TSG 2: New developments and trends in mathematics education at primary level

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Aims and Focus

The goal of TSG 2 was to provide highly relevant and interesting presentations of new developments and trends in primary mathematics education from around the world. The sharing of international perspectives offered an opportunity to engage with the highlights and challenges of different professional settings with the intention of applying this new knowledge in local contexts.

As is often the case with international conferences, participants all seemed to find topics of personal interest, while acknowledging the commonality of many of the challenges faced by those engaged in the important enterprise of mathematics education.

The TSG sessions were organised around three themes.

1. Important mathematical ideas for the primary years.
2. Effective teaching of primary mathematics.
3. Linking the in-school and out-of-school mathematical knowledge of learners.

Organising Team members opened up the discussion with a brief overview of key developments in their respective countries. The Co-Chairs, Wan Kang and Doug Clarke, then outlined the plan for the work of the TSG over the coming days. This introduction to the TSG was followed by papers addressing the three themes.

Paper presentations 1: Important mathematical ideas for the primary years.

Ronald Keijzer (The Netherlands) described the process of developmental research in measurement in “Deca is ten”. Two important mathematical ideas were identified: the starting point of the process, converting between related units (metres to centimetres or decametres for example), and the use of length units in describing area measures. Children’s familiarity with benchmarks for mass, length, and volume were strengths already apparent in the Dutch curriculum. A poster for classroom use was developed to highlight the prefixes (giga, mega, kilo, hecto, deca, deci, centi, milli, micro, nano) for several measures: mass (grams), volume (litres), length (metres), digital information (bytes) and time (seconds). Classroom activities were devised and refined. Firstly, children suggested benchmark measures for given objects, for example, a bottle of shampoo holds around 200ml. Then, using the poster, they converted that measure to 0.2 of a litre. Reflection on this task revealed that fractional prefixes formed an additional barrier in the understanding of metric language. In the second task, therefore, examples were chosen that used powers of ten. Children explored how many square metre tiles were in a square, one metre by one metre, (one), and how many square metre tiles were in a square, one decametre by one decametre, (100). This paper highlighted how Dutch curriculum developers try out important mathematical ideas in classroom activities and supporting materials, then use a process of reflection and refinement that is centred on the characteristics of this activity that support the students’ development of these key mathematical ideas. This is done in order to translate important mathematical ideas into thoughtful classroom activities.

Taro Fujita (UK) and Shinya Yamamoto (Japan) discussed how the process of Japanese Lesson Study was used to evaluate Substantial Learning Environments in which the object was not just to deliver curriculum on conceptual mathematical concepts but to articulate what types of activities helped children to move to multi-structural and relational levels of understanding of the concepts encountered. These levels of understanding were based on the SOLO taxonomy. The Substantial Learning Environments were a series of lessons moving towards relational understanding. Number patterns, rather than unrelated practice of number operations were one way that the researchers suggested that this might happen. A cumulative adding pattern similar to Pascal's triangle but in a rectangular array format, "bamboo numbers," was used. This array enabled horizontal as well as vertical patterns to be observed. The authors report that all of the students in the pilot study demonstrated multi-structural thinking and that the structure of the four lessons and the tasks had enabled 62.5% of the class to advance to relational thinking.

The two papers on this theme showed that important mathematical ideas require children to explore underlying mathematical structures, for example, the nomenclature system for metric measures, and the patterns underlying addition. Both papers suggested that children's understanding of important mathematical concepts was more relational when different sources of related information could be coordinated: in metric measures this consisted of seeing related use of metric prefixes for different attributes; for bamboo numbers this coordination was of horizontal and vertical patterns and missing numbers.

Paper presentations 2: Effective teaching of primary mathematics

Mary Margaret Caparo, Alma Rangel-Chavarez, and Robert Caparo (USA) described a study of the effective teaching of pre-service teachers, designed to improve their pedagogical content knowledge in K-4 algebra. The paper was premised on the belief that improved teacher pedagogical content knowledge correlates with improved student performance in the primary classroom. Several online modules were developed for the pre-service teachers, focussing on interpreting primary students' work samples, observing classroom tasks on video, and making conjectures about students' and teachers' strategies for learning and teaching from a simulated classroom task. These online units proved effective in developing algebraic habits of mind in the pre-service teachers for several reasons. They enabled extra activities to be completed outside the methods classes. They provided pre-service teachers with a controlled, simulated classroom environment that they may not have seen during their field-based classroom placements. And, lastly, these online units provided an opportunity for pre-service students as a group to discuss and reflect on the same student work, lessons, vignettes, and streamed videos.

Tracey Muir (Australia) presented a model of effective teaching and a case study of upper primary teachers. She elaborated how the principles of practice: making connections, challenging all pupils, developing conceptual understanding, purposeful discussion, focussing on mathematics, and a positive attitude, are enacted in the primary classroom. Muir pointed out that while classroom tasks by themselves may meet the criteria for requiring students to use complex thinking, sometimes teacher instructions accompanying the task directed children to access the task at a lower level, for example, being instructed to "guess and check" as a strategy combined with filling in a pre-made table. In the classroom practice of the case study teachers Muir observed them making connections between real life and mathematical concepts as well as between different aspects of mathematics.

Jessica Pierson, Luz Maldonado and Erika Peirson (USA), described a teacher behaviour that contributed to the effective teaching of addition in a kindergarten classroom. This behaviour was probing questioning by the teacher of two children's responses to the following task. "There are three boys playing in the housekeeper centre. Two girls join them. How many children are playing in the housekeeping centre?" The teacher was not satisfied with a correct numerical answer and probed, ("why did you choose two and three?") to find out whether the child could metacognitively describe where the numbers came from and when it is appropriate to choose your own numbers. The teacher and the child were unable to establish a shared discourse because despite probing questions, the child continued to answer a different question. However, despite a lack of shared focus, the interaction successfully reinforced this particular mathematical community's classroom norms that: 1) telling an answer is not sufficient; 2) an explanation should be one that others can understand; 3) reliance on the community to challenge, clarify and help you think; and 4) it is okay to struggle and make mistakes.

Jill Cheeseman (Australia) described how effective teaching of mathematics is evident in young children's ability to recall mathematical conversations with their teacher and explain their mathematical reasoning. Using video-stimulated recall, the researcher gave 5 to 7 year-old children the opportunity to recall an incident or task from that day's mathematics lesson, describe the events, explain their mathematical thinking, and articulate what they had learned. A high proportion of the children could explicitly describe their mathematical thinking and specify their learning. Some children described learning how to do something, for example, "[I] learned how to count by nines", while others could link this to a broader concept, for example, "I think I may have learnt some more times tables...some were like 9 x 6".

These four papers focussed on different facets of effective teaching of mathematics. The students ranged from early and upper primary, to pre-service teachers. The evidence for effective teaching came from student performance—improved test scores for pre-service teachers and an ability to describe their mathematical learning in early primary children. Observations of teacher behaviour revealed the importance of task selection and probing questioning. A model for effective teaching encompassed both desired outcomes and descriptions of how this is enacted in the classroom.

Paper presentations 3: Linking the in-school and out-of-school mathematical knowledge of learners

Annie Savard (Canada) reported that the Quebec curriculum emphasised contextualising mathematical knowledge in real life situations in order to develop citizenship. In the classroom, this means that in a mathematics lesson there can be three different layers of conversation occurring: the mathematical context, the sociocultural context, and the citizenship context. In a quiz on gaming experiences, the students were asked: "After getting three heads what will be the next outcome?" As gambling is a problem in wider society (citizenship context), the low mathematical odds of winning because of the independence of each toss (mathematical context) was contrasted with other reasoning, for example, superstitions or personalised interpretations about manipulatives (sociocultural context). Interestingly, children's alertness to cheating (a citizenship context) drew them more towards sociocultural explanations than towards mathematical understandings of probability in response to this initial task. However, the further task of making and recording 100 coin tosses and discussing their findings, enabled the children's sociocultural understandings to be restructured with mathematical understandings. At the end of the teaching experiment, when asked the same question, all of the children used what they had learned about independence between outcomes and variability to answer the question. Real life contexts were not used because the children have access to correct mathematical thinking in analogous contexts because the evidence presented here suggests that some sociocultural understandings are not mathematically correct. This paper argued that when students were moved from a sociocultural context to a mathematical context, their understanding became more complex. This shift was enabled by the teacher providing mathematical contexts that both confronted their sociocultural knowledge and also offered a new context in which to articulate their understandings.

The programme concluded with the Chairs thanking all presenters and participants of TSG 2 for their enthusiastic participation.