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The twenty-third ICMI study: primary mathematics study on whole numbers

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Abstract

A new study on the teaching and learning of whole number arithmetic in primary school and pre-school will be conducted by the International Commission on Mathematical Instruction (ICMI). The study is organized around themes concerning foundational aspects of whole number arithmetic (cultural, historical, epistemological, as well as (neuro)cognitive), the teaching and learning of whole number arithmetic, and the connection of whole number arithmetic with other mathematical topics. The International Program Committee invites papers for the new study.

Keywords: Whole numbers; Arithmetic; ICMI study; Primary mathematics; Pre-school mathematics

Background

The International Commission on Mathematical Instruction (ICMI) announces a new study on whole number arithmetic in the official discussion document posted at http://www.mathunion.org/icmi/conferences/icmi-studies/ongoing-studies/icmi-study-23/. This study, the twenty-third led by ICMI, addresses for the first time mathematics teaching and learning in primary school (and pre-school as well) for all, taking into account inclusive international perspectives including socio-cultural diversity and institutional constraints. One of the challenges of designing the first ICMI primary school study is the complex nature of primary mathematics. For this reason, a specific focus has been chosen, as the key and driving feature, with a number of questions connected to it. The broad areas of whole number arithmethic (WNA), including operations and relations and the solution of arithmetic word problems, are the kernel or core content of all primary mathematics curricula. The study of this key core content area is often regarded as foundational for later mathematics learning. However, the principles and main goals of instruction in the foundational concepts and skills in these aspects are far from universally agreed upon, and practice varies substantially from country to country. An ICMI study that provides a meta-level analysis and synthesis of what is known about this core area of primary mathematics would provide a useful base from which to gauge gaps and silences and an opportunity to learn from the practice of different countries and contexts.

Whole numbers are part of everyday language in each culture, but there are different views on the most appropriate age at which to introduce whole numbers in school. Whole numbers, in some countries, are approached in pre-school, with nearly all the children before the age of 6 attending pre-school. The OECD has reported that, in general, participation in pre-school produces better learning outcomes for 15-year-old students (OECD PISA FOCUS 2011). In some countries, primary school includes grades 1 to 6; in others, it includes grades 1 to 5. Also the entrance age of students for primary school may vary from country to country. For all these reasons, this study addresses teaching and learning whole numbers from the early grades, i.e., the periods in which whole numbers are systematically approached in the formal school, hence, when it is the case, also in pre-school.

ICMI Study 23

In Berlin, in January 2014, the International Program Committee (IPC) (see 'Appendix') for ICMI Study 23 met and agreed upon four principles.

First, it was decided that *cultural diversity* and how this diversity impinges on the early introduction of whole numbers would be one major focus. The study will seek contributions from authors from as many countries as possible, especially those in which cultural characteristics are less known and yet they influence what is taught and learned. In order to foster the understanding

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of the different contexts in which authors have developed their studies, each applicant for the conference will be required to prepare background information (on a specific form) about this context.

Second, it was decided to find better ways to involve *policy makers* (who have the duty to offer to every child the opportunity to go to school and to learn arithmetic) and, in order to take care of this specific aim, to solicit also contributions in the form of commented and annotated video clips about practical examples with a (potentially) strong impact.

Third, it was decided to collect experiences about teaching and learning *for all*, including students with special needs, considering that in some countries, they have special classrooms and teachers and even special schools while in others, they are enrolled in mainstream classes.

Fourth, it was decided to focus also on *teacher education and professional development*, considering that in order to teach elementary mathematics, there is a need for sound professional knowledge, both in mathematics and in pedagogy.

In order to meet this complex set of principles, the IPC delineated a set of *themes* to serve as the organizing framework for the study conference.

This document presents the background of the study, together with its challenges and aims. These sections lead to the description of the five organizing themes of the study. Because the study conference will be organized around discussion within each theme (with some overarching sessions), each proposed contribution to the study should be addressed to the theme into which it will fit best (with a first and a second choice, according to possible multiple foci). Finally, this document briefly outlines the organization, timing, and location of the study conference and the timetable of the milestones leading up to the conference and to ICMI publication.

Background of the study

Primary schooling is compulsory in all countries, although with different facilities and opportunities for children to take advantage of it. Mathematics is a central feature of all primary education. The content and quality delivery of that curriculum is important in all countries for the kinds of citizens each seeks to produce.

In the international literature, there are many contributions on primary school mathematics. In many cases, especially in the West, early processes of mathematical thinking, usually observed in early childhood (i.e., 3- to 8-year-old children), are also investigated by cognitive and developmental psychologists. These researchers sometimes study the emergence of early processes of mathematical thinking in laboratory settings, where children are stimulated by suitable displays (to observe the emergence of one-to-one correspondences, counting, measuring, and so on). In several countries, Piaget's theory is very influential despite its critics. Also, neuroscientists have been studying for some years the emergence of 'number sense,' but it has been observed (UNESCO 2013) that what is still missing is a serious and deep interdisciplinary work with experts in mathematics education.

Discussion

A recent document prepared by ICMI's Past President Michéle Artigue and commissioned by UNESCO (2012) discusses, from a political perspective, the main challenges in basic mathematics education. It reads, in part:

> *We live in a world profoundly shaped by science and technology. Scientific and technological development has never been faster, has never had an impact as important and as immediate on our societies, whatever their level of development. The major challenges that the world has to face today, health, environment, energy, development, are both scientific and human challenges. In order to take up these challenges, the world needs scientists able to imagine futures that we barely see and able to make these possible, but it also needs that the understanding of these challenges, the debate on the proposed changes, are not reserved for a necessarily limited scientific elite, but are very widely shared. Nobody can now doubt that positive, sustainable and equitable evolutions cannot be achieved without the support and contribution of the great majority of the population.*

Drawing on this idea, ICMI has acknowledged that it is timely to launch, for the first time in its history, an international study that especially focuses on early mathematics education that is both basic and fundamental mathematically. Primary school mathematics education has been present in other ICMI studies, but in most cases, secondary school mathematics education has been predominant. When foundational processes are concerned, a strong epistemological basis is needed. This might be the added value of ICMI involvement with respect to the analysis carried out in other fields. Such epistemological analysis was part of classical works of professional mathematicians (e.g., Klein, Smith, Freudenthal) who played a big role in the history of ICMI (ICMI 2008) and considered mathematics teaching as a whole. It is worthwhile to mention here a comment by Felix Klein, the first president of ICMI, used as an epigraph in the website on the history of ICMI (ICMI 2008).

> *I believe that the whole sector of Mathematics teaching, from its very beginnings at elementary school right through to the most advanced level research,*

should be organised as an organic whole. It grew ever clearer to me that, without this general perspective, even the purest scientific research would suffer, inasmuch as, by alienating itself from the various and lively cultural developments going on, it would be condemned to the dryness which afflicts a plant shut up in a cellar without sunlight (Felix Klein, 1923).

One cannot study school mathematics teaching without focusing also on the teacher's role and responsibility. The attention towards mathematics teacher education and professional development has been a constant preoccupation of ICMI. The case of primary school and (more generally) the case of early education deserve special attention. The complex nature of arithmetic and its foundational value for mathematics are well known by mathematicians and mathematics educators. However, primary school teachers work within systems which may or may not support a rigorous professional environment in which they are knowledgeable and respected professionals who are experts on both the mathematics and the pedagogy of what they teach. In some systems, teaching WNA may be treated as something that virtually any educated adult can do with little specific training; WNA may be viewed by some as straightforward and intuitive and involving no more than showing children how to cope with everyday life and to carry out algorithms.

There are systems where primary mathematics teachers are specialists and others where they are generalists. It is not within the aims of this study to enter deeply into the pedagogical debate about specialist vs generalist teachers in early education, as both models show advantages and disadvantages. What is important to highlight is that much is already known from research about productive ways to teach WNA, yet this knowledge cannot be enacted in systems in which teachers are not proficient in elementary mathematics and the particular pedagogical approaches. Effective teacher education may require a backdrop of a culture in which teachers are expected to be highly educated professionals.

Aims of the study

This study aims to produce and share knowledge on the sustainable ways of realizing teaching and learning WNA for all, taking into account the large body of theory and research already existent as well as socio-cultural diversity and institutional constraints. In particular, the following specific aims were acknowledged by the IPC, for the early teaching and learning WNA:

- ➢ Bring together communities of international scholars representative of ICMI's diverse membership across regions and nationalities in addressing the theme of WNA for the production of a study volume.
- ➢ Provide a state-of-the-art expert reference on the theme of WNA.
- ➢ Contribute to knowledge, better understanding, and resolution of the challenges that WNA faces in diverse contexts.
- ➢ Collectively represent the great variety of concerns in the field of WNA and reflect upon it.
- ➢ Facilitate multi and interdisciplinary approaches (including cooperation with other bodies and scientific communities) to advance research and development in WNA.
- ➢ Disseminate scholarship in mathematics education—research; methodologies, theories, finding and results, practices, curricula—in the theme of WNA.
- ➢ Pave the way towards the future by identifying and anticipating new research and development needs of WNA.
- ➢ Be of interest and a resource to researchers, teacher educators, policy, and curriculum developers and analysts and the broad range of practitioners in mathematics and education.
- ➢ Promote and assist discussion and action at the international, regional, or institutional level.

The themes of the ICMI Study 23

The ICMI Study will be organized around five themes that provide complementary perspectives on the early approach to whole numbers in mathematics teaching and learning. Contributions to the separate themes will be distinguished by the theme's specific foci and questions, although it is expected that interconnections between themes will emerge and merit attention.

The five themes are as follows:

1. *The why and what of whole number arithmetic*
2. *Whole number thinking, learning, and development*
3. *Aspects that affect whole number learning*
4. *How to teach and assess whole number arithmetic*
5. *Whole numbers and connections with other parts of mathematics.*

Themes 1 and 2 address foundational aspects from the cultural-historic-epistemological perspective and from the (neuro)cognitive perspective. What is especially needed are reports about the impact that foundational aspects have on practices (both at the micro-level of students and classrooms and at the macro-level of curricular choices).

Themes 3 and 4 address learning and teaching, respectively, although it is quite hard, sometimes, to separate the two aspects, as suggested by the fact that in some languages and cultures (e.g., Chinese, Japanese, Russian) the two words collapse into only one.

Theme 5 addresses the usefulness (or the need) to consider WNA in connection with (or as the needed basis for) the transition to other kinds of numbers (e.g., rational numbers) or with other areas of mathematics, traditionally separated from arithmetics (e.g., algebra, geometry, modelling).

Each theme is briefly outlined and followed by exemplary questions that could be addressed in the submitted contributions. An overarching question which cuts across all the themes concerns teacher education and development:

How can each of the themes be effectively addressed in teacher education and professional development?

The why and what of whole number arithmetic

This theme will address cultural-historic-epistemological issues in WNA and their relation to traditional, present, and possible future practices.

The sense of numbers is constructed through everyday experience, where culture and language play a major role; hence, ethnomathematics has paid attention to the different grammatical constructions used in everyday talk (e.g., Maori numbers as actions; Aboriginal Australians' spatial approach to numbers). Ways of representing whole numbers and making simple calculations (e.g., with fingers or other body parts; with words; with tools, including mechanical and electronic calculators; with written algorithms) have enriched the meaning of whole numbers through the ages.

The base-ten system is critical for our current sophisticated understanding of WNA. The long and difficult development of place value systems is well documented in the history of mathematics (the introduction of place value in China and India; the migration to Europe through the Arabic culture; the invention of zero; the strategies for mental calculation) and indicates the need to study place value and the base-ten system deeply for understanding.

The above issues (and others) have been considered in different ways by different cultures throughout history. Beside the use of numbers in practical activities, there is evidence (in the history and in educational research) that the exploration of the properties of whole numbers, relations, and operations paves the way towards the introduction, with young students too, of typical mathematical processes, such as generalizing, defining, arguing, and proving.

Some references may be found in the ICMI Studies 10, 13, 16, and 19.

The following possible questions will help to illuminate this theme further:

- *What goals underlie the teaching and learning of WNA?*
- *Taking a mathematical perspective (as practiced by the current community of mathematicians) combined with an educational perspective, what are core mathematical ideas in paths to developing WNA?*
- *What are distinctive features concerning whole number representation and arithmetic in your culture? What is the grammar of numbers? In what ways does language or ways of representing and using numbers influence approaches to calculation or problem solving? How do these features interact with the decimal place value system?*
- *What is the role of mathematical practices and habits of mind in teaching and learning WNA? How can teaching and learning WNA support the development of mathematical practices and habits of mind?*
- *How much is the base-ten place value emphasized in your curriculum?*
- *How much computational facility is important for later mathematics learning and learning in other areas? What about mental calculation? What about speed of calculation?*
- *How do policies and the educational environment and system support or not support a culture in which teaching WNA is seen as requiring detailed, specific professional knowledge?*
- *What were the main historic features and their origins of WNA in (ancient) west/east? What were some factors that led to such historic features? What were the effects on the development of mathematics curriculum?*
- *How does your curriculum develop understanding of the structural features of whole number arithmetic and its extensions?*

Whole number thinking, learning, and development

This theme will address the relationships between cognitive and neurocognitive issues and traditional, present, and possible future practices in the early teaching and learning of WNA.

The idea of number sense was in use for decades in the literature on mathematics education before entering into the cognitive and neurocognitive literature, with some similarities and differences. (Neuro)cognitive scientists have focused the children's spontaneous tendency to focus on numerosity in their environment, the development of rapid and accurate perception of small numerosities (subitizing) in connection with visualization and structuring processes, the ability to compare numerical magnitudes, and the ability to locate numbers on a (mental) number line. There are models for children's informal knowledge of counting principles and informal counting strategies and their development into more formal and abstract arithmetic notions and procedures.

A recent focus concerns developmental dyscalculia, as a difficulty in mathematical performance resulting from impairment to those parts of the brain that are involved in arithmetical processing, without a concurrent impairment in general mental function.

Recent debates concern the embodied cognition thesis resulting in the evidence, shared by many researchers that, although mathematics may be socially constructed, this construction is rooted in, and shaped by, the body and bodily experiences.

Some references may be found in OECD EDUCERI 2010 and UNESCO 2013.

The following possible questions will help to illuminate this theme further:

- *To what extent is basic number sense inborn and to what extent is it affected by socio-cultural and educational influences? How is the relationship between these precursors/foundations of WNA, on the one hand, and children's whole number arithmetic development?*
- *What can we learn from the (neuro)cognitive studies in WNA? Do their findings essentially confirm insights that are present (and were already present for a long time) in the mathematics education community or do they point to truly new insights and recommendations about the kind of tasks and instructional approaches children need? How do we integrate different perspectives about the foundations and development of whole number arithmetic concepts and skills?*
- *What are specific effects of the structure of the individual finger counting system on mental and linguistic quantity representation and arithmetic abilities in children and even in older learners and adults?*
- *How can an embodiment framework can be used to analyze and/or design educational approaches based on suitable representations (*e.g., *through the number line) or on manipulatives and modern technological devices (touch screens)?*
- *What are appropriate ways of analyzing the multimodal nature of mathematical thinking (*e.g., *the role of bodily motion and gesture)?*
- *What is the relationship between the embodied cognitive approach and older approaches, for example, Montessori and Piagetian, which had a strong influence on elementary school mathematics worldwide?*
- *How can the tools of the embodiment framework/ analysis be integrated/combined with socio-cultural perspectives to compare/contrast approaches where embodiment is exploited or hindered?*
- *How can teachers be educated in order to exploit the (neuro)cognitive foundations for WNA?*

Aspects that affect whole number learning

This theme will address some aspects affecting learning of WNA in both positive and negative ways.

Socio-cultural aspects influence enumeration practices, algorithms, and representations as well as metaphors or models (e.g., the number line). Hence, students' language and culture may help or hinder the construction of WNA not only in schools but also in informal settings. On the one hand, the recourse to tools from the history of mathematics (e.g., counting sticks; different kinds of abaci; reproduction of ancient mechanical calculators) may be effective to foster learning of WNA with explicit reference to the local culture. On the other hand, intentionally designed tools may address the effective learning processes evidenced in the literature (e.g., technological tools including the multitouch ones).

Low achievement in WNA is a major focus in debates at all levels, from school practice to international studies. Literature shows that it may depend on very different aspects: context variables (e.g., marginalized students; migrant and refugee students; education in fragile democracies), institutional variables (e.g., different languages in school and out of school context), learning disabilities (dyscalculia; sensual impairment for deaf and blind students), on affect factors (e.g., self-beliefs, anxiety, motivation, gender issues), on didactical obstacles (e.g., a too-limited approach as in the case of teaching addition separate from subtraction or multiplication as a repeated addition only), and on epistemological obstacles (related to the historical process of constructing WNA by mankind).

Some references may be found in the ICMI Studies 17 and 22 and, for general issues concerning the contexts, UNESCO 2010.

The following possible questions will help to illuminate this theme further:

- *What are the features of your language related to whole numbers, operations, and word problems that could affect learning in a positive or negative way? How these features are mirrored in formal, informal, or not formal settings?*
- *What main challenges for learning WNA are faced by marginalized students or, in general, in difficult contexts?*
- *What main challenges are faced for learning WNA by students with sensual impairments (blind and deaf)?*
- *What main challenges are faced for learning WNA by dyscalculic students?*
- *In your country, are students with special needs enrolled in mainstream classes (inclusive systems) or in special education classes? To what extent may the strategies especially developed for students with special needs be useful for all students in WNA?*

- *In your country, are there evidence that the literature on either didactical or epistemological obstacles had impact on classroom practice?*
- *Which tools (from the ancient or new technologies) are useful to enrich the classroom activity for all or to help low achievers for WNA? Are there evidence on effective use of traditional manipulatives (including the ones rooted in local cultures), virtual manipulatives, and technologies (including the recently developed multi touch technologies)? Are there classroom studies on the comparison of different kinds of tools?*
- *What strategies may be implemented by teachers in relations with the above issues?*

How to teach and assess whole number arithmetic

This theme will address general and specific approaches to teach and assess the learning of WNA. WNA appears in the standards for mathematics of every country (see http://www.mathunion.org/icmi/other-activities/database-project/introduction/), in specific international studies (e.g., the Learner's Perspective Study, with 16 country teams). In some countries, also, independent research communities have developed projects on teaching and assessing WNA, which in some cases, are internationally acknowledged (e.g., Realistic Mathematics Education in the Netherlands; NCTM Curriculum and Evaluation Standards in the USA; Davydov's math curriculum in Russia; the Theory of Didactical Situations in France). In the ethnomathematics trend, projects sensitive to the local cultures and traditions have been developed (e.g., in Australia, Latin America, the USA, and Canada). A specific Symposium on Elementary Mathematics Teaching (SEMT) is held every second year in Prague since 1991.

Some issues to be focused may be the following: textbooks and future teaching aids (e.g., multimedia; e-books) for WNA, tools to approach specific elements of WNA (e.g., manipulatives, technologies), specific strategies for some fields (e.g., for word problems, the Chinese tradition of problems with variation, Singapore's model method, the extended literature on word problems and relations with real life situation), examples of practices rooted in local culture, and metacognitive aspects in national curricula (e.g., early approach to mathematical thinking processes).

In recent years, the assessment debate at the local and school level has been very much biased by the results of international studies (e.g., OECD PISA, TIMSS), which are likely to produce assessment-driven curricula. An ICMI study on assessment was produced in the early 1990s (ICMI Study 6), but updating might be necessary for the relevance and the media-wide appeal of the international studies.

Some references for this theme may be found in the proceedings of ICMI Congresses and Regional Conferences (http://www.mathunion.org/icmi/Conferences/introduction/).

The following possible questions will help to illuminate this theme further:

- *What are the consequences of policy decision making related to WNA teaching based on evidence in comparison with policy decision making based on opinions?*
- *How is the intended curriculum reflected in textbook and other teaching aids?*
- *What are the changes (if any) that have resulted from the use of technology to teach WNA?*
- *How complete is understanding of the place value system developed, and at what points in the/your curriculum are key features of place value explored in greater depth?*
- *How does the/your curriculum foster the transition from a counting or additive view of number to a ratio/multiplicative/measurement view of number?*
- *How do children acquire WNA concepts and procedures outside of school? How can teachers built up on the knowledge children acquire outside school?*
- *What are the approaches that have proven to be effective in your school setting to teach elements of WNA, for example, number sense, cardinality, ordering, operations (subtraction with re-grouping, etc.), problem solving, estimation, representing, mental computation…?*
- *Problem solving context, should it be realistic? Should it be authentic? Always? What is the place (if any) of traditional word problems? What is the role of (real world) context in WNA? Always necessary?*
- *How to develop positive attitudes towards mathematics while teaching WNA?*
- *How teachers promote the development of student's metacognitive strategies during the learning of WNA?*
- *What main challenges are faced by teachers when teaching and assessing WNA?*
- *What innovative assessment approaches are used to evaluate the learning outcomes of WNA? What are the changes (if any) in assessment WNA that have resulted from the media appeal of international studies like PISA or TIMSS?*

Whole numbers and connections with other parts of mathematics

This theme will address WNA in terms of its interrelationships with the broader field of mathematics.

Some connections concern the following: pre-algebra and algebraic thinking (e.g., looking for patterns; schemes for the solution of world problems), geometry or spatial thinking (e.g., triangular or square numbers and similar; number lines), rational numbers and measurement (e.g., Davydov's curriculum for arithmetic), and statistical literacy (e.g., mean, median and mode, interval, scale, and graphical representation).

Evidence suggests that the earliest formation of WNA can support the learning of mathematics as a connected network of concepts and, vice versa, embedding WNA in the broad field of mathematics can foster a better understanding. Some references for this theme may be found in the ICMI Studies 9, 12, 14, and 18.

The following possible questions will help to illuminate this theme further:

- *How can WNA teaching and learning contribute to understand other interconnected mathematical ideas and build on one another to make students view mathematics as a coherent body of knowledge?*
- *In your country, to what extent are connections between WNA and other mathematics topics pointed out in the curriculum syllabus and textbooks, and how are they approached?* i.e., *WNA and measurement, WNA and elementary statistics? Pre-algebra patterns, WNA and algebra?*
- *In your system/country, are symbolic and non-symbolic approaches to word problems compared? To what extent are connections made? Is the analogy of between base-ten arithmetic and polynomial arithmetic emphasized? To what extent are the rules of arithmetic/properties of operations used as a guide in learning manipulation of algebraic expressions?*
- *In your country/system, to what extent are connections between WNA and other mathematics topics stressed in the teachers' education programs?*
- *In what ways does the connection between WNA and specific themes in other areas of mathematics contribute to students' understanding of these themes?*
- *What learning conditions enable students to make connections between WNA and other mathematics topics?*
- *In which ways does the practice of connecting WNA to other areas of mathematics contribute to the development of mathematical thinking?*
- *How can the connection of WNA with other areas of mathematics improve communication of mathematical ideas?*
- *How can technology be used to make connections between WNA and other mathematics topics?*
- *How does the use of representations in WNA teaching and learning contribute to build connections with other mathematical areas? For example, to what extent is the number line used to exhibit the connections between WNA and arithmetic of fractions?*

Conclusion

As in every ICMI study, the ICMI Study 23 is built around an international conference and directed towards the preparation of a published volume. The study conference

Table 1 Members of the International Program Committee

Member	Division	Institution	Email address	Position
Maria G. (Mariolina) Bartolini Bussi	Department of Education and Human Science	University of Modena and Reggio Emilia, Italy	bartolini@unimore.it	Co-chair
Xuhua Sun	Faculty of Education	University of Macau, China	xhsun@umac.mo	Co-chair
Berinderjeet Kaur	Centre for International Comparative Studies	National Institute for Education, Singapore	berinderjeet.kaur@nie.edu.sg	
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Roger E. Howe	Department of Mathematics	Yale University, New Haven, CT US	howe@math.yale.edu	ICMI liason
Ferdinando Arzarello	Department of Mathematics	Univeristy of Turin, Italy	ferdinando.arzarello@unito.it	ICMI President
Abraham Arcavi	Department of Science Teaching	The Weizmann Institute of Science, Rehovot, Israel	abraham.arcavi@weizmann.ac.il	ICMI Secretary General

will take place in Macau, China, and will be hosted by the University of Macau (*June 3* to *7, 2015*).

As is the usual practice for ICMI studies, participation in the study conference will be by invitation only for the authors of submitted contributions which are accepted. Proposed contributions will be reviewed and a selection will be made according to the quality of the work, the potential to contribute to the advancement of the study, with explicit links to the themes contained in the discussion document and the need to ensure diversity among the perspectives. The number of invited participants will be limited to approximately 100 people. Deadlines for contributions are published in the discussion document:

http://www.mathunion.org/icmi/conferences/icmi-studies/ongoing-studies/icmi-study-23/

The *first product* of the ICMI Study 23 is an electronic volume of proceedings, to be made available first on the conference website and later in the ICMI website: it will contain all the accepted papers as reviewed papers in a conference proceedings (with ISBN number).

The *second product* is a gallery of commented video clips about practices in WNA, to be hosted in the conference website and, possibly, later, in the ICMI website.

The *third product* is the ICMI study volume. The volume will be informed by the papers, the video clips and the discussions at the study conference as well as its outcomes.

The IPC for ICMI Study 23 invites submissions of contributions of several kinds: theoretical or cultural-historic-epistemological essays (with deep connection with classroom practice, curricula, or teacher education programs), position papers discussing policy and practice issues, discussion papers related to curriculum issues, reports on empirical studies, and video clips on explicit classroom or teacher education practice. To ensure a rich and varied discussion, participation from countries with different economic capacity or with different cultural heritage and practices is encouraged.

The ICMI Study 23 website can be found at the address http://www.umac.mo/fed/ICMI23/.

The website contains the official discussion document for ICMI Study 23 and will be regularly updated with information about submission procedure and the study conference and will be used for sharing the contributions of those invited to the conference in the form of conference pre-proceedings. Further information may be asked at the following address:

icmiStudy23@gmail.com

Appendix

Members of the International Program Committee are shown in Table 1.

Competing interest
The author declares that she has no competing interests.

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