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Introduction to the papers of TWG13: Early years mathematics

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INTRODUCTION

The aim of the Early Years Mathematics working group is to share scholarly research related to mathematics education concerning children aged 3–8. This age group spans preschool through the early grades of primary school, and takes into consideration that in different countries children begin primary school at different ages. During CERME9, there were approximately 30 participants (authors and co-authors), with 20 accepted papers and 7 accepted posters. Of the 20 papers, one paper was a literature review paper on early childhood education (Alpaslan & Erden); the rest were empirical studies (12 related to preschool and 7 to primary school). There were 6 posters reporting empirical studies conducted within the preschool environment and one poster which described a STEM project promoting popular science which involved both mathematicians and scientists (Sorokina)¹.

The structure of the timeslots was designed in order to stimulate interaction and collaboration among participants and was as follows. Related papers were paired and after a short presentation of the first presenting author, a prepared question was posed by the second presenting author which initiated a general discussion. The roles of the presenting authors were then exchanged. Each pair of papers was allotted nearly 40 minutes. Posters were also allocated a few minutes of presentation time within the working group. One timeslot was devoted to small group discussions about general issues that had been raised during the papers and posters presentation. This report draws on the

outcomes of these small group discussions and of an extra meeting of co-leaders with a few participants who had volunteered to help in the preparation of the report. On the last day of the conference, our room was visited by more than twenty colleagues from other working groups, where a lively discussion ensued.

In addition to the presentations, we had the privilege of visiting a local preschool. Very early in the morning, a group of participants visited the *Materska Skola, Opletalova 14, Praha 1*, directed by J. Moravcova, accompanied by Michaela Kaslova, one of the participants of the TWG. This visit was really interesting as it explained, better than a report, the organization of preschools in the Czech Republic.

IS EARLY YEARS MATHEMATICS "MATHEMATICS"?

The above question was raised and discussed in the first session of the TWG and continued to be in the background of many discussions throughout the conference. Our shared answer was positive. Early years mathematics is mathematics when it fosters the development of mathematical processes. We can study the construction of mathematical meaning at each age. Some of the participants preferred to use the terms pre-mathematics or prepa-maths (see Fuchs et al., 2015; Kaslova, 2010) in order to emphasize that during the early years, the concern is for the processes which enable construction of mathematical meanings as opposed to the rote learning of terminology, techniques and calculation. It is important to raise public awareness about early years mathematics (e.g., through informal mathematics or new STEM projects). The papers and posters presented during

¹ These short references hint at the authors of papers/posters in the TWG.

TWG13 sessions offer a wide variety of examples of mathematical meanings to be constructed during those early years.

Preschool mathematics

The construction of mathematical meanings in preschool was presented by several authors in a variety of cases: the give-N task (Rinvold & Erstad); comparison of whole numbers (Tubach); conceptual subitizing (Rodrigues, Cordeiro, & Serra); the meaning of double (Björklund); mathematical discourse (Lavi); the coordination of the audible, the visible and the tangible (Pimm & Sinclair); unsolvable problems (Tirosh, Tsamir, Levenson, Tabach, & Barka); measurement (Erfjord, Carlsen, & Hundeland; Skoumpourdi), shapes (Erfjord, et al.; Pettersen, Volden, & Ødegaard), and symmetry (Demetriou).

While discussing the various mathematical activities described in the studies, it became apparent that different countries have different curricula with specific mathematical goals for preschool. The group expressed the need to know more about the organization of preschool in each country. Two cases were explicitly discussed – Italy and Sweden – observing that in both cases the preschool curriculum had been developed (in Italy in 1991, in Sweden in 2010) following Bishop's (1991) analysis of the universal activities for mathematical enculturation: counting, locating, measuring, designing, playing, explaining (Svensson). In addition, it was noted that programmes for preschool teacher education and development must be encouraged, where clear mathematical goals and ideas for learning trajectories for children are pinpointed. A specific example of a test for diagnostic purposes was analysed (Kaslova). The group discussed the risk that this kind of testing may introduce (e.g., teaching to test).

Primary school mathematics

Several authors offered examples concerning mathematics in early primary school:

Grade 1: inclusive definition of squares and rectangles (Bartolini Bussi & Baccaglini-Frank); conceptualizing parallel and perpendicular lines (Vighi).

Grade 2: multiplication tables (Maffia & Mariotti); magic squares (Maj-Tatsis & Tatsis).

Grade 3: patterns (Ferrara); fractions on the number line (Robotti, Antonini, & Baccaglini-Frank); em-

ploying the bar model for solving arithmetic word problems (Koleza).

In most of the above examples, argumentation was also emphasized.

The teacher's role in promoting mathematics was the explicit focus of some contributions (Delacour; Erfjord et al.) but was also discussed in other cases. The group agreed that it is important to reach a balance between structured activities controlled by the teacher and fostering conditions which will encourage children's agency. The issue of agency in preschool was the explicit focus of one contribution (Erfjord et al.).

CONTEXTS

Part of the time during small group work was used to discuss the issue of different contexts. Without entering into a review of the related literature, there is a risk of misunderstanding the notion of context. However, defining what is meant by context that was not the aim of this working group. Instead several papers and posters related to context either when describing a specific task, a specific piece of mathematics knowledge or a specific intention of the teacher/researcher. More generally, there are also institutional contexts (see, for instance, the short reference above on curricula in different countries) and the sociocultural contexts (Jaworski et al., 2015).

We collected meaningful examples of different contexts (in all of the above meanings) concerning

- outdoor activities in northern countries in the very cold winter (Delacour in Sweden and Erfjord et al. in Norway), which was quite astonishing for researchers from southern countries but are, on the contrary, a part of the shared values of their culture;
- families as places for mathematical play (immigrant families in Germany, Solmaz);
- informal (out of school) activities (Math circles, STEM camps, talks with a mathematician, Sorokina).

When the focus was on school mathematics, we had many examples of using manipulatives, either con-

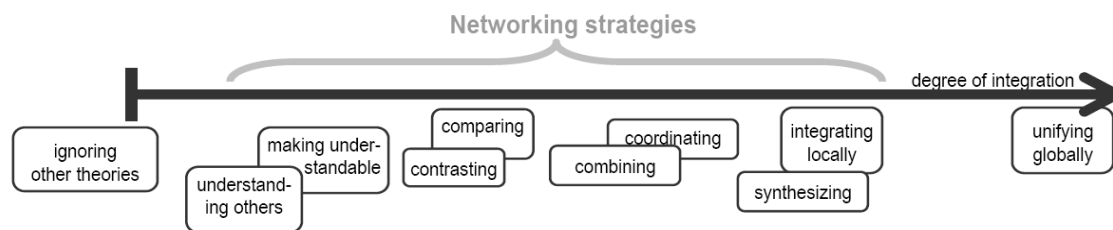


Figure 1: Networking strategies

crete manipulatives (cardboard collection, Demetriou; straws, Vighi; three dimensional models and folding solids, Pettersen et al.; blocks, Solmaz; virtual manipulatives (programmable robots, Bartolini Bussi & Baccaglioni-Frank; softwares and apps, Pimm & Sinclair). Comparing concrete and virtual manipulatives was also investigated and discussed (Demetriou).

THEORETICAL FRAMEWORKS AND RESEARCH QUESTIONS

Several different theoretical frameworks were mentioned:

- variation theory after Marton (Björklund);
- levels of artefacts after Wartofsky (Svensson);
- semiotic mediation after Bartolini Bussi & Mariotti (Bartolini Bussi & Baccaglioni-Frank; Maffia & Mariotti);
- discursive approach after Sfard (Lavi; Vighi);
- semiotic bundle after Arzarello and colleagues (Ferrara);
- theory of didactic situation, didactical contract after Brousseau (Delacour);
- theory of knowledge objectification after Radford (Rinvold & Erstad);
- Interactional niche after Krummheuer (Solmaz);
- grounded theory (Arnell);
- sociocultural theories after Rogoff (Erfjord et al.).

In most cases, it seemed that theoretical frameworks are chosen with reference to either authors or groups of authors from the same country; this choice could

be misunderstood as patriotism, it is not necessary the case. For instance, the semiotic mediation theory is useful in countries where the focus is on long term studies, which in turn depend on the institutional role of a teacher working for more than one year with the same group of pupils (Italy: Bartolini Bussi & Baccaglioni-Frank, Ferrara). Hence, we have another interesting example of the influence of cultural contexts research on early years mathematics.

The relationship between context and theoretical framework is a big challenge for the diffusion of findings and the possibility of exploiting findings from different cultural contexts (Bartolini & Martignone, 2013). The presence of different theoretical frameworks shows that it is timely to discuss networking theories, according to the vision developed by Bikner-Ahsbals and Prediger (2014, p. 170).

This issue might be focused in CERME10.

According to different theoretical frameworks, the authors of papers/posters have developed different kinds of empirical studies:

- intervention studies (short term and long term studies; attention to the teacher's role or focused on learners; examples of STEM in informal education)
- observation studies (observing learners; observing teachers; observing classroom processes)
- studies on teacher education .

It is difficult in some cases to make this clear distinctions, as in developmental projects the main idea of the activities is a result of a process of the engagement between researchers and teachers.

CONCLUDING REMARKS

The discussion sketched above left a problem open. During the last meeting with visitors from other TWGs we realized that there was some overlapping between the TWG13 and other groups, for instance the TWG02 on *Arithmetic and number systems*, where a major focus was on primary school arithmetic. One possibility to avoid overlapping is to interpret *Early year mathematics* as focused solely on preschool. This choice might be problematic because of the different institutional interpretation of preschool and primary school in different institutional context (a relevant example was offered by Vennberg, with the “transition” year between pre-school and primary school in Sweden). One of the arguments for continuing the TWG13 on *Early year mathematics* with focus on both is the importance to study also continuity between the two kinds of schools. Participants of TWG13 added that the exchange between researchers of both levels contributed to the general understanding of issues related to teaching and learning mathematics during these critical years.

and Mustafa Alpaslan in a traffic accident. Gisan was part of our group in TWG13 and as the first author of a paper she proved her talent in mathematics education and we learnt to know her as a very nice colleague. She will be sadly missed.

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A few months after the conference, we received the very sad news of the death of Zişan Güner Alpaslan