DG 18: Current problems and challenges in primary mathematics education

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Aims and focus

The importance of primary mathematics education cannot be overemphasized. It is in the primary years that students from any part of the world learn number concepts and numeration, shapes and figures, and basic measurement skills, among other beginning mathematical skills. Yet, ironically, in the primary grades mathematics learning becomes more problematic than could be expected. Indeed, it is never true that teaching primary school mathematics is without effort.

DG 18, whose task was to address *current problems and challenges pertaining to the teaching and learning of mathematics at the primary level*, prioritized among the many important issues the following on which the group should focus:

1. *The social aspects of mathematics learning*
   How do the opportunities of pupils who enter primary school change in different parts of the world? What structures and facilities are available to students (buildings, classrooms, books, libraries, technologies, school buses)? Will the gaps among the First, the Second, and the Third Worlds be destined to widen more and more?
2. *The primary learner's motivation, strategies, understanding, individual development of mathematical thinking, curricular and pedagogical concern;*
   Children are naturally excited and interested in mathematics in, say, the first three years of school. Then many get disenchanted. Why? What is it about mathematics in the first years that keep them interested? How important are word problems for the development of mathematical thinking, on the one hand, and the ability to make use of mathematics in every day life, on the other? What mechanisms should there be to connect mathematical contents in the school curriculum over the years?
3. *Teacher preparation*
   How should teachers be prepared to be more effective in the classroom, or what are the characteristics of good teachers, irrespective of country?
4. *Technologies*
   How are different parts of the world coping with the challenges of embracing and using new technologies such as calculators and computers in the teaching and learning of primary school mathematics?

Papers posted for discussion

A few papers were posted on the DG 18 website to provide some impetus for a stimulating discussion of the important issues.

Ewa Swoboda proposed the inclusion of more geometry in primary education. In most countries, much of primary mathematics education consists of number concepts and very little geometry. Geometry is one area of study that could enhance children's

intuitive thinking; it emphasizes the study of patterns, to which children seem to have a natural inclination. Moreover, geometrical signs and symbols are between the abstract and the real thing, making geometrical language much easier to understand.

Ed Wall's paper tackled the issue of how pupils in elementary school should behave. How can we teach students in a mathematics class to be respectful listeners and encourage them to pay attention to the different reasoning of their schoolmates? Some of the key ideas put forth are active listening, listening event, anticipation, appropriation, harkening, and attuning. Such ideas make one think of the many instances in the classroom when teachers could have spent more time trying to understand what really went on in the minds of students who appeared to be listening.

Results from a study in Germany by *Klaus Hasemann*, revealed that an abstract-symbolic approach to developing insight in word problems among low-achieving second-graders helps improve their performance in solving word problems and their arithmetical skills. Surprisingly, low-achieving second-graders who went through a program that focused on students' real-life action related behavior had the lowest success. Could this be a formula to help low-performing students succeed in mathematics?

Victor Polaki reported a wide gap between the mathematics curriculum contents on number concepts and operations as articulated in the documents written by the Ministry of Lesotho and the teaching materials that students have access to. This gap essentially revealed that students in Lesotho are, potentially, not able to learn much of the said contents in the intended curriculum. The implication is to strengthen the capabilities of elementary mathematics teachers and enable them to bridge the gap by developing more appropriate materials for their teaching.

A real novel idea to help elementary mathematics teachers overcome their insecurities about mathematics was discussed by *Virginia Keen*. She proposed that by giving preservice elementary teachers the experience of writing children's books that focus on mathematical ideas, they can overcome their fears of mathematics and even become more excited about it. What other ways can we use to help elementary teachers, who are often non-specialists, become more confident and competent in teaching mathematics?

Michaela Kaslova deals with approaching algebra in primary school and, mainly, working with letters and substitutions. The provisional conclusion of the research is that better results are achieved using letters than using pictures. Pupils tend to interpret the use of pictures as 'games', while they attribute to the letters a more 'important' role in a mathematical sense.

The sessions

In the course of the two sessions many of the proposed topics were discussed. As regards the four issues, the issue on social aspects was not discussed directly but was rather more implicitly referred to. The themes of the second issue were lengthily discussed, mainly those concerning mathematical language. Such a fact highlights the accord on its importance, mainly in the primary school, in the building of meaningful mathematical concepts.

Issue 2: The primary learner's motivation, strategies, understanding, individual development of mathematical thinking, curricular and pedagogical concern

On students: A point was made that a main objective in teaching should be to develop a mathematical disposition in students and good habits of mind. In this connection, a question was raised whether or not dispositions can, indeed, be taught (or are teachable).

On the curriculum

Geometry: Geometry is an important domain for exploration as well as for building up and developing important ideas to support the mathematical thinking of children by directing them to find general rules. On the other hand, it is a fact that geometry is more or less ignored in primary mathematics all over the world. One reason for this fact might be that arithmetic more easily lends itself to testing than geometry; even if a child sees a pattern in a mathematical situation this does not mean that s/he has already grasped a general rule or a mathematical concept.

Numbers: The difficulties of numerous children with mathematics are partly due to using numbers exclusively as calculating numbers. The weaker pupils already in their very first grades should particularly learn (and need the teacher's help) to shape relations between numbers, and not just be restricted to the conception of numbers as quantities and to actions with quantities. This argument is in accordance with Jeremy Kilpatrick's demand in the Plenary Interview Session to have a good balance between the power of the concrete, on the one hand, and the abstract and conceptualisation, on the other.

Mathematical language:

- It was concurred that *all* children must be given the chance to use the *mathematical language* as a powerful and typical human ability.
- *Metacognition and metalinguistics*: Many researchers think that the mediation of the natural language – written and spoken – since the first years of the primary school must precede the formalisation and the reflection on the systems of symbolic notation peculiar to mathematics. One could synthesise two views:
  - On the one hand, to favour a math education based on metacognitive (as a reflection on processes) and on metalinguistic aspects (as a reflection on languages) is considered a strategy of increasing importance in order to build *meanings* with students.
  - On the other hand, a usual sentence of the teachers is: "I think that the discussion in math classes can be very useful but I am afraid to do it because I know when it begins but I do not know when it finishes".
- Is a meaningful compromise possible between the two positions? Is *discussion* in mathematics a widespread practice? Is it considered important? Can mathematics be used – also in primary school – as a means of communication? Can mathematics be seen as a *social activity*, deeply concerned with *communication*? Is this a challenge in order to improve learning/teaching of mathematics? Is a meaningful discussion in a class of 30 or 40 pupils, lifting their hands in order to answer to a question of the teacher, possible? Are they learning *to speak mathematically*?

- *Linguistic approach*: A determining role is attributed to the *linguistic* approach and to research that affronts the didactical developments starting from the *concept of algebra as a language.* This role becomes even more significant if it is associated with the hypothesis of an *early initiation to algebraic* education beginning from the didactical readings of the relations between arithmetic and algebra. Research does demonstrate just how students' limited arithmetic experience becomes an obstacle when learning algebra. It is thought that an earlier approach can reduce this difficulty. It is only recently that interest has been shown towards an early approach to algebra, thus there is not yet much documentation regarding this area. Questions and answers are being formulated, such as: How early should *early algebra* be? What are the *advantages and disadvantages* of an anticipated start? How are the answers to these questions connected to *theories* of cognitive development and learning, and to the cultural and educational *traditions* of teaching algebra? Which algebra and algebraic thinking aspects should be part of an early algebraic education? What consequences would an early algebraic education have concerning *teachers and their formation*?

High-stakes testing: High-stakes tests exert undue pressure on teachers, forcing them to emphasise competition rather than conceptual learning of mathematics. The challenge is to turn these tests around so that they can support conceptual learning rather than detract teachers from it.

Issue 3: Teacher preparation

A challenge was given to the group, namely, how to help teachers to develop an open learning environment. It was stated that this should be a starting point for discussion and research. Reference was then made to the use of the interactive or digitized whiteboards in classroom instruction as a tool to encourage open discussions in mathematics classes. Another challenge that was posed is to review preservice teacher programs, but in what direction? One idea is to focus preservice programs on building metacognitive skills of teachers who in turn could help pupils develop their own metacognitive skills. The question of how much mathematics content knowledge primary mathematics teachers need to learn continues to challenge us as well. For many teachers what is needed is a long-term commitment to professional development activities such as the workshops that were run to teach the national standards in the US. Finally, a "burning" question was asked: What does it take to become a good teacher of mathematics? A good teacher needs to be involved in a number of hours of professional development so as to improve content knowledge – enough time and proper emphasis is needed. This is a continuing issue in mathematics education. Suggestions for holding conferences to discuss the issue further and compare achievements of countries in this area were strongly supported.

On parental involvement: More and more it becomes imperative for parents to become active participants in their children's primary school education. For poorer countries at least, the problem has more to do with both parents needing to work and therefore lack time and opportunity to get involved. In others, experiences by teachers have shown that how parents view the role of the school affects their level of involvement in their child's education. The challenge is how to get all parents to support and get involved in

their children's learning? One recommendation that was well-received was to educate parents on how their children's educational success could translate to the families' potential economic progress.

Issue 4: Technologies (IT)

The role of IT in primary education: All participants agree that children have to learn mental calculation; however, the grasping of pattern as a basis for elementary algebra might be supported by the use of calculators and computers.

Access to computers: One participant pointed out that a major issue in his part of the world is the mere getting *access* to computers. They may be plentiful in some countries, or at least more plentiful than in most countries. But, there are countries in which students have no access to calculators or to computers in learning mathematics which indeed is a major challenge.

IT and geometry: A couple of examples were given on the use of technology, especially in teaching counting and geometry. Reference was made to a recent series of primary school textbooks in Germany [Wittmann and Müller] in which excellent software is used in teaching, closely aligned to the students' textbooks, to teach counting, estimation, and various operations. There seemed to be a sentiment in the group that technology has a great potential in teaching geometry and that geometry could very well be learned effectively in an "open" environment. The same can be said of developing students' number sense.

A final word

The discussion group realised that the challenges and issues that have been identified will remain to be such, at least for the next few years. At ICME-10, DG 18 was unsuccessful in putting a closure to the many questions that have been raised in the course of the discussions. The group, therefore, believe that a continuing dialogue among the many players in primary mathematics education would benefit our primary mathematics students. The team strongly suggests that succeeding discussion groups on primary mathematics education continue to focus on the same issues and questions that were outlined for ICME-10.

References

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