International Commission for the Study and Improvement of Mathematics Education

CIEAEM71
Braga, Portugal 22 - 26 July 2019

THEME
Connections and understanding in mathematics education: making sense of a complex world

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Conference venue
Instituto de Educação da Universidade do Minho, Campus de Gualtar, Braga, Portugal

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Theme of the conference:
Phrases like 'mathematics is the language in which God has written the universe' (Galileo Galilei) or 'all things in nature occur mathematically' (René Descartes) express the idea that if we want to understand the world, then we need to use mathematics. But can we use mathematics without understanding? John von Neumann once said 'Young man, in mathematics you don't understand things. You just get used to them.' One way to interpret this statement would be to say you could use mathematics (with success) without understanding it. Or, perhaps we can speak of a kind of understanding that is merely instrumental instead of relational (Skemp, 1976) or intuitive, or formal (Byers & Herscovics, 1977). Another different way to read von Neumann's statement is to take it as a clarification that understanding is not a white or black issue. There may be degrees of understanding. And there may also be understanding that impedes better understanding. In the words of Richard Skemp, "to understand something means to assimilate it into an appropriate schema. This explains the subjective nature of understanding, and also makes clear that this is not usually an all-or-nothing state" (Skemp, 1971, p. 46). Pragmatically, the

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power of adaptability of a schema results from its connection to a greater number of concepts, but it may happen that what is an appropriate schema at one particular time may be obsolete and turn into an obstacle later on (Brousseau, 1997).

Let's get back to René Descartes: 'All things in nature occur mathematically'. A different idea implied by this saying would be that to understand mathematics we need to connect our mathematical understandings with our understandings of the world we live in (natural, psychological and socio-cultural; see also Skemp, 1979). This idea is at the base of the concept of mathematization, or, more precisely, horizontal mathematization (Freudenthal, 1991). Concurring with this idea is the belief many have that Mathematics is a cultural product based on human experiences, such as counting, measuring, locating, designing, explaining, and playing (Bishop, 1988). Nevertheless, mathematical understanding has to do with both the learning of invariants and the acquisition of cultural tools in which children can represent mathematical ideas, in a dynamic and interconnected process (Nunes & Bryant, 1997). This idea is in line with a recent formulation of understanding in epistemology, in which understanding of a given phenomenon has to be maximally well-connected and it may have degrees of approximation (Kelp, 2015).

Concerning the learning and teaching of mathematics in the complexity of our world, we can revalue the ideas of Galileo, Descartes and Von Neumann on the central role of mathematics in the context of the genetic approach of epistemology proposed by Piaget to the logical-mathematical dimension of the construction of scientific knowledge. Piaget proposed to replace the positivist hierarchization of science with an interdisciplinary cyclic epistemology. This approach to epistemological interrelationships in the context of learning, conceived in the digital environment of education, calls into question not only the connections of mathematics as a scientific discipline, but also the connections of mathematics as an academic subject. How is it possible to make the presence of mathematics visible in the understanding of other school subjects? How to collaborate with other teachers of mathematics and of other courses? This question of interdisciplinarity is in close interaction with the learning and teaching of the complexity and variety of the natural and social phenomena of our era.

Subthemes:
1. Learning in an increasingly complex world
How can we re-conceptualise learning with understanding in a complex world?
How can we promote learning with understanding in an increasingly complex world?
What features should a task have in order to promote learning with understanding? How to research about the complex dynamic of learning with understanding promoted by such tasks? What can we learn from this research to use within the classroom and in designing lessons/tasks?
How can we establish connections in mathematics learning: Between different areas of mathematics? Between mathematics and other subjects? Between mathematics and everyday life?
What implications has the increasingly complex world in terms of numeracy or mathematics literacy? How does this inform our practices within the classroom and in designing lessons/tasks?

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2. Mathematics Teacher Education
What kind of mathematics training should teachers have in order to be able to promote learning with understanding?
How can teacher training contribute to establishing connections between the various areas of Mathematics?
How can teacher training contribute to establishing connections between Mathematics and other subjects?
How to promote connections between school mathematics and academic mathematics, in teacher training?
What type of competences do we need to include in professional training programs for mathematics teachers to cope with the increasingly complex world challenges?

3. Teaching for connections and understanding
In relation to connections and understanding, what kind of teaching methods are more appropriate?
How do we evaluate and/or research about the resources from the perspective of the connections and understanding they try to promote?
How can we promote mathematics education as a means to explore environmental issues?
How can we promote mathematics as a means to reflect on the sustainability of the world?
How can mathematics promote "living together"?

4. Mathematics Education with Technology
How can ICTs contribute to learning rich in connections, in an increasingly complex world?
How can ICT be used in teacher training to promote understanding in mathematics?
How can we use ICT as teaching-learning tools, rather than instruments that replace students' cognitive efforts?

5. Connections with culture
Is it possible to understand peoples' lives from an ethnomathematics perspective?
How can school mathematics take into account the culture developed by young people in their everyday life?
How to take advantage of cultural aspects to enrich the teaching and learning of mathematics?
How can we create hybrid spaces linking school-mathematics to mathematics situated in cultural, everyday contexts?
What does it mean to develop a critical approach to mathematics and culture in an increasingly complex world?

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PROGRAM OF THE CONFERENCE
The program of the conference includes several activities: plenaries, semi-plenaries, working groups, oral presentations and lectures, and a forum of ideas.

Plenaries
The program includes plenary and semi-plenary sessions where invited speakers will focus on aspects of the conference theme. The plenaries and semi-plenaries provide a shared input to the conference and form a basis for discussions in the working groups.

Plenary speakers:
- Terezinha Nunes, Department of Educational Studies, University of Oxford
- Carmen Batanero, Departamento de Didáctica de la Matemática, Universidad de Granada
- Joaquin Giménez Rodriguez, Departament d'Educació Lingüística i Literària, i Didàctica de les Ciències Experimentals i la Matemàtica, Universitat de Barcelona
- João Filipe Lacerda de Matos, Instituto de Educação da Universidade de Lisboa
- Kay Owens, School of Teacher Education, Charles Sturt University (pending confirmation)