agency and of negotiation. We have chosen to describe the following five tasks in detail as they represent a width of what happened during the course.

Example 1. Drawing on Mukhopadhyay & Greer (2001), an activity intending to address the learning of proportional calculation was designed. Barbie dolls were an important artifact in the activity. The students worked in groups of three, using the height of one student in the group as reference. They answered questions like ñIf Barbie had been the same size as you, how big would her feet be? Her eyes? Her breasts? Fingers?ò Annica pushed this exercise a bit further than Mukhopadhyay & Greer (2001) do. Firstly, as there were boys in the classroom they worked on the Ken doll. This raised typical questions among the students as what are gender specifies, why do they exaggerate e.g. Barbieôs eyes and Kens shoulders? Why are Barbieôs feet so small (like baby feet) while Kenôs are big if they were in our size? Why do they both have (very) small

front pages of Runners World magazines were analysed. Runners World is an international magazine with a reputation of promoting good health information with good and well-written articles on food, training and health issues. The six volumes we looked at were from 2007. They had running women on their front pages except one with a male runner. The analysis was pushed further discussing what sells, why do women look as they do on the front pages, and whether they looking like ñrealò women. And what about the man? Measures were maid and discussions on how we can use mathematics to see through e.g. adverts for (male and female) magazines, clothes and make-up were raised. Some students turned up with examples from other magazines the week after and showed how eyes were bigger; finger nails longer in adverts for make-up. And this wasnôt possible to see at a simple glance: the students had to measure to conclude whether the pictures had been exaggerated or not.

Example 2. Inspired in Frankenstein (2008), Annica introduced the students to mathematical argumentation. A pile of daily newspapers were brought into the mathematics classroom and based on different news articles we discussed how to make sense of the big numbers mentioned in different articles. Questions such as why do they show this number in percentage, but that as a fraction? when is it smart to use whole numbers? were raised. Then we decided to use an article on big numbers, concerning the yearly salary of the director of a Swedish insurance company at that time. How much money was it really about? What could that money be used for? The issue was not only to compare, but also to break down the numbers in a way that made sense to the students and hence made the big number comprehensible. The students were free to choose topics and came up with ideas such as the numer of schools for children in Africa that could be built; the number of people who could go on holiday to Thailand; the number of school books that could be bought in Swedish schools; the possible human aid issues like e.g. providing AIDS medicine in South Africa etc. The mathematical topics touched during these sessions were percentage, fractions, decimal numbers, large numbers and basic counting skills.

ask (according to the studentsôevaluation) was a statistical task, which covered mathematical goals to reach in statistics both in the Mathematics A course and the Mathematics B course. This group work was conducted at the end of the Mathematics A course and in collaboration with the teachers in religion education and computer education. The students had, as an assessment task, to do a survey and then write an essay on the chosen topic where they presented a data analysis in appropriate diagrams and tables. They reached statistical goals as e.g. counting means and deviations. The content of the survey was based on questions supervised by the religion education teacher. As counting and data diagrams were done in the data program Excel and presented in Power Point the students also had the opportunity to reach goals in the Computer A course. In the Mathematics course the boundaries were pushed a bit and the students were asked to take a stance in relation to their survey and argue for it in their diagrams and text. By that they were ñaloudò to manipulate diagrams (but not fake them) ð just as newspaper articles and advertisements do. With this exercise they learnt to see through, or at least become aware of, that diagrams and tables seen in the press are usually constructed with a hidden agenda behind.

Example 4. An art class inspired a geometry task. The students got a frame and papers of different colours to choose. The task was to make a pyramidal shaped lantern with a specific volume. The mathematical skills needed were geometric formulas, Pythagoras theorem, algebra calculations and basic arithmetic knowledge. The lanterns turned up in different colours and sizes as the students used different pyramid bases in their calculations. They trained skills as cooperation, collaborative decision making and argumentation within the groups. This task was not planned as a critical mathematics task. However, the studentsôevaluation of the task motivate it being described here.

Example 5. An ongoing discussion over the whole course period was inspired by the ethnomathematics movement. During some lessons we discussed e.g. different Indigenous peoples counting systems and that mathematics different from our ñWesternò mathematics actually do exist in all communities. Relating

the dominance of the ñWesternò mathematics. Possibilities to discuss issues related to topics e.g. in the social science classes were obvious.

MATHEMATICS EDUCATION, MEANING AND SUBJECTIFICATION

The evaluation of what had *given meaning to the students* in the compulsory Mathematics A course took place six months after the students completed the course and was answered by 20 students, using a mixed method research design. First the students evaluated the 15 different topics and education methods from the course in chronological order using a 4-point Lickert scale (Bryman, 2004). Second they were given the opportunity to make comments on each topic they evaluated and these comments we found much more informative than their grading on the scale. The studentsôown comments to the scale gave us an understanding of why they evaluated the way they did in some cases. The third part of the evaluation was an analysis of studentsôtest results and grades during the course.

Evaluating what had *given meaning to the students* and *their experienced personal meaningfulness* two of the topics on critical mathematics education scored highest: the statistics task and the group work on percentage-counting. But also the geometry task making lanterns, scored high. We see that these three activities have in common the possibility for students to exercise a degree of personal agency, defined here as the opportunity to act deliberately according to oneôs own will (Lange, 2009). Contrary to many other mathematical tasks that do not allow agency, these activities allowed students making decisions on the processes of mathematical enquiry This was cofirmed by Peter, one of the students in the class: ñone gets more engaged when one works with something of your own willò

Many students expressed their experiences of agency and meaning. Karin, commented on an awareness of her personal learning strategy: ñ learn best when engaging in group work and less when counting in the book. For me it was meaningful because I learnt a lot. One could talk to each other in the group and help

e understands better when it is fun.ò Vanessa also reflected on a similar issue: ñIt was very meaningful. I learnt statistics in a fun but also in a very worthwhile and instructive way and I know I am very clever reading diagrams in metro☺.ò Knowing to be critical is described by Kim as: ñIt was fun to learn because I didnôt know one could cheat in these waysò Jacobôs comment resonates with Kimôs: ñIt was very good for me how to e.g. see through layoutôart how one gets cheated by a diagramò So did Mariaôs: ñHelpt (me) to become critical to diagrams one seesò Sandra, describing herself as a ñmath-haterò said that ñthis (the statistical task) is the only time in my life I have found maths useful for meò but, sadly, she also said ñand I will never find that againò Anna concluded with a more general comment: ñI think maths becomes more meaningful if one puts it in a real/actual perspectiveò

We interpret the studentsô answer as an expression of having experiencied agency in the course. Many students express their opinion in a very personal way, while few produce more general, objectified sentences about their experience. Independently of the form, we interpret these assertions as an experience that is real/actual for the students themselves. Being able to become more autonomous in thinking and acting is an important part of the subjectification process.

Analysing subjectification and qualification together we conclude all students completed and passed the final national test in this course. Examining the individual studentsôresults and grades a tendency for other students performing well in mathematics than the usual ones in ordinary mathematics test situations could be noticed. It seems as students not usually performing well in mathematics education achieved better results on the topics educated differently when examining the national tests. If this tendency can be verified in coming research it is a very important argument for a different mathematics teaching.

As expected, students who were going to take further mathematics courses pointed to the importance of counting in the mathematics textbook to be well

s. Tinaôs comment ñCounting in the book is good for youôand Robinôs ruseful for further studies in mathematicsòillustrates these opinions. These comments we see more related to these studentsô personal foregrounds, and as seeing future mathematics education in the discourse they have known mathematics education through primary school.

One of the purposes of our research is to elaborate the above-described findings further and suggest implications for mathematical education recognising the students as cultural and social participants. Or, as Pring (2000:18) puts it:

> Central to educational research [é] is the attempt to make sense of the activities, policies and institutions which, through the organization of learning, help to transform the capacities of people to live a fuller and more distinctively human life. Such research needs to attend to what is distinctive of *being a person* – and of being one in a more developed sense.

We conclude by agreeing with Frankenstein (2008, p. 11): ò*n*tegrating math with social studies is an effective way to bring math alive to studentsò

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