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Introduction to the work of TWG08: Affect and the teaching and learning of mathematics

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Introduction

The work of the Thematic Working Group 8 (TWG08) “Affect and the teaching and learning of mathematics” started with a revision of the call for papers in 2019. The call for papers included theoretical, methodological and empirical fields of research on affective constructs for students and teachers. Because of the variety of affective constructs, we could point out in the call only few examples of affective constructs in the area of beliefs, attitudes, emotions and motivation. Spreading of the COVID pandemic all over the world affected our preparation for the CERME 12 conference, which was moved from February 2021 to February 2022. In order to make the communication on affect possible, we followed the call of the program committee to offer a short virtual meeting on affect in the framework of the virtual CERME in 2021. In this virtual meeting, we presented an overview of research on affect and discussed urgent questions for mathematics education (e.g. What is the impact of COVID pandemic on research in affect?) and questions of importance for research on affect (e.g. Do emotions and motivation affect performance in mathematics?) in small groups and in the whole group. We continued with the preparation of the group’s work for CERME 12, which was eventually held as a virtual conference. In this chapter, we would like to introduce our work in TWG08, discussions on affect in teaching and learning of mathematics and new developments in the field.

The sound number of submissions and participants confirmed the long-term interest of researchers in affect-related research in mathematics education. In total, 26 papers and 4 posters were submitted to our group and 24 papers and 3 posters were accepted for presentation. Of the presented studies, 23 papers and 3 posters were accepted for publication in the conference proceedings. In addition to the different European countries, our group included presentations from Australia, Canada, Israel and the United States of America. Researchers from 13 countries participated in the work of our group. Many newcomers joined the group, indicating that interest in research in the area of affect is constantly increasing.

We started our work with an ice-breaking activity. Each participant talked about his country and topic of research interest to the audience. After the ice-breaking activity, a reflection of the prior work done in CERME conferences was presented in the whole group and open questions in research on affect

were discussed in breakout rooms. Following a tradition of the TWG08 group regarding importance of small group discussions for scientific activities, we scheduled a considerable amount of time for this type of work in following sessions. The contributions in each session were assigned to the topics beliefs, attitudes, motivation, emotions or other affective constructs. After a short presentation (3 – 5 slides, 5 min) and clarifying questions (3 min) for each paper in a session, we assigned participants to breakout rooms with 4 – 6 participants. In order to structure the small group work and to support the content of the discussions, at least one co-leader and one of the authors joined each group. Each small group could decide which of the presented papers or posters they would like to discuss with the author(s) and other group members (25 – 40 min). In the last 10 minutes of each session, we shared our thoughts about the topics of discussions with the whole group. In the last session, we presented a synopsis of the small and whole group discussion, which were again discussed in breakout rooms. At the end, we reminded participants on the importance of revisions of contributions in the final phase of the revision process.

Reflection on prior research in affect

Inés Gómez-Chacón presented an overview of the work that has been done in the past conferences in TWG08. An essential part of the overview was presenting the changes in research on affective concepts over the past 15 years. A part of the overview was included in the final report about the work of TWG 8 that was videotaped by Çiğdem Haser and Stanislaw Schukajlow.

A review paper by McLeod (1992) serves, usually, as the starting point for systematic research on affect in mathematics education. According to this taxonomy, research on affect can be assigned to one of the three major categories: beliefs, attitudes or emotions. In McLeod's framework, beliefs are the most stable in time, less intense and most cognitive. On the opposite side of the range, McLeod posed emotions, which are considered as less stable in time, most affective and less cognitive. Attitudes are situated between beliefs and emotions regarding temporal stability, affect and cognition.

In the last decades, researchers elaborated repeatedly on the taxonomy of affect proposed by McLeod. One influential model was proposed by Hannula (2011) in CERME 7. He analysed research in mathematics education and suggested distinguishing between cognitive, motivational and affective dimensions, unstable states and stable traits as well as social, psychological or physiological dimensions of affect.

Another possibility to think about affect is to distinguish between three characteristics: object of the affect (e.g., mathematics, problem solving or strategy use), subject (e.g., teacher, students or policy maker) or valence (positive, negative or neutral; Schukajlow, Rakoczy, & Pekrun, 2017). Further, the theoretical approach, such as acquisitionist or participationist, can be considered of importance for research on affect. A strong interdependence of affective constructs is another essential characteristic of affect. In research on beliefs, these interdependencies are reflected in the emphasis of the so-called beliefs system. A strong interdependence of affective constructs is another essential characteristic of affect. An affective system includes different affect components that are closely related to each other. Changes in one component of affect system result in changes in other components and vice versa. For example, increasing interest in mathematics may positively affect enjoyment and negatively boredom. A holistic view on the affect system might be important for getting a comprehensive view

on affect and its development in students and teachers. This research perspective calls for using multidimensional approach to affect and applying different methods (e.g. qualitative, quantitative and mixed methods).

In the past, we observed growing attention to the clarification of concepts that were used in research on affect. As many affective constructs are defined as complex phenomena, different affective constructs revealed a conceptual overlapping in some parts. For example, emotions include a part of physiological, affective and expressive components, and also cognitive and motivational parts. Therefore, an emotion can overlap with motivational constructs, such as interest or self-efficacy beliefs, on the theoretical level.

A relationship between different affective constructs and cognitive outcomes, such as achievement related choices and performance, was another topic of high interest in the past. Prevalent questions were: (a) What affective reactions can be observed during learning of mathematics? and (b) Whether changes in students' emotions, motivation, beliefs or attitudes are related to students' learning and learning outcomes. The underlying theme of research was often an idea that improving students' affect will increase motivation, positive emotions, growing mindset or positive attitude.

Contributions in the TWG08

Now we would like to present the papers and posters that are published in the proceeding. Andrà et al. found out that mathematical views of undergraduate mathematics students are related to achievement and preferences for different teachers' lesson types. Haser analysed students' beliefs about problem posing and their place in mathematics-related belief systems. The poster by Brunetto and colleagues presented a methodology for clustering students' mathematical views. Vankúš et al. reviewed in their poster the methodology used in the research in affective domain.

Schukajlow and Rellensmann analysed a relationship between motivational components (self-efficacy, value, and cost) and gender. Krawitz and Hartman investigated preservice teachers' interest and self-efficacy while posing problems to descriptions of real world situations. Developing and validating survey instruments for assessing beliefs and motivation in mathematics were presented by Pedersen and Haavold. Capone and Lepore analysed engagement, motivation and participation of undergraduate students during Covid pandemic. Pan et al. were interested in indications of students' wellbeing in terms of primary students' values.

Sumpter et al. investigated gendered self-evaluation in mathematics. Herset and Ghami presented an experimental study on difficulty level marking in mathematics tasks. Biton et al. analysed students' perceptions of mathematics learning environment in a virtual communication messenger. Stereotypes in a polarized world and their relation to mathematical identity were the focus of the study by Kaspersen and Gjøvik.

Vasilopoulou and Triantafillou presented students' perspectives on inclusion and peer-collaboration. Zakariya et al. analysed the relations between attitudes, prior knowledge, self-efficacy and grades in mathematics. Kourti and Potari identified and analysed pivotal teaching moments of emerging emotions during decision making. Weber et al. investigated a development of mathematical anxiety of prospective elementary teachers. Holm explored mathematical stories of future elementary

teachers and shifts in affect in mathematics. Viola and Gambini presented an analysis of cooperative group work in game theory activities. Analysis of attitudes of women and racially/ethnically minoritized students was presented by Uysal and Clark. Viitala carried out a case study on teacher identity and long-term professional development.

Báró studied changes in affect due to problem posing in Hungary and Romania. Pierri explored engagement and affect in the context of storytelling. Liljedahl analysed social persuasion through a teacher's actions in a mathematics classroom. Courtney et al. investigated teacher's understanding of mathematics in a remedial course and the role of affect in the process of understanding.

Evolution of the TWG

This year many passionate young researchers joined the group. The number of contributions addressed similar topics as in the past conferences (e.g., self-efficacy expectations). Some new topics, such as mathematical well-being and stereotypes, and a new group of research subjects, such as marginalized students, were addressed in CERME 12. More studies focused on the relationships between affect and cognition. New theoretical approaches emerged in the group. Some examples of these approaches are dual process theory, value-fulfillment theory, activity theory, positioning theory or model of problem posing. New measurement instruments were developed and analysed by using sophisticated qualitative and quantitative methods. In several contributions, researchers addressed gender studies and derived implications for research on affect. Different objects of affect in varied contexts, of very different sorts, were presented in the group. Some examples of these objects are drawing strategy, level marking, social media, pivotal teaching moments, intelligent tutoring systems, and digital interactive storytelling.

During our final discussion, we summarized directions for future research. One example was expanding the view on affective variables and see them (a) as independent constructs that can be manipulated in order to increase performance, (b) as dependent variables that can be affected by, for instance, different teaching methods, (c) as mediation variables that can transmit the effects of teaching methods on cognition, and (d) as moderating variables that affect the effects of teaching methods on cognition. Furthermore, we call for more research on linking affect to cognition, more attention to theorising and embodiment, more focus on equity, more longitudinal and comparative studies and stronger focus on cross-domain research.

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