

## **Topic Study Group 19**

### **Mathematical Literacy, Numeracy and Competency in Mathematics Education**

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#### **1. Aims of the TSG**

The Mathematical Literacy Topic Study Group 19 at ICME-14 was organized around four key themes that drew from emerging findings in the literature related to discussions about the Mathematical Literacy field:

The “place” of mathematical literacy: What are the specific focuses and topics that can characterize the notion of mathematical literacy? How does the notion of mathematical competency relate to mathematical literacy? How should mathematical literacy be taught directly, as a by product of regular mathematics or integrated across subjects?

Theories of mathematical literacy: What are some theories and methodologies that can help us understand the issues central to the teaching and learning of mathematical literacy?

Research issues: What can research tell us about the teaching and learning of mathematical literacy? What do empirical results from large- and small-scale studies indicate that can inform our thinking about the conceptualization, teaching, learning, or assessment of mathematical literacy? What are some understandings of mathematical literacy, and how do these permeate the curricula, teachers’ identities, beliefs, attitudes and practices, teacher education, learning materials, and assessments, etc.?

Views about the future of mathematical literacy: If we are committed to developing mathematical literacy at the school level, what barriers should we overcome? What new types of initiatives, policies, or collaborations (across subject areas, outside schools) are needed? What are potential gains or losses with possible initiatives?

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### 1.1. Submissions

Papers and discussions related to these themes were intended to stimulate discussion about key directions for future research related to mathematical literacy. Overall, at the conference our TSG had a total of 17 oral presentations and one poster presentation.

### 1.2. Sessions

There were three sessions in total, the first one was 2 hours and the second and third ones were 90 minutes each. There were two invited speakers who presented in the first two sessions.

### 1.3. Paper topics

The list of papers that were presented in the sessions appears in Tab. 1.

Tab. 1. List of papers and authors

Paper and author(s)
[1] Common European numeracy framework — a multifaceted perspective on numeracy. <b>Kees Hoogland</b> (The Netherlands), <b>Javier Diez-Palomar</b> (Spain), and <b>Niamh O'meara</b> (Ireland).
[2] Mathematical literacy: what, why and how. <b>Ross Turner</b> (Australia).
[3] Elements and definitions of the core literacy of mathematics in primary school from an international perspective: based on NVivo 12.0 coding analysis. <b>Xuan He</b> and <b>Yunpeng Ma</b> (China).
[4] Top-level design and systematic thinking for the cultivation of math competencies-case study and inspirations. <b>Feng Ma</b> (China).
[5] It is time pre-service teachers develop their numerate abilities to support their students numeracy learning. <b>Kathy O'Sullivan</b> (Ireland).
[6] Aspects of fair-minded critical thinking in mathematics education: based on the perspective of critical mathematics education. <b>Yuichiro Hattori</b> and <b>Hiroto Fakuda</b> (Japan).
[7] How teachers generate ideas for classroom numeracy tasks. <b>Vince Geiger</b> (Australia).
[8] Pre-service teachers' experiences with the Australian national numeracy test. <b>Jennifer Hall</b> and <b>Anna Podorova</b> (Australia).
[9] Mathematical Literacy in pre-service teacher-designed mathematics picture books. <b>Zetra Hainul Putra</b> , <b>Gustimal Witri</b> , and <b>Syahrilfuddin Syahrilfuddin</b> (Indonesia).
[10] Identifying 9th grade students' errors in solving a mathematical literacy problem. <b>Maryam Mohsenpour</b> , <b>Mahbobeh Rohanipur</b> , and <b>Zahra Gooya</b> (Iran).
[11] A new model design to improve mathematical literacy: A dual focus teaching model. <b>Cigdem Arslan</b> , <b>Murat Altun</b> , <b>Tugce Kozakli-Ulger</b> , <b>Isil Bozkurt</b> , <b>Recai Akkaya</b> , <b>Furkan Demir</b> , <b>Zeynep Ozaydin</b> , and <b>Burcu Karaduman</b> (Turkey).
[12] Unpacking some challenges of learning mathematical literacy in South Africa. <b>Sarah Bansilal</b> (South Africa).
[13] Designing PISA-like mathematics task using Asian games context. <b>Ratu Ilma Indra Putri</b> and <b>Zulkardi Zulkardi</b> (Indonesia).
[14] Assessing PISA-like tasks considering levels of context use for mathematics problems. <b>Ahmad Wachidul Kohar</b> , <b>Tatag Yuri Eko Siswono</b> , and <b>Dayat Hidayat</b> (Indonesia).
[15] Financial numeracy practices in secondary school: A study with mathematics teachers from Quebec. <b>Alexandre Cavalcante</b> and <b>Annie Savard</b> (Canada).
[16] A semantic network analysis of information literacy in school mathematics in Korea. <b>Eun Hyun Kim</b> and <b>Rae Young Kim</b> (South Korea).
[17] Mathematical literacy in Norway. <b>Oda Heidi Bolstad</b> (Norway).
[18] A survey on primary school mathematics teachers conception of mathematics core literacy in the context of Chinese curriculum reform. <b>Qiuchan Li</b> (China). (Poster)

## 2. Themes

There were a large variety in research topics presented during the sessions, however there seemed to be three overarching themes that emerged across the presentations. The first related to interpretations of mathematical literacy and its broader purposes in different countries. The second theme concerned issues related to developing mathematical literacy skills or practices. The third theme related to issues about task design for mathematical literacy. The discussion around these themes are presented below.

### *2.1. Understanding mathematical literacy and exploring interpretations of constructs related to mathematical literacy.*

In his invited talk<sup>[2]</sup> Ross Turner raised the point that although there is no agreed definition of the term “mathematical literacy”, there are components which need to be considered in any definition. These are: practical aspects including number sense, arithmetic and spatial skills; procedural knowledge which includes knowledge about procedures, theorem and definitions; and, a more pervasive way of thinking about mathematics including thinking mathematically, reasoning and communication. Hoogland in his invited talk<sup>[1]</sup> presented findings raising from the project that aimed to develop a Common European Numeracy Framework (CENF) for adult learning. The framework recognizes numeracy as a social practice and takes into account meta-cognitive aspects, psychological and sociological facets, and power-related factors, which influence the quality of numerate behavior among adults.

Many presentations focused on the curriculum interpretation or on teachers’ interpretations of constructs related to mathematical literacy in various countries. He and Ma<sup>[3]</sup> looked at the elements considered as the core literacies in primary school mathematics curricula in the US, UK, Australia, Japan and Singapore while Ma<sup>[4]</sup> focused on the competencies covered in the mathematics curriculum of the 2-year IB programme designed for high school learners. Bolstad<sup>[17]</sup> analysed curriculum documents to identify how mathematical literacy was treated in Norway and suggested that teachers need more advice and support about how to implement the ideas in the classroom. Kim and Kim<sup>[16]</sup> conducted an analysis of 30 mathematics teacher guidebooks from Korea to better understand how information literacy was interpreted and recommended for use by teachers in their classrooms. Li<sup>[18]</sup>, in a poster session, reported on a survey on primary school mathematics teachers’ conceptions of mathematics core literacy from a rural district in the context of Chinese curriculum reform. Arslan and her colleagues<sup>[11]</sup> outlined a dual focus model that was introduced to middle school mathematics teachers in Turkey which focuses on acquisition of concepts as well as on applications in order to develop the mathematical literacy skills of their students. Cavalcante and Savard<sup>[15]</sup> conducted a study with Canadian teachers to understand how they incorporated financial numeracy in their classrooms and found

that the teachers delved into issues mainly related to personal finances and not those of citizenship or social justice.

## **2.2. *Research about developing skills related to mathematical literacy***

Hattori and Fakuda<sup>[6]</sup> looked at the notion of fairminded critical thinking and how this could be actualised amongst their students. They shared an example of how this was targeted in lesson practices. The lessons focused on developing critical citizenship through the implementation of statistics education in the context of the environment.

O'Sullivan<sup>[5]</sup> researched the numeracy skills of 204 preservice-teachers in Ireland and found that most were not able to complete all of the numeracy tasks. Hall and Podorova<sup>[8]</sup> explored the experiences of 458 PST's with the high stakes, mandatory test, Literacy and Numeracy Test for Initial Teacher Education (LANTITE). They found that there were connections between the students' preparation and their perceptions of the test as well as differences by demographic groups.

Mohsenpur and her colleagues<sup>[10]</sup> conducted interviews with nine Grade 10 students in Iran, to better understand the errors they made when solving a mathematical literacy problem. Bansilal<sup>[12]</sup> presented a contextual attributes framework for identifying and describing some of the challenges experienced by learners in working with contexts within mathematical literacy tasks.

## **2.3. *Research related to the design of Mathematical literacy tasks***

Putra<sup>[9]</sup> and her colleagues from Indonesia looked at tasks designed by 13 groups of preservice teachers and found that the most popular contexts were those based on personal issues. Kohar<sup>[14]</sup> and his colleagues from Indonesia analysed 130 mathematical literacy task to identify the levels of context use and found that 29%, 65% and 6% displayed a zero, first and second order use of contexts respectively. Putri and Zurkardi<sup>[13]</sup> from Indonesia set out to assess how well tasks set within the Asian Games context, could work to support learning. Geiger<sup>[7]</sup> looked at the different ways in which teachers generate ideas for the design of numeracy tasks, including taking advantage of incidental events; bringing together elements of curriculum from different learning areas; and archiving ideas.

## **3. Areas for Future Research**

The closing discussion touched on a number of areas such as the fact that there is no established definition of mathematical literacy for which there is wide agreement. It is clear that there are varying ideas about the need for, and value of, mathematical literacy and how it fits into the curriculum. One presenter commented that if one thinks about mathematical literacy as the ability to implement mathematics, then it reproduces the view that mathematical literacy is a discipline instead of it being recognised as a practice. This discussion highlights the need for more interrogation of what

mathematical literacy is and how mathematical literacy practices could be enhanced. Most participants agreed that we need increased attention to teaching practices, as well as teacher preparation and professional development programmes which can help teachers to improve the numerate behaviour of their students. The presentations also articulated the need for more attention in future research to assessment design as well as curriculum policies.

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