TSG 37 New trends in mathematics education research

Team Chairs: Ming Fai Pang, Faculty of Education, The University of Hong Kong, Hong Kong SAR, China, pangmf@hkucc.hku.hk.
Carolyn A. Maher, Graduate School of Education, Rutgers University, USA, carolyn.mather@gse.rutgers.edu.
Team Members: Mogens Niss, The Departmemt of Science, Systems and Models, Roskilde University, Denmark
Ravi Subramaniam, Homi Bhabha Centre for Science Education, India
Romulo Lins, Mathematics Department, IGCE, UNESP-Rio
Claro, Brazil

Introduction

Our TSG offered an opportunity to explore the various contemporary developments in our broad area. The team decided to delimit the scope of our discussion to the following potential themes.

1. New trends in methodologies. This might include expanding existing methods, combining existing methods, changing emphases on existing methods, etc.
2. New trends in concerns about the outcomes of mathematics education research; new trends in policy decisions in light of research findings, etc.
3. New trends in research issues. This might include new kinds of research questions, new kinds of recipients of mathematics education, new content, new collaboratives, etc.
4. New trends in conceptualizing the field of mathematics education as a discipline and in relation to other fields, new views on institutionalization, etc.
5. New trends in how theoretical frameworks frame the research.

We received a good number of proposals from scholars from different nations. The following paper presentations, after peer review, were accepted and the four working sessions were organized in the following way:

First Session – July 8th Tuesday

- Organization to the work and introduction to the theme by Co-chairs
- Paper 1: *Using Discourse Analysis to Study Learning Communities in Cross-Disciplinary and other Divergent Contexts* Marjory F. Palius, Linda J. Anthony, Carolyn A. Maher, and Prabhas V. Moghe, USA
- Critical reaction by John Francisco and floor discussion.

Second Session – July 9th Wednesday

- Paper 2: *Using Learning Study grounded on the Variation Theory to Improve Students' Mathematical Understanding* Ming Fai Pang, China
- Paper 3: *Frameworks and Contexts: The Making of Theoretical Models in Mathematics Education Research* Jean-François Maheux & Nadine Bednarz, Canada
- Critical reaction by K. Subramaniam & Zeynep Ebrar Yetkiner and floor discussion

Third Session – July 11th Friday

- Paper 4: *Drawing from Cognitive Research for Curriculum Design* K. Subramaniam, India
- Critical reaction by Carolyn A. Maher and floor discussion

Last Session – July 12th Saturday

- Paper 5: *The Interplay of Mathematical Beliefs and Behaviors: Insights from a Case Study* John Francisco, USA
- Paper 6: *Effect Size and Confidence Interval Reporting Practices in Mathematics Education* Zeynep Ebrar Yetkiner, Robert M. Capraro, Linda Reichwein Zientek & Bruce Thompson, USA

- Critical reaction by Jean-François Maheux & Marjory F. Palius and floor discussion
- Floor Discussion: Perspectives for the future

The papers are available from the TSG website (http://tsg.icme11.org/tsg/show/38). This report highlights the key themes and summarise some of the central ideas and issues that arose in the group's discussions.

Paper presentations and discussions

The TSG began with an introduction by the Chairs, followed by the first presentation by Palius, who shared an innovative methodological approach that emerged through research conducted in collaboration with co-authors. They presented the design, development, and assessment methodology for an experimental forum aimed at fostering effective research communication skills among doctoral graduate students in science, technology, engineering, and mathematics fields that are becoming increasingly interdisciplinary (Anthony, Palius, Maher & Moghe, 2008; 2007). A significant outgrowth of studying this discourse-based community of practice is their development of a new research tool and methodology to enable more effective analyses of rich data sets generated by videotaped records and other assessment instruments. After fully describing this new methodology, which they call Graphical Record of Discourse (GROD), they invited consideration of how it might be adapted for use in contexts of interest to mathematics education researchers, particularly to investigators seeking to analyse discursive interaction among members of a community in studies about learning.

The second paper introduced an innovative way of conducting research in mathematics education through the use of learning study (cf. Pang & Marton, 2003) which involves a group of teachers who undertake theoretically grounded collaborative action research on their own practice, with or without a researcher. Unlike design experiments, a learning study emphasises teachers' involvement in and ownership of the innovative practices that echo the spirit of the lesson study. The primary role of the researcher(s) in a learning study is to have a professional dialogue with the teachers and to provide professional support when necessary. Furthermore, the major focus of a learning study is on the objects of learning, that is, on what students are expected to learn, rather than on the teaching arrangements. Pang presented two learning studies conducted in Hong Kong, in which teachers make use of a relatively new learning theory, the variation theory from phenomenography (Marton & Pang, 2006, Pang & Marton, 2007), as well as their own professional expertise and collaboration to help students improve their mathematical understanding. The results show that there was a marked improvement in students' mathematical understanding after learning studies grounded in the variation theory were introduced.

The following paper argued that there is an emerging trend for researchers in mathematics education to use frameworks coming from mathematics education itself as well as from other domains, to design teaching situations in mathematics education that could support significant learning of mathematics by students. Using their own work as a background, they attempted to illustrate these new ways of developing such teaching situations, in a dialogue between theoretical models elaborated by researchers, practical way of thinking mathematics teaching mobilised by teachers, and re-construction of these situations by students. In close interactions between these different perspectives (researcher, teachers and students ones), they showed how a teaching situation is emerging through the different contexts of its development, from a first reading of a theoretical model and a literature review, to its experimentation with Grade 7 students.

The paper presented by Subramaniam explored another key issue, that is drawing from cognitive studies of mathematical learning for curriculum design. He envisaged that one of the problems that engage the attention of mathematics educators is how to facilitate learners in making sense of symbolic mathematics. Meaning for symbols, and warrant for reasoning about representations in mathematics, is drawn from different sources of control, which can broadly

be classified as semantic (real world referents), syntactic (rules and procedures) and structural (translations between representations). Researchers have explored in detail how to enrich semantic sources of control for reasoning about symbolism. Recent research on mathematical representations, however, has pointed to the importance of structure as a source of control. A long range view of different topics in elementary mathematics – whole numbers, fractions and beginning algebra - shows the importance of structural understanding. To exemplify this, he provided an analysis of students' understanding of the domain of whole numbers drawing from available literature. Following this, he indicated briefly how students' understanding of whole numbers and the structural control on symbolic mathematics can be drawn upon while designing the curriculum in the topic areas of fractions and beginning algebra.

The paper presented by Francisco offered insights into how frameworks can both shape and be shaped by the research approach taken. His research compares the mathematical beliefs of a student and his actions in a problem-solving mathematical task. The student was a participant in a longitudinal study in which students engaged regularly in challenging open-ended after-school mathematical investigations as a context for the development of particular mathematical ideas, forms of reasoning and proof making. The study used a phenomenological design and took place in the 12th year of the longitudinal study when the student was in high school. The purpose of this research was to highlight the advantages of an analytical framework that examines simultaneously individuals' views and behavior, particularly in situations that challenge the students' beliefs. The findings challenge misconceptions regarding epistemological beliefs of students below college level, and provide insights into how the framework could be further extended to provide a more comprehensive account of students' epistemological beliefs.

The final paper in this session, presented by Yetkiner and Capraro, circled back to the theme of methodology through examination of trends in reporting the results of quantitative studies in mathematics education research. They assert that the construction of a knowledge base upon which educational practices can be reliably grounded is dependent upon conducting quality research and reporting the research in compliance with empirical research reporting standards. When reporting the results from quantitative studies, both American Psychological Association and American Educational Research Association standards recommend including effect sizes and confidence intervals (CIs) rather than relying solely on the dichotomous null hypothesis statistical significance testing. The study presented by the authors examined effect size and CI reporting practices in two prominent mathematics education journals to aid in creating a "warranted" (AERA, 2006, p. 33) empirical research base in mathematics education. 104 quantitative articles published between 1996 and 2007 in *Journal for Research in Mathematics Education* and *School Science and Mathematics* were analysed for the reporting of effect sizes and CIs.

Summary

The papers represented a rich collection of methodologies dealing with relevant issues in research on the learning and teaching of mathematics. They featured new approaches, such as the work by Palius et al. to graphically represent the flow of discourse along a time scale and juxtapose it with the analysis of the discourse contents. They featured phenomenological approaches, such as the innovative work by Pang and Marton on learning study and the work by Francisco on the intersection of epistemology and beliefs. They draw from research in other fields to shed light on learning and teaching mathematics, such as Subramaniam's work that uses cognitive science to address issues of curriculum design and the work of Maheux and Bednarz to draw upon frameworks in multiple domains to design teaching situations. They also assess trends in reporting mathematics education research, such as the work of Yetkiner et al. that examines how quantitative research results are being reported in light of recommendations made by two major American professional associations. In sum, the papers and discussion reflected the diverse and innovative interests of researchers in mathematics education.

References

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