Topic Study Group 50

Mathematics Education in and for Work; Continuous Mathematics Education Including Adult Education

Lisa Björklund Boistrup[1] and Geoffrey Wake[2]

ABSTRACT In this report we give account for how TSG-50 was organised, both in terms of structure, and in terms of content of the area of the TSG. The papers presented are summarized and future directions are suggested, including the relevance of a TSG with this theme also for future ICMEs.

1. Organization and Aim

TSG-50 was organised by the following people:

Chair: Lisa Björklund Boistrup, Malmö University, Sweden
Co-chair: Geoffrey Wake, University of Nottingham, UK
Members:
Pradeep Kumar Misra, Chaudhary Charan Singh University, India;
Maria da Conceição Ferreira Reis Fonseca, Universidade Federal de Minas Gerais, Brasil;
Haixia Si, Hangzhou Normal University, China
Gail FitzSimons, Melbourne University (extra member)

Topic study group 50 at ICME-14 had as its aim to exchange ideas and knowledge with regards to two related themes: mathematics in and for work, and continuous mathematics education including adult education. The TSG received eight paper contributions and one poster presentation. Present at the TSG sessions were 15–20 people, where also co-authors took part. In our TSG sessions during the conference, we addressed key questions as an overarching organising structure:

- What issues do we need to consider in designing for mathematics education in and for work?
- What role can theory play in our mathematics education research?
- How can we support the learning of mathematics by adults?

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We allocated time according to the schedule below for contributions to facilitate the discussions around the key questions. In the end of each meeting there was time to discuss the questions across the presented papers.

2. Report from the Sessions of TSG-50

Below we give account for the subthemes and papers of the sessions of TSG-50 (Tab. 1).

Tab. 1. The list of papers for each theme

Paper and author(s)
Session 1: What issues do we need to consider in designing for ME in and for work?
[1] Designing for the learning of mathematics for vocational competence. ***Geoffrey Wake*** (UK).
[2] Construction of mixed training model for rural mathematics teachers in junior middle school. ***Xiaocheng Li***, *Guanghui Zhou, Jun Tao, and Dongxue Tu* (China).
[3] Sociomathematical norms in vocational mathematics education. ***Trude Sundtjønn*** (Norway).
[4] Infographics about the world of work: an experience with students of vocational education integrated to high school. *Guilherme Guilhermino Neto*, ***Lauro Chagas e Sá***, *and Maria Auxiliadora Vilela Paiva* (Brazil). (Poster)
Session 2: What role can theory play in our mathematics education (ME) research?
[5] Investigating interfaces between mathematics and vocational content: logos and praxis in education. ***Lisa Björklund Boistrup***, *Matilda Hällback, and Divo Racheed* (Sweden).
[6] "Here we are the boss": numeracy practices as resistance tactics of clothing factory workers in Brazilian northeast. ***Maria da Conceição Ferreira Reis Fonseca*** (Brazil).
Session 3: How can we support the learning of mathematics by adults?
[7] Re-thinking the assessment of adults' numeracy skills: new challenges, new responses. ***Javier Díez-Palomar*** (Spain), *Kees Hoogland* (The Netherlands), *and Isabelle Demonty* (Belgium).
[8] Moocs for lifelong mathematics learning of adults in India: promises and strategies. ***Pradeep Kumar Misra*** (India).
[9] Adults' proportional reasoning in a volume scaling situation. ***Linda Marie Ahl*** *and Lars Ola Helenius* (Sweden).

1.1. Session 1, Tuesday July 13th

The subtheme of this session is: *What issues do we need to consider in designing for ME in and for work?*

This theme was focused by the input of three papers and one poster. These looked at issues relating to developing mathematics education (ME) in preparation for, and in, work. These contributions signaled the wide range of issues to be considered, from overall drivers such as qualifications through to learning based on the use of specific tasks.

Wake[1] developed an argument that we need to consider carefully what we consider to be an appropriate form of the learning which we wish to promote. Consequently, he points to how learners need to get an awareness of how mathematics is developed and applied in vocational domains in ways that are sensitive to the idiosyncrasies that may arise in work settings. He also argued that because application of simple mathematics is important there needs to be time and space dedicated to learn how to do this in ways that are authentic to workplace settings. In this sense he emphasized that learning in and for work is primarily about learners who are involved

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in identity development as they become members of workplace communities and that a mathematics curriculum should support them in this. Li et al.[2] picked up this theme by illustrating a model of teacher training for rural mathematics teachers of junior middle school students. The paper provided insight into how workplace learning, in the case of teachers promoted a range of carefully designed learning modes that involved them in reflection in different stages that involved them in activity that is both school based and online in a mixed model.

Sundtjonn[3] focuses more closely on students' learning whilst working on a task in a lesson on a vocational education programme in Norway. She considers that even though the task being used is carefully designed to provide some engagement in an authentic activity both teachers and students exhibit behaviours that are those we might expect in traditional school mathematics classrooms. Their focus is primarily on getting mathematical solutions without considering the implications in terms of the real world situation. The study points to how strongly traditional sociopmathematical norms are embedded in the lives of teachers and students and to break through the barriers these present it will be necessary to provide teachers with specialized guidance. The poster[4] by Guilhermino from Brazil likewise looked at students' engagement in a learning activity for students on a Biotechnology technical course. This was found to be motivating as students took ownership of the themes they chose to work with and they drew on learning from other parts of their course as they carried out data collection, analysis and communication through the means of an infographic.

The discussion in this theme pointed to the different levels of support needed if we are designing mathematics education for the world of work. At the strategic levels we have to consider carefully the curriculum and qualifications we design through to the support we give teachers with their teaching at the tactical level of implementation and down to the detail of task design at a tactical level. There is much to do if we are to implement learning mathematics for work successfully.

1.2. Session 2, Friday July 16th

The subtheme of this session is: *What role can theory play in our mathematics education (ME) research?*

Two papers addressed issues of the use of theory in research with a focus on learning mathematics in and for work. Boistrup et al.[5] used the ideas of Chevallard's Anthropological Theory of Didaactics (ATD) to analyse data from collaborative teaching in mathematics and vocational education in the 'beauty' industries (facial make-up and hair). Their analysis considered both logos (knowledge and theory) and praxis (tasks and techniques) in the vocational tasks that students worked on. They reported, and illustrated, how in two tasks that learners worked on, (symmetry in) facial make-up and (angles in) curling of hair, demonstrated how logos from both mathematics and the world of work were needed and the praxis required was mainly from the vocational context. Their discussion pointed to how their use of ATD led them to confirm the work of other researchers who point to how mathematics can help clarify

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work practices and vice versa, the context of work can help provide insight into, and explain mathematical ideas.

In a more overtly political paper[6] Fonseca reported ethnographic research that explored the practices that were forged in work, school, and daily life activities of students from Youth and Adult Basic Education (YAE), aged 16. With a focus on the numeracy practices Fonseca's analysis Fonseca identified in the workplace tactics of resistance (Certeau, 2011) to oppressive ways of life and production being delineated, established, and developed. These practices were constituted by diverse discursive practices, including numeracy practices, generally marked by the Cartesian rationality used by capitalist logic. Fonseca suggested that their ways of doing mathematics, the workers were cunningly circumventing the distribution of tasks. They used tricks and expertise to improve and speed up the production — and thus make greater collective gains, not per piece made by each.

These two very different approaches to using theory in general suggest that theorizing our research can provide new insights into what are often complex socio-cultural situations.

1.3. Session 3, Saturday July 17th,

The subtheme of this session is: *How can we support the learning of mathematics by adults?*

A focus on adults learning mathematics was the common thread in the three papers presented in this session. Again, as in the first theme, the contributions provided a glimpse into the diversity of work that might be considered in research in this area, particularly at strategic, tactical, and technical levels.

At a policy level, Díez-Palomar et al.[7] went back to consider exactly what we mean by the term "numeracy", it's history and its relationship with quantitative literacy. They considered how international studies such as PIAAC are used to measure competence in this area across countries and then argued that we now face new challenges as adults are starting to have to consider solving problems that involve big data, social media, and other new e-social technologies that are deeply transforming social interaction. They point to how there are additional demands being made in terms of employability, citizenship, community participation, etc. and such considerations suggest that we need to rethink how international assessments for adults engage with the new "digital" era.

Picking up this theme, Misra[8] explored the potential of Massive Open Online Courses (MOOCs) as a medium for the education of adults in mathematics. Misra discusses this in the context of India, the worlds' second most populated country, where there are clearly challenges in reaching adult learners in ways that meet their needs in relation to societal, institutional, and governmental needs. The paper suggests that MOOCS offer great potential in this area and is optimistic that this approach can be successful in India.

In a final paper in this theme, Ahl and Helenius[9] considered the learning of a specific mathematical concept, that of proportionality in the specific contexts of

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volume scaling, speed and cost effectiveness. The fresearch was carried out with adult Swedish students in a prison education programme and contrasted with resuts from upper secondary students in Denmark. It was found that, in the case of volume scaling, the secondary schools students performed considerably better than the adult students. It was suggested that preliminary analysis of the other tasks were pointing to similar results. The authors suggest that proportional reasoning experienced in real situations does not seem to provide useful insight into the scientific ideas that were needed in the tasks used here.

3. Main Outputs and Future Directions

The two themes of the TSG, mathematics in and for work, and continuous mathematics education including adult education, are often related and TSG-50 combined them to consider mathematics education from the different contexts of where mathematics is either related to work (e.g. Wake[1], Sundtjønn[3], Fonseca[6], Boistrup et al.[5]) or other important aspects in the lives of adults (e.g. Li et al.[2], Neto et al.[4], Ahl and Helenius[7], Misra[9]). TSG-50 focused on lifelong mathematics learning and was concerned with mathematics education that takes place in formal education settings, such as formalised adult education; semi-formal settings, such as part of vocational education organized for example by employers or by workers' associations; and informal settings, that may be part of the daily activities of adults in and outside work.

TSG-50 viewed mathematics to be inclusive of the formal academic discipline of mathematics and mathematical processes such as modelling and problem solving in addition to many other informal forms of quantitative and spatial reasoning that arise in a wide range of settings and situations.

The discussions in TSG-50 were lively and focused, with both interactions online, as well as with participant on-site. The contributions pointed towards the future, both in the sense of addressing emerging and current issues, and in relation to the need for joint publications within the area. The plan is to have in process at least one joint publication until next ICME. A conclusion was also the need for a TSG such as TSG-50 also at future ICME's.

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