INTRODUCTION

MULTIMETHOD APPROACHES TO THE MULTIDIMENSIONAL AFFECT IN MATHEMATICS EDUCATION

Markku S. Hannula, (chair), *University of Turku, Finland*

Marilena Pantziara, *University of Cyprus*

Kjersti Wæge, *Norwegian University of Science and Technology, Norway*

Wolfgang Schlöglmann, *Universität Linz, Austria*

The first working group on affect was organized in CERME 3 in 2003. This was the fourth affect working group and like the previous three, it was an energizing and inspiring event. We had 18 participants and 17 papers were submitted to our working group. One of the papers was cancelled, and the peer review process led to rejection of one paper before the conference. Several papers were revised and all except one of these were accepted for publication in the proceedings, leading to 14 published papers.

Early in the conference, Di Martino reminded us of why this field of study is important. He made reference to several mathematics education researchers who have emphasized the role of affect in our efforts to understand human behaviour in mathematical thinking and learning. One of the quotes he shared with us was the following:

"…researchers who are interested in human performance need to go beyond the purely cognitive if their theories and investigations are to be important for problem solving in classrooms" McLeod (1992).

Numerous research studies carried out more recently in mathematics education emphasize in similar fashion the importance, hence relevance of affective factors in interpreting students mathematics performance, behaviour and difficulties in mathematics (e.g. Philippou & Christou, 2002, Young, 1997). In the papers accepted for the proceedings you will find 14 interesting perspectives into the complex world of affect, emotions, motivation and humour in mathematical thinking and learning.

The participants in this Working Group considered it important to report also the way of organized our sessions. The dilemma is to focus discussion in a way that it relates to the papers that each participant is familiar with, but so that it also is able to go beyond presentation of papers. First of all, we were fortunate to have a more or less optimal group size that allowed rich discussions where each participant was able to contribute. The authors of the accepted papers were asked to prepare in advance one or two slides based on their paper on each of the following topics:

- Theoretical framework

- Methodology
- Key findings
- Implications for teaching
- Implications for further research

Slides were collected and organised according to themes at the beginning of the conference. In the sessions each slide was briefly presented by the respective author, which (usually) initiated a discussion. When the momentum of the discussion was used out, the next presenter took the stage.

This way of organizing allowed each participant to have his or her main ideas in the focus of attention. Moreover, this allowed discussion to focus on topics and supported referring to ideas from previous presentations.

THEORETICAL FRAMEWORKS

The group had very intensive discussion on the topic of theoretical frameworks. A helpful framework to structure discussion was the figure from CERME5 summary presentation (Figure 1).

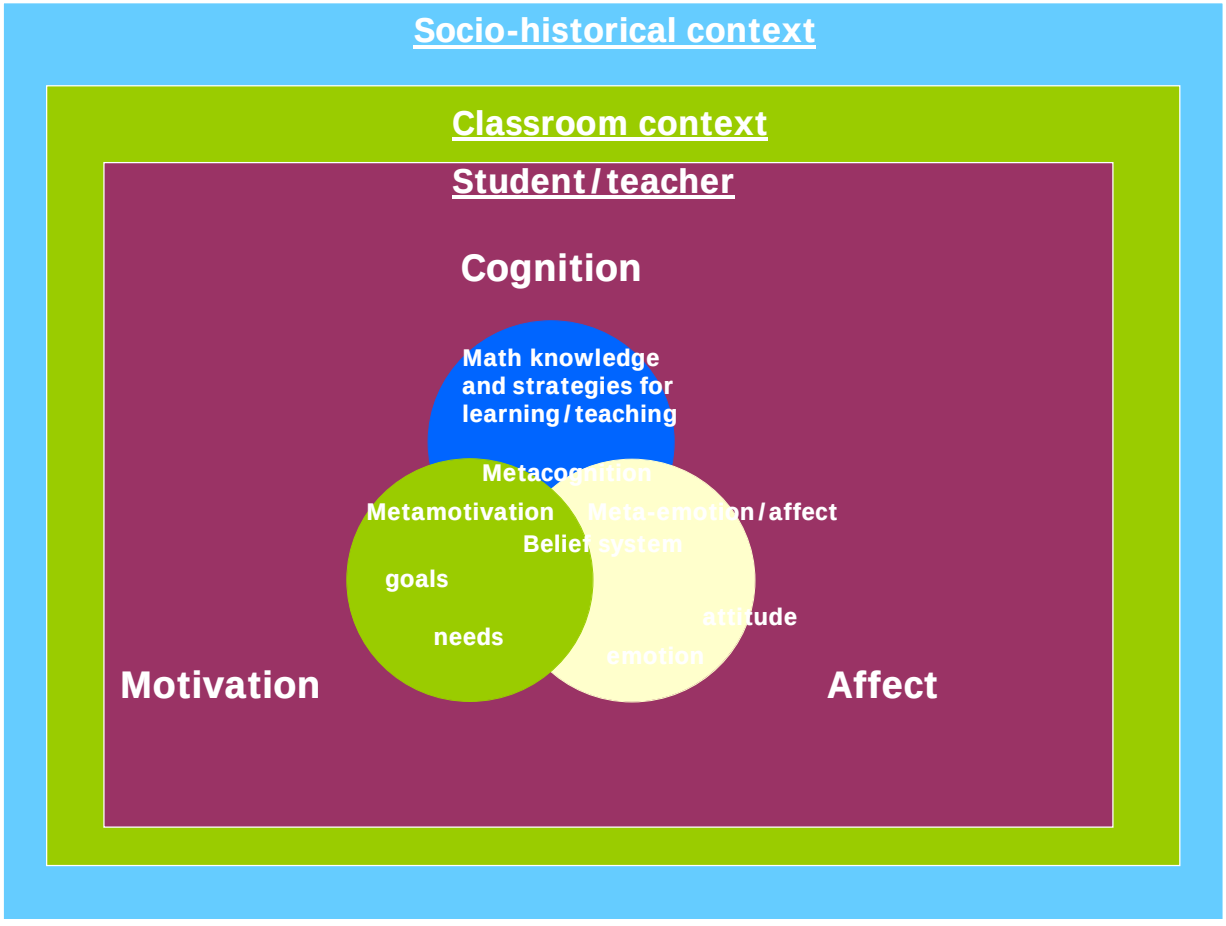

Figure 1. An overall framework for affective constructs within mathematics education research (Hannula, Op 't Eynde, Schlöglmann & Wedege, 2007, p. 204)

The proposed model is based on the socio-constructivist perspective on learning and it is characterized both by its focus on the situatedness of learning (classroom and socio-historical context) and by the recognition of the close interactions between (meta)cognitive, motivational and affective factors in students' learning (Op 't Eynde et al., 2006).

One of the issues that has been discussed in previous CERME-meetings and that was revisited again was the definition of beliefs (Di Martino; Liljedahl; Osterholm). This is an issue, where Furinghetti & Pehkonen (2002) concluded that there can not be a single definition for beliefs that is appropriate for all purposes.

We revisited the characterization by McLeod (1992), where affective domain is divided into emotions, attitudes and beliefs. There was an agreement that beliefs are different from the other concepts in that it is possible to consider their truth value, whereas emotions and attitudes are subjective by their nature. The paper by Österholm led us to discuss the distinction between beliefs and knowledge. Our preliminary conclusion at the conference was that the difference lies in knowledge being determined socially and beliefs being the individual aspect of knowledge (cf. Furinghetti & Pehkonen, 2002).

Self-efficacy issues were also presented in the group (Sofokleous and Gagatsis). We discussed Bandura's framework of self-efficacy, which has not been integrated into belief systems framework. Instead, self-efficacy beliefs seem to have remained a relatively independent framework with some connections to both belief theories and motivation theories.

Epistemological beliefs of mathematics was another framework of interest (Liljedahl). The differentiation between system, toolbox and process view of mathematics has long history from Dionne (1984); Ernest (1991); and Törner and Grigutsch (1994). Morover, there was lively discussions about the generation of mathematical beliefs (Hannula).

Another concept which we discussed thoroughly was motivation. We recognized that motivation has two dimensions that require attention, namely the quality and the intensity of motivation. The different approaches used in the conference papers (Athanasiou, Pantziara, Wæge) include theory, personal Investment theory, Achievement goal theory and Self Determination Theory of needs and goals. Regarding the generation of motivation, needs, competence based variables, social, demographic and neurophysiological predispositions were recognized (Schlöglmann).

As new theoretical approaches to affect we were introduced to the concepts *personal meaning* (Vollstedt), *humor* (Shmakov & Hannula) and teachers' *emotional knowledge* (Lavy & Shiriki). In the discussion it was argued that it might be more appropriate to call the last of these *emotional skills*. It was reminded that one issue in earlier CERME affect groups had been the need to develop a more coherent language

and/or conceptual system for research on affect. Therefore the group concluded that these new concepts must be related to the existing ones in the domain.

RESEARCH QUESTIONS

The variety of the research questions presented in our group made the use of various research methods (qualitative and quantitative) necessary.

In particular three main themes of research questions were presented, with the first one referring to beliefs:

- The origin of the beliefs. Are all beliefs constructed in the same way or are some beliefs socially constructed while some others are mainly individual? (Hannula)
- Changing beliefs as changing perspective. (Liljedahl)
- "Maths and me": software analysis of narrative data about attitude towards math. (Di Martino)
- Students' beliefs about the use of representations in the learning of fractions. (Gagatsis, Panaoura, Deliyianni & Elia)
- The relation between self-efficacy beliefs and students' achievement. (Sophocleous & Gagatsis)

The second theme referred to motivation aspects:

- Students' motivation for learning mathematics in terms of needs and goals. (Wæge)
- Identification of students' inner characteristics that may develop students' motivation. (Panaoura, Demetriou & Gagatsis)
- Social variables (teachers' practices) that may develop students' motivation. (Panziara & Philippou)
- The effects of changes in the perceived classroom social culture on motivation in mathematics across transitions. (Athanasiou & Philippou)

A third theme covered the new approaches to affect:

- The kind of personal meaning that students relate with mathematics education. Comparison between German and Hong Kong. (Vollstedt)
- Emotional knowledge of mathematics teachers. (Lavy & Shiriki)
- Humour as a means to make mathematics enjoyable. (Shmakov & Hannula)

The discussion on research methods showed several studies to have advanced beyond simple correlation and descriptive studies (Pantziara & Philippou). Some use a systemic approach and study several different aspects in connection with each other (e.g. Hannula; Panaoura et al.). There are also studies that use methods that allow examining changes in beliefs and motivation (Athanasiou and Philippou).

DISCUSSION AND CHALLENGES

One apparent main focus for research and practice in this domain has been to develop richer theoretical frameworks using aspects and develop better concepts and instruments, preferably combining qualitative and quantitative methods. The frameworks should recognize the close relation between beliefs, motivation and competence. Another, related focus has been the relations between different constructs in the affective domain and their connection to other areas in the realm of mathematics education. A third focus identified was change in beliefs and motivation; how it can happen and how to initiate change.

One specific issue we discussed was the different understandings of the stability of affective constructs. The first aspect here is to distinguish between affective state and affective trait. The second aspect to notice is affects resistance to change. The third aspect of stability is the robustness of affective constructs. The fourth aspect is the relative stability of affect, which means the tendency of people to keep the same order even if their affect might be changed.

When looking into the future, we recognized some promising approaches. In mathematics education affect has typically been approached through psychology. Looking at affect as biological or social phenomenon might open up new insight.

With regard to research on emotions, there is need to move beyond simplistic positive/negative view of emotions and distinguish different types of negative emotions (fear, dislike, sadness, anger) and positive emotions (joy, serenity). We also realized that most research on affective processes has focused on intensive emotions or non-routine mathematical activities. Therefore, it might be interesting to explore students' affect when they experience routine mathematics. Moreover, the research on affect could be extended to various contexts in mathematics, such as vocational education and mathematics at work.

CLOSING REMARKS

In each CERME the effort is denoted to identify some emerging or significant themes that might reflect the field in general, not restricted to the studies presented in the conference. The enrichment of the theoretical framework by clarifying specific constructs related to affect and by introducing new approaches has continued. Besides the illumination of relations among the various affective constructs (e.g. students' and teachers' beliefs, students' achievement goals, students' motivation) and other variables in the mathematics education domain (e.g. students' competence, teachers' practices, and teachers' knowledge) had been proceeded. The clarification of the terminology used in affect together with the new perspectives of stability of affective constructs develop this research domain. Due to the multidimensional face of the variables involved in the affective domain, the multi-method approach is becoming indispensable in the identification of relations among this area of research.

There is still much to be clarified and revealed in the realm of Affect in Mathematics Education. Therefore we go on and look ahead to the next affect working group at CERME 7.

References

Dionne, J. (1984). The perception of mathematics among elementary school teachers. In J. Moser (Ed.), *Proceedings of* the *6th Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (PME) (pp. 223 – 228). Madison (WI): University of Wisconsin.

Ernest, P. (1991). *The philosophy of mathematics education*. London: Falmer.

Furinghetti, F. & Pehkonen, E. (2002). *Rethinking Characterizations of Beliefs.* In: G. C. Leder, E. Pehkonen & G. Törner (Eds.), *Beliefs: A Hidden Variable in Mathematics Education?* (pp. 39 – 57). Dordrecht/ Boston/ London: Kluwer.

Hannula, M. S., Op ’t Eynde, P., Schlöglmann, W. & Wedege, T. (2007). Affect and mathematical thinking. In D. Pitta-Pantazi & G. Philippou (Eds.), *European Research in Mathematics Education V; Proceedings of the Fifth Congress of the European Society for Research in Mathematics Education*; *Larnaca, Cyprus 22 - 26 February 2007* (pp. 202 – 208). Nicosia, Cyprus: Department of Education - University of Cyprus.

McLeod, D. B. (1992). Research on affect in mathematics education: a reconceptualization. In D. A. Grouws (Ed.), *Handbook of Research on Mathematics Learning and Teaching* (pp. 575-596). New York: MacMillan.

Op ’t Eynde, P., De Corte, E., & Verschaffel., L. (2006). Accepting emotional Complexity. A socio-constructivist perspective on the role of emotions in the mathematics classroom. Education Studies in Mathematics, 63, 193-207.

Philippou, G. & Christou, C. (2002). A study of the mathematics teaching efficacy beliefs of primary teachers. In G.C. Leder, E. Pehkonen, & G. Törner (Eds.), *Beliefs: A hidden Variable in Mathematics Education?* (pp. 211-231). Netherlands: Kluwer Academic Publishers.

Tömer, G. & Grigutsch, S. (1994). "Mathematische Weltbilder" bei Studienanfangem - eine Erhebung. *Journal für Mathematik-Didaktik* 15 *(31* 4), 211 -251.

Young, A. J. (1997). I think, therefore I’m motivated: The relations among cognitive strategy use, motivational orientation and classroom perceptions over time. Learning and Individual Differences, 9, 249–283.