ERME Column

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ERME Thematic Working Groups

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 (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 Thematic Working Group 5 – Probability and Statistics Education
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1. COVID-19: The relevance of Statistical and Probabilistic Reasoning

As we write this article, most of the world is in isolation or lockdown due to the COVID-19 pandemic. There is a proliferation of data representations and models of the pandemic which are keeping us attuned to emerging trends and developments. The term 'flattening the curve' has become a part of everyday parlance, even amongst those who would not normally engage in statistical reasoning. These recent developments make the following words of H.G Wells (cited in Huff, 1954) all the more relevant, when he states that 'Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write'.

2. Probability and Statistics Education Thematic Working Group (TWG5)

Much like the field of statistics and probability education, the *Probability and Statistics Education* Thematic Working Group (TWG5) is a vibrant and energetic community within the CERME biennial conference. The working group's responsiveness to an evolving and growing field of scholarship is evident in the transformation in CERME9 from its previous nomenclature of the *Stochastic Thinking* working group to encompass probability education in the newly named *Probability and Statistics Education* Thematic Working Group. The growth in international research in statistics and probability education (evident in the proliferation of publications, conferences and discipline-specific journals) was reflected in the increase in submissions to the working group and subsequent necessity to expand into two subgroups

at the most recent CERME11 conference. Consequently, there were 27 papers and 9 posters presented by over 42 participants reaching far beyond the borders of Europe.

The research studies presented at the conference focused predominantly on three themes: teacher education, reasoning about data, and statistical and probabilistic thinking and reasoning. Although they may appear as discrete themes, there are overlaps and similarities across subthemes, for example, research focusing on teacher education also explores teachers' reasoning about data and their statistical and probabilistic thinking and reasoning. Furthermore, reasoning about data and statistical and probabilistic thinking and reasoning are not seen in a disjoint way – which means, in both of these subthemes we can of course also find submissions with connections between the "data world" and the "probability world".

At the outset of the CERME conferences, we endeavour to focus participants on linking their own research with the field of scholarship in general, and on considering ways in which their work can advance scholarship in the fields of statistics and probability education. To this end, we pose a series of questions generated from our review of the work being presented alongside current developments in the fields of statistics and probability research. These questions are discussed in an initial plenary session by all participants, are revisited in the subgroups throughout the duration of the conference and then re-examined in our culminating session at the final TWG5 plenary. Examples of focus questions explored over the past two CERME conferences are:

- How should tasks and learning environments be designed to enhance reasoning about data and statistical and probabilistic thinking and reasoning for learners (primary students, high school students, teachers, etc.)?
- Which research methods are and should be used to explore students´ or learners´ reasoning with data and statistical and probabilistic thinking and reasoning?
- How can we build bridges between data analysis, probability and inference? What role does context play?
- In what ways can the use of digital tools enhance statistical reasoning (reasoning about data and statistical and probability reasoning)?
- What about the handling of big data in the upcoming data science era? How can we (statistics education) profit from the availability of big and open data? What implications does it have for statistics education?

Discussions of various papers addressing *teacher education* revealed a number of questions and themes regarding how to prepare teachers to address and foster students' reasoning and thinking about statistics and

probability. As a field, we are still grappling with ways to enhance the pedagogical content knowledge[1] facets of statistical knowledge for teaching, and not just focus on the subject matter knowledge facets. We recognise the need to make teachers familiar with performing statistical tasks and investigations from a procedural, interpretative and contextual perspective, while making connections among fundamental ideas of statistics (e.g., data and randomness in sampling), chance, relevant and appealing real-life contexts, software and technology. There is growing appreciation among the participants of TWG5 for attending to the development of statistical ideas (both formal and informal) in early years education, and to preparing teachers to address and foster this emerging understanding. In supporting teachers, our research also explores and recognises the features of successful Professional Learning Communities (i.e., communities of practice within schools and beyond), which support teachers in developing understanding and skills in a range of areas such as task design, assessment methods and other contributors to high-quality statistics and probability instruction.

A number of key ideas and research foci have been identified from discussions around the theme of *reasoning about data*. The emergence of the era of data science is an exciting development. The exploration and analysis of big data and open data will be a fundamental aspect in reasoning about data, and these areas are ripe for research and inquiry. Furthermore, there are other data collection methods which are becoming more relevant (e.g., with sensors, web scraping, etc.) and which provide new types of data. We are more cognisant of the necessity to cooperate with other disciplines such as computer science, social science and citizen science, and such cooperation is becoming increasingly evident. Concomitantly, the use of digital tools when exploring data is fundamental, and we need to consider and make the distinction between educational software tools (such as Tinker-Plots or Fathom) and professional software tools (e.g. R, Python), and recognise the potential of open source and online tools such as Gapminder and CODAP (Common Online Data Analysis Platform), which can help develop reasoning about data.

3. Conclusion

The research findings presented in TWG5 cover a wide range of learners, from children to university students – particularly pre-service mathematics teachers – and their thinking and reasoning about data and chance. These can inform teacher education programmes at the universities in terms of designing courses for pre-service teachers to enhance their content knowledge as well as pedagogical content knowledge regarding statistics and probability. From our discussions of various papers focusing on statistical and probabilistic thinking and reasoning, we acknowledge the critical role played by the use of context, real problems and visualisation tools in supporting

statistical and probabilistic thinking and reasoning in data and chance explorations. We have noticed a shift in focus on misconceptions of learners towards recognising nascent understandings through building on learners' intuitions and emerging conceptions. Further research is necessary here as this reconceptualisation may prove to be more useful for supporting the early development of thinking and reasoning in data and chance. We also acknowledge the need to move the field forward through consideration of design-based research as a methodology to further inform the community on how to build learning environments that support learners' statistical and probabilistic thinking and reasoning through iterative cycles of design and research.

We conclude with a reminder to remain mindful of the need to diversify our research design and approaches to inquiry – incorporating attention to fine-grained studies, eye-tracking research, larger cross-comparative studies and experimental design, to name but a few – all in an effort to advance our understanding of the complex and evolving areas of statistics and probability education.

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Jason Cooper is associate staff scientist 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 mathematics and contributions of research mathematicians to the professional development of mathematics teachers.

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[1] See in Shulman, L.S. (1986) Those who understand: Knowledge growth in teaching. *Educational Researcher* 15(2), 4–14.