

The 24th ICMI Study: Mathematics curriculum reforms around the world

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Introduction and background

School mathematics curriculum reforms are a widespread and very long-standing practice across the world. Yet it is only in this *twenty-fourth* ICMI Study that this critically important and most impactful area in mathematics teaching and learning has come under scrutiny as an ICMI Study. The last ICMI Study that focused on mathematics curricula was ICMI Study 2 on *School Mathematics in the 1990s* [2].¹ This ICMI Study 2 followed after the publication of a seminal volume five years earlier, *Curriculum Development in Mathematics* [1], that provided an overview of school mathematics curriculum reforms in the preceding decades.

The ICMI Executive Committee announced the launch of *ICMI Study 24: School Mathematics Curriculum Reforms: Challenges, Changes and Opportunities* in Hamburg, Germany, in July 2016 during the 13th International Congress on Mathematics Education (ICME-13). A diverse International Programme Committee (IPC) met the following year in Berlin, in November 2017, to finalize the ICMI Study 24 Discussion Document, which set out the scope of the study and called for papers for the ICMI Study 24 Conference [4]. The Study Conference took place in Tsukuba, Japan, a year later in November 2018, after which the task of compiling the Study Volume began. The work of developing the Study Volume, which in itself was a complex task given the study topic, faced several additional setbacks during the devastating global challenge of COVID-19, but endured and was finally published in June 2023 [5].

¹ICMI Studies may be accessed at <https://www.mathunion.org/icmi/digital-library/icmi-studies/icmi-study-volumes>.

ICMI Study 24 demonstrates a diversity of studies and findings from international experience and research that can and do influence the nature of curriculum changes, and the possibilities of educational reform and its implementation: curricular design results; a revised role for components in the teaching of mathematics (e.g., mathematics content, pedagogy, and assessment); the role of technology; and new cognitive, sociocultural and sociopolitical perspectives. The consideration of curriculum reforms from various perspectives and constructs (mathematical literacy or competencies, for instance) raises many issues from scientific, political and cultural points of view, which need to be taken into account by communities of researchers, teachers and policymakers involved.

The scope of the Study, the Discussion Document and the Study Conference

ICMI Study 24 was conceptualized to focus on *School Mathematics Curriculum Reforms: Challenges, Changes and Opportunities*. This topic invoked not only questions about changes in curriculum design but also about the implementation of these changes across an educational system. What functioned (or not) at the time of implementing a curricular change? What are the limitations? How have resources (e.g., textbooks and technology) influenced the reforms and their enactment? How should large-scale teacher preparation be conducted to achieve the reform goals? How do diverse social, economic, cultural and national contexts condition the nature and extent of curricular reforms, especially teacher expectations, attitudes and beliefs, and the social and cultural background of students? How do assessments of students' learning influence curriculum reforms? The study opened opportunities for a synthesis or meta-analysis of different aspects of school mathematics reforms historically, geographically and globally.

The overarching question of this ICMI Study, as captured in the Discussion Document, was to explore what school mathematics reforms have been or are taking place, especially at meta, macro or system levels, and to learn about the many different aspects of mathematics curriculum reforms from past experiences, to specify the current status and issues in reforms worldwide, and to identify directions for the future of school mathematics. The Discussion Document was disseminated in December 2017, inviting participation in the Study Conference, which took place in the Tsukuba International Congress Center from November 25 to 30, 2018. The conference was organized around working groups in the five themes described in the next section. These groups met in parallel during the conference and their work is captured as chapters in the ICMI Study Volume. The Conference Proceedings provided the foundation for discussions during the conference and the production of the Study Volume.

The ICMI Study 24 Conference attracted 96 participants and 68 papers from various countries or regions and from educational systems with different cultural, economic, political and historical backgrounds. The Study Volume included 71 authors, with 66 participants contributing chapters from the Study Conference. This diversity provided rich discussions on current and future thinking about school mathematics curriculum reforms, cases of reforms, and opportunities to juxtapose different cases highlighting commonalities and differences. The range of countries (approximately 30) represented in the Study Conference translated into a diverse authorship in the Study Volume, drawing on mathematics curriculum reforms across the world, while acknowledging under-representation from some world regions. The diversity of the Study Conference and of the Study Volume also brought a variety of positionalities with respect to mathematics curriculum reforms as receivers or drivers of a particular reform and with differing knowledge, skills, expertise and experiences.

The main themes in ICMI Study 24

When developing the Discussion Document for ICMI Study 24, the IPC came to a consensus on five main themes, which provided the basis for the Study Conference Proceedings and for the Study Volume. For each theme, a set of questions was identified which addressed curriculum elements such as content, pedagogy, textbooks, technology, assessment, teacher professional development, curriculum development, design processes, and the role of agents. Contributions were invited to the separate themes and distinguished by the theme foci and questions.

Theme A. Learning from the past: Driving forces and barriers shaping mathematics curriculum reforms. This theme provides historical perspectives on school mathematics curricula, highlighting key issues around past reform movements, thereby ensuring that their lessons and challenges can inform future movements. The first chapters in this theme present four cases of national reforms in the period since the 1960s and then extend the empirical landscape framed by each case. It addresses research questions about the aspects of mathematics teaching, and learning processes certain international reforms attended to, identifies key stakeholders in curriculum reforms, factors that underpinned curriculum reforms and barriers that inhibited reform efforts. Relations between curriculum reforms and cultural values are also analyzed, as is the question of mathematical content and how it is treated and affected by past curriculum reforms. The theme concludes by summarizing the drivers and barriers of school mathematics curriculum reforms.

Theme B. Analyzing school mathematics curriculum reforms for coherence and relevance. This theme on coherence and relevance of school mathematics reforms examines the role and importance of mathematics as a school subject and its relation to other subjects in an educational system. Chapters in this theme begin by examining the notion of coherence in depth, within and between components of curricula, and between the curriculum and the system in which it is enacted. Then the focus moves to the relations between mathematics and other disciplines and explores the role mathematical modeling plays in transdisciplinary approaches to school curricula. The next chapter identifies the increasing range of physical and digital curriculum resources that have been developed to support particular curriculum reforms, the characteristics of such resources, and the constraints that weigh on achieving the goals of coherence and relevance. A chapter that examined theories and methodologies for researching and analyzing mathematics reforms and their limitations is also featured. Some guiding principles deriving from the theme are set out in the concluding chapter.

Theme C. Implementation of reformed mathematics curricula within and across contexts and traditions. The cultural, social, economic, historical and political contexts and positions for the implementation of a school mathematics curriculum are important considerations in reform efforts. Chapters in this theme begin by sharing experiences and examples of the implementation of mathematics curriculum reforms in different countries or regions from a plenary panel, which demonstrate how reforms are diverse, multifactorial, uncertain and require both top-down and bottom-up strategies. This is followed by a chapter that examines factors that intervene within mathematics curriculum reforms and seeks ‘processes, models, or best/common practices’ that can be relevant for the progress or success of a reform. Next, the initial preparation and professional development of teachers in curriculum implementation, and the interrelation between reform and teachers’ actions are analyzed. The concluding chapter proposes several ‘laws’ from the studies in this theme.

Theme D. Globalization and internationalization, and their impacts on mathematics curriculum reforms. This theme points to factors that advance globalization and internationalization, and influence mathematics curricula through rapid changes in the nature of communication and availability of information. It begins with an exposition on the definition of key concepts. This is followed by a chapter on the emergence of numeracy and mathematical literacy and their relationship with curriculum reform processes. Then the impact of TIMSS and PISA is compared in economically and geographically diverse countries. The inclusion of new areas in recent mathematics curriculum reforms of algorithmic/computational thinking is examined next. The theme concludes by mapping out future visions of the impact of internationalization and

globalization on school mathematics curriculum reforms, and offers recommendations for future reforms.

Theme E. Agents and processes of curriculum design, development, and reforms in school mathematics. This final theme acknowledges that curriculum reform processes are as much a political matter as they are educational; and nowadays involve a broad range of stakeholders with vested interests. The first chapter comprises four contributions from prominent leaders of mathematics curriculum reforms in different cultures, countries and contexts. The next chapter proposes a model of curriculum reform as a system of: agents (who is involved); objects (what materials, etc. they are working with); processes (how agents work with objects and other agents); and in terms of arenas (where the reform takes place). This is followed by a chapter on communication and negotiation among stakeholders in different communities of practice. The professional dynamics stemming from the relationship between the stakeholders leading the reform and the stakeholders responsible for translating the official curriculum into the classroom is examined in the next chapter. The concluding chapter addresses implications for active curriculum reform work, challenges for conducting curriculum reform research, and future research directions.

Reflections and commentary on ICMI Study 24

The 24th ICMI Study Volume was released on June 29, 2023, as an open access book, and within a month had garnered more than 100,000 downloads. There are several points of reflection in the Study Volume. The first is raised by Jeremy Kilpatrick, in a chapter that captures a historical perspective and his reflections on the current status and future trends in school mathematics reforms. A second point of reflection is offered by Berinderjeet Kaur in a chapter as a reaction to two contrasting curriculum perspectives, namely, the OECD Learning Compass 2030 framework (Miho Taguma) and the Common Core State Standards in Mathematics in the USA (William McCallum), with reflections based on her experience and involvement in the Singapore school mathematics curriculum reforms. A third point of reflection consists of two commentaries on the volume as a whole, from two leading scholars in mathematics education research with a keen interest in school mathematics curriculum reforms, who did not participate in the ICMI Study 24 Conference. Anjum Halai draws attention to the importance of language in mathematics reforms as an equity issue; and Paola Valero offers a cultural-political reading of mathematics curricula.

The final point of reflection is offered by the editors in the introductory and concluding chapters. In the first chapter, it is acknowledged that school mathematics curriculum

reform has been a diverse and widespread practice but an un- or under-explored area of research in mathematics education, and therefore there is not much scholarly work to guide and understand this critical aspect of mathematics education. The final chapter distills key learning points from the themes and chapters that may be of use to school mathematics curriculum reform researchers, practitioners and policymakers. This includes: difficulties in defining school mathematics curriculum reforms; inadequate theories and methodologies for studying mathematics reforms; significant shifts in the content of mathematics curriculum reforms; the crucial role of teachers, teacher education and professional development to make or break a curriculum reform; the growing importance of resources and technology in reform efforts; the alignment of components of a mathematics curriculum reform; and recognition of how these reforms are context bound and have invariant aspects.

This ICMI Study allowed for a more informed and comprehensive analysis of the roles of different actors, of the many aspects influencing and shaping mathematics curriculum reforms and of the possibilities and means to tackle a curricular reform in the current scenario. It is as crucial an issue for the global South and the global North, given the widespread changes taking place in societies, as they confront challenges of growing inequality, unemployment, poverty, mass migration, environmental disasters, various forms of discrimination and conflicts, to name but a few, within which school mathematics reforms must take place. New phenomena such as actions against infectious diseases (e.g., COVID-19), and the massive shift to online teaching and learning create urgent imperatives related to mathematics curricula. ICMI Study 24 demonstrates that further research and publications on mathematics curriculum reforms are needed, notwithstanding recent volumes [3, 6], which point to the potential for evidence-based mathematics curriculum policy generation and implementation. By continuing to study curriculum reforms across diverse contexts, key messages and lessons may be derived to inform, improve and better conduct future mathematics curriculum reforms.

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