Proposal: Comparative research project on components of analytical competences

Lena Lindenskov and Vibeke Hetmar, The Danish School of Education, Aarhus University.

Email: lenali@dpu.dk; hetmar@dpu.dk

In this proposal, the term 'analytical competences' refers to *being a doer of mathematics* (Cobb, Gressalfi & Hodge 2009) in many different contexts inside and outside of school. In accordance with prominent tendencies in many post-Lave-and-Wenger research communities, the proposal is based on the assumption that a complex relationship exists between the development of competences and the development of learners' behaviour as doers inside the domains in which the specific competences are expected or demanded.

Background

References to the notion of beliefs have become increasingly common in the field of mathematics education research, especially in the last twenty years. Most of this research is focused on teachers' and pre-service teacher students' beliefs but students' beliefs are also investigated by mathematics education researchers (Schoenfeld 1985 and 1992; Goldin 2002; Goldin et al. 2009; Leder et al. 2002; Kislenko et al 2007; Maass and Schlöglmann 2009; Perrenet & Taconis 2009). Several issues on students' beliefs have been explored, e.g. relationships between beliefs and other constructs such as students' motivation, interest, performance, problem-solving behaviour, meta-cognition, self-efficacy and use of mathematical conceptions. However, the notion of beliefs is still disputed among researchers and one of the main disagreements concerns whether beliefs should be regarded as phenomenon or as situated process and action.

Some researchers conclude that students' performances are strongly related to their beliefs and attitudes towards mathematics while others conclude the opposite (Callejo & Vila 2009: 113). Results from PISA 2003 point to a rather complex and ambiguous relationship. This complexity is confirmed by Callejo & Vila (2009) who found an observable, complex relationship between students' belief systems and approaches to problem-solving activities when they considered a wide variety of beliefs, e.g. beliefs about the nature of mathematics and problem-solving activities together with motivational beliefs. But according to Callejo & Vila, it is not possible to point to any causality between specific beliefs and students' problem-solving strategies (or vice versa).

In Denmark, we have collected and analysed data from students in a grade 9 in a small study presented at the conference in Seoul October 2009. Our analyses support our assumption that students' beliefs and students' performance in mathematics are interrelated. In the light of this, we invite researchers in network 5 to replicate this Danish study in order to carry out a comparative study based on small scale national studies.

Objectives

The main objective is to investigate relationships between students' performances in mathematics and their beliefs and positionings as doers of mathematics in lower-secondary (grade 8-10) classrooms and to compare the results from a number of different countries.

Theoretical perspective

The term *positioning* is a relatively new concept in educational research. It is rooted in socio-psychological theory and refers to the ways in which individuals relate to each other when interacting in different kinds of discursive practice. We use the term *discursive practice* in accordance with Bronwyn Davies and Ron Harré, i.e. as a reference to "all the ways in which

people actively produce social and psychological realities" (Davies & Harré 1990: 45). According to positioning theory, human identity should be seen as a combination of, or interplay between, a continuous personal identity and a dynamic and discontinuous personal diversity which is realised through the many different discursive practices in which an individual takes part. Davies and Harré state the following:

> An individual emerges through the processes of social interaction, not as a relatively fixed end product but as one who is constituted and reconstituted through the various discursive practices in which they participate (Davies & Harré 1990: 46).

David Wagner and Beth Herbel-Eisenmann, two researchers in mathematics education who are inspired by Ron Harré & Luke van Langenhove's book *Positioning Theory* (1999), have analysed "the way positioning is conceptualised in current mathematical education literature" (Wagner & Herbel-Eisenmann 2009: 1). We agree with their claim that positioning theory leaves a lot of questions unanswered but, nevertheless, we find the concept of positioning extremely well qualified as a basic component in the understanding, describing and planning of classroom activities and interactions.

Most parts of positioning theory research are focused on different kinds of oral conversation and on classroom communication. Among the exceptions are some parts of Norwegian research in writing education where the concept of positioning is used to analyse how student writers express themselves through their written products (Smidt 1997, Ongstad 1996). In our study, we have extended the use of the concept by considering it a basic category for analysing students' statements about their notions and beliefs in mathematics. In this context, one main question has been how students position themselves as doers of mathematics through the ways in which they express their beliefs.

On the face of it, this question does not seem to be entirely in line with the positioning theory offered by theorists as Harré, van Langenhove and Davies as they emphasise the foregrounding of an immanent perspective when dealing with the concept of positioning. According to these theorists, the concept refers to dynamic, mutual established interrelationships in different kinds of discursive practice, i.e. when an individual positions him/herself in interaction with other individuals, he or she at the same time contributes to the possibilities and limitations of the other individuals' positionings. Within the immanent perspective, the main focus is on interpersonal communication which is understood as mutual exchanges of storylines and positionings.

As mentioned above, Davies and Harré describe what is usually termed *identity* as the interplay between a continuous personal identity and a dynamic and discontinuous personal diversity. Inspired by this, we understand students' beliefs together with the ways in which they position themselves as doers of mathematics as parts of their continuous personal identities (e.g. 'I am one of those who find mathematics difficult and boring' or 'I am not one of those intelligent people who can cope with mathematical problem-solving') and we assume that their beliefs and positionings are due to the interplays between being positioned and taking positions in communication about mathematics that the students have been involved in over the years inside and outside of school.

Informants

The informants are students and teachers of mathematics in lower-secondary school. We suggest that the students should attend a grade which leads to a final exam at the end of the school year. For the Danish part of the project, this means that the informants will be chosen from a number of grade-9-classes, i.e. among 15-16 year old students, in urban schools – in Denmark in the city of

Copenhagen. Furthermore, we suggest that all researchers aim at choosing classes from schools which are not known to be especially high or low performing.

Project design on the national level

We suggest a design that follows the following steps:

1. The teachers of mathematics are asked to divide all their students into the following three groups: high-performing students, middle-performing students and low-performing students, and to report this assessment to the researchers.
2. The students are asked to write down their reflections on three questions which they will receive on A4-paper arks. The questions are: 1) What is mathematics? 2) What is mathematical thinking? 3) How to solve a mathematical problem? At first, the students are asked to answer the questions as carefully and elaborated as possible. Finally, the students are asked to write their names, date and class before handing the paper back.
3. Based on the teachers information about high-, middle- and low-performing students, three students from each group are interviewed by the researchers. The interviews should be based on the students' written reflections on the three questions and recorded on tape or mp3-files. Estimated time for each interview: 30 minutes.
4. The researchers listen to the tapes/sound-files from the interviews and central parts of the students' statements are transcribed.
5. Analyses of the students' written responses to the three questions and of their statements in the interviews. These analyses should focus on statements that point to the students' beliefs and the ways in which they seem to position themselves when faced with mathematical problems in order to point to cultural differences and similarities. The main questions for the analyses should be: Do the students position themselves as knowledgeable doers of mathematics or as more or less confused, troubled and/or bored students? In what ways do they express their beliefs and positioning in different cultural contexts?
6. Finally, the students' statements about beliefs and positionings will be related to the teacher-based division in high-, middle- and low-performing students and to the students' marks at the final exam at the end of the school year.

In our paper for the conference in Seoul October 2009, we have taken the first steps towards a conceptual basis for analysing and categorizing the students' statements. We will be happy to send the paper to colleagues and to discuss and elaborate these first attempts to develop a method for studying the interplay between students' beliefs and positionings on the one hand and their performances as mathematical problem solvers on the other hand.

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