# ERME Column

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## YESS-9

The 9th ERME Summer School for young researchers will take place on 20-25 August 2018 in Montpellier, France. The school provides a unique opportunity for young researchers (graduate students and researchers up to 3 years after receiving a PhD) to discuss their research in mathematics education with a board of experts and with fellow students. For more details, please visit the website (https://yess9.sciencesconf.org/).

## Introducing CERME Thematic Working Groups 15 and 16 – Teaching and Learning Mathematics with Technology and Other Resources

*Group leaders: Alison Clark-Wilson and Hans Georg Weigand*

The European Society for Research in Mathematics Education (ERME) holds a biennial conference (CERME), in which research is presented and discussed in Thematic Working Groups (TWGs). We continue here the initiative of introducing the working groups (which began in the September 2017 issue of the Newsletter) 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.

TWGs 15 and 16 are concerned with the roles of technology and other resources (e.g. textbooks and manipulatives) in mathematics education and, in particular,

with the transformative impact of technology on the ways in which mathematics is taught and learned at all levels of education. CERME has been concerned with these issues since its inception in 1999. The separation of teaching and learning was a necessity due to the high level of participation, reflecting the growing prominence of research in the field.

The growth and evolution of these groups is founded upon the inextricable link between mathematical knowledge and the capability afforded by mathematical digital tools such as computer algebra systems, and dynamic geometry and dynamic graphing software applications. The nature of the tools, and the underlying principles that guide their design, are leading to new forms of mathematical representation and syntax; in a sense, technology is transforming what it means to "know" mathematics. Hence, in its early days, the technology group's analysis of "tools" was framed by two main concerns: *interactions between tool and knowledge* and *interactions among knowledge, tool and the learner* [1].

As these tools began to find their way into mathematics classrooms, they came to have considerable impact on the mathematical practices that teachers and students engaged in. Accordingly, research has moved from experimental "lab" environments, where new tools have been tried and analysed, to real classrooms, creating a third concern: *integration of a tool in a mathematics curriculum and in the classroom* [1].

Digital tools for education have further developed to support the organisation of various aspects of learning and teaching, including digital curricula, communication tools, digital learning environments and learning management systems. There are also tools for the assessment of learning, which include digital testing and automatic analysis and reporting of results. The proliferation of such tools has led to wide interest and involvement amongst teachers and researchers.

Existing digital tools for education bridge and connect many mathematical topics: software such as Geogebra[1] combines computer algebra systems, function plotters, spreadsheets and dynamic geometry software, making multi-modal representations of mathematical objects such as functions (linked numeric, symbolic and graphic representations) readily available; 3D programmes such as Cabri3D[2] provide new access to 3D geometry; and new developments such as augmented or virtual reality are not only opening new perspectives on geometry but are also supporting connections with other sciences such as physics, biology, chemistry and engineering, and are providing the basis for the emerging field of *embodied cognition*.

The range of topics that this academic field addresses includes: design of tools and resources (e.g. linked multimodal representations); impact (epistemic and affective) of digital tools on students' and teachers' experiences (e.g. implications of dynamic mathematical applications); ongoing critique of the nature of mathematical and curricular knowledge in light of digital tools and resources (e.g. a trend to link mathematics and computer science through the inclusion of technology-based algorithmics in mathematics curricula); and implications of the above for teacher preparation and for ongoing professional support.

Collaboration among communities is common, in an attempt to bridge the diverse domains of expertise that the field draws upon. Often, seeds of ideas for new digital tools originate in mathematics classrooms or through curricular design, ideas that are then honed and developed through longer term collaborative projects. However, participants in TWGs 15 and 16 have been almost exclusively from the field of mathematics education. As technology makes its way into universities, the relevance of this field for higher education is growing. Teachers of university-level mathematics have much to contribute to this field of research and also much to gain from its findings. Both TWGs warmly welcome participation and contributions from the wider mathematics community.

[1] www.geogebra.org.
[2] http://cabri.com/en/.

## References

[1] Laborde, C., Gutiérrez, A., Noss, R., & Rakov, S. (1999). Tools and Technologies. In I. Schwank (Ed.), *Proceedings of the First Conference of the European Society for Research in Mathematics Education* (Vol. 1, pp. 183–188). Osnabrück: Forschungsinstitut für Mathematikdidaktik.

*Jason Cooper is a research fellow at the University of Haifa's Faculty of Education. He is also a researcher at the Weizmann Institute's Department of Science Teaching. His research concerns various aspects of teacher knowledge, including 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.*

*Alison Clark-Wilson is a principal researcher in mathematics education at the University College London Institute of Education. Her research focuses on the design, enactment and impact of information technology on mathematical learning at upper primary and secondary levels, on teachers' knowledge and pedagogical use of information technology and on models for teachers' collaborative learning.*

*Hans Georg Weigand is a professor of mathematics education at the University of Würzburg (Germany). He studied mathematics and physics and taught for six years at a German grammar school (Gymnasium). He is interested in the use of new digital technologies in mathematics education and in teacher education. He has written books on didactics of algebra, geometry and calculus, and on the use of computers in mathematics education.*