ERME Column

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ERME Thematic Working Groups

The European Society for Research in Mathematics Education (ERME) holds a bi-yearly conference (CERME), in which research is presented and discussed in Thematic Working Groups (TWG). We continue the initiative of introducing the working groups, which we began in the September 2017 issue, focusing on ways in which European research in the field of mathematics education may be interesting or relevant for research mathematicians. Our aim is to extend the ERME community with new participants, who may benefit from hearing about research methods and findings and who may contribute to future CERMEs.

Introducing CERME's Thematic Working Group 6 – Applications and Modelling

There is a long tradition and worldwide consensus shared by researchers, practitioners, and policymakers on the important role of applications and modelling in mathematics education. In the last decades, especially in Europe, there has been a large movement of curriculum reforms including the integration of applications and modelling at different school levels. It has provided many achievements in the field (as surveyed by Blum, 2015), but has also opened up several questions related to the effects of the teaching and learning of mathematical modelling and to the promotion of new methods of assessment and evaluation, among other issues that are part of the current research agenda in the field.

CERME's Thematic Working Group 6 (TWG6) focuses on the research field of teaching and learning mathematical modelling at various educational levels. TWG6 started at the fourth ERME Congress (CERME4) in 2005 in Sant Feliu de Guíxols (Spain). It has since continued to be an active thematic working group in the biennial ERME conferences, receiving an increasing number of contributions. At the seven meetings from CERME4 to CERME10, the working group has already produced and presented 133 papers and posters. At CERME11, which took place recently (February 2019) in Utrecht, The Netherlands, 21 papers and 7 posters were presented. Those contributions came from 17 different countries, with most, but not all, being from European countries.

The overarching themes addressed in TWG6 show the diversity of research questions, the different school levels addressed – spanning primary to tertiary education – and the theoretical approaches endorsed (Kaiser & Sriraman, 2006). We summarise a selection of important topics that have been discussed recurrently at the CERME congresses:

The first topic focuses on the role of mathematical modelling and applications in connection to other school subjects and disciplines. There is a long tradition of discussing examples from engineering education in TWG6 at various ERME conferences; however, some papers discuss explicitly the role of mathematical modelling in interdisciplinary contexts, such as involving mathematics and history or archaeology, or mathematics and biology. Under this topic, a debate has also taken place on the differences between modelling at the practitioner level and at the school level. Industrial examples have played a powerful role in education, to analyse and replicate the authenticity and complexity of real tasks and their role in mathematical modelling from an educational point of view.

The second topic, developed under a cognitive perspective, focuses on students' cognitive processes when solving modelling problems and the existing cognitive barriers that students encounter when working on modelling problems. Cognitively oriented analyses have been a prominent approach of the researchers in the group at previous CERME conferences. Several theoretical and methodological tools, based on the conceptualisation of the modelling cycle and the underlying modelling competencies, have been developed and used for the analysis of the students' work.

The third topic refers to the study of constraints or barriers and favourable conditions for the inclusion of mathematical modelling in teaching and learning practices. The themes range from the analysis of the ways in which curricula and educational policies can favour the implementation of modelling and applications in school to the analysis of teachers' beliefs in relation to the teaching of mathematical modelling. Those questions have been examined at all previous conferences, thus revealing the significance and urgency of this topic.

The fourth topic, the instructional perspective, underlines the necessity of high-quality modelling education in order to promote an effective learning of mathematics. The question of how to implement effective modelling environments is a recurrent point in the work of TWG6. The discussion has included a variety of themes, such as the use of experimental materials and technology in modelling or new ways of assessing the learning of mathematics and modelling.

Finally, yet importantly, the topic of teacher education is a valued one within the group, based on the acknowledged need to prepare pre-service teachers and in-service teachers for the teaching of applications and modelling. Notwithstanding the importance of this topic, at previous CERME conferences it has been less prominent; however, at CERME10 and again at CERME11

there has been a significant increase in papers related to this topic. Teachers and their education are a key factor for the effective and efficient integration of mathematical modelling into mathematics education at various levels (for details see Barquero, Carreira & Kaiser, 2018).

The work of TWG6 was embedded in the discussions that took place at the biennial international conference series on the Teaching and Learning of Mathematical Modelling and Applications (ICTMA). At these conferences, empirical studies are strongly discussed, which contain examples for classroom activities and empirical evaluations of their implementation, including many non-European researchers, especially from East Asia. The recent literature review on the state of empirical research on the teaching and learning of mathematical modelling by Schukajlow, Kaiser, and Stillman (2018) provides in-depth insight into strengths and weaknesses of the current state of empirical research on modelling and applications. The survey pointed out that qualitative studies are strongly dominating quantitative studies, probably, amongst other reasons, due to the emphasis on implementation studies. Furthermore, it became clear that only a small number of papers have been published in journals in recent years, which should be changed in the future. TWG6 may support this goal by providing clear guidance on what it means to carry out high-quality research on the teaching and learning of mathematical modelling.

The relevance of mathematics and applied mathematics to the teaching and learning of modelling and applications is unequivocal. Pollak has been one of the influential authors in this discussion (Pollak, 2007) but research shows that only more recently has attention been given to the fact that mathematical modelling must find its way into school mathematics. Actually, there seems to be still a lack of dialogue between practitioners, industrial researchers, lab technicians, scientists, mathematicians, and mathematics education researchers in generating ideas, examples, tasks, and materials that value mathematical modelling for school levels. Generative inputs from the community of research mathematicians will certainly be useful from many perspectives, namely in offering interesting real-world problems in ways that are accessible to students and to school institutions as well as in collaborating in curricular reforms for the integration of modelling and applications. The design of modelling problems and challenges, such as the case of modelling competitions that are already taking place in different countries in the world (e.g., COMAP's Mathematical Contest in Modelling (MCM)), is also an opportunity to engage mathematicians in nurturing and promoting students' enjoyment of mathematics through mathematical modelling and applications.

References

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Berta Barquero holds a doctoral degree in mathematics (2009) focusing on the design of teaching proposals to integrate modelling at university level. She is assistant professor at the Faculty of Education of the University of Barcelona. Her research focuses on modelling in school and university, interdisciplinary education, and primary- and secondary-school teacher education. She has been involved as co-leader and as leader in TWG6 – Applications and Modelling – in recent CERME conferences.

Gabriele Kaiser holds a master's degree as a teacher of mathematics and humanities for secondary level. For her doctorate in mathematics education (1986) she studied application, and modelling. Since 1998, she has been a full professor for mathematics education at the Faculty of Education of the University of Hamburg. Her areas of research are empirical studies on teacher education and teachers' professionalism, modelling and applications in school, international comparative studies, gender and cultural aspects in mathematics education.

Jason Cooper is a senior intern at the Weizmann Institute's Department of Science Teaching. His research concerns various aspects of teacher knowledge, including the roles of advanced mathematical knowledge in teaching and contributions of research mathematicians to the professional development of teachers. He has been a member of the ERME board since 2015.