Chapter 20
Introduction

Max Stephens, Djordje M. Kadijevich, Mogens Niss, Nadia Azrou, and Yukihiko Namikawa

Theme *Globalisation and Internationalisation and Their Impacts on Mathematics Curriculum Reforms*: Specific Foci and Questions From the Discussion Document (ICMI, 2017)

1. How have results of international experience and research in the teaching and learning of mathematics influenced curricula changes? To what extent can local curriculum reforms be examined against an emergent 'international' mathematics curriculum?
2. How have particular international studies become drivers for school mathematics curriculum reforms? What new discourses with dominant theoretical and conceptual underpinning have emerged; and how have these been taken up in curriculum reforms in different contexts? For example, how have the OECD's

M. Stephens (✉)
University of Melbourne, Melbourne, Australia
e-mail: m.stephens@unimelb.edu.au

D. M. Kadijevich
Institute for Educational Research, Belgrade, Serbia
e-mail: djkadijevic@ipi.ac.rs

M. Niss
Roskilde University, Roskilde, Denmark
e-mail: mn@ruc.dk

N. Azrou
Department of Mathematics and Informatics, University of Yahia Fares, Blida, Algeria
e-mail: nadiazrou@gmail.com

Y. Namikawa
School of Science, Nagoya University, Nagoya, Japan
e-mail: namikawa@sugiyama-u.ac.jp

Y. Shimizu, R. Vithal (eds.), *Mathematics Curriculum Reforms Around the World*, New ICMI Study Series, https://doi.org/10.1007/978-3-031-13548-4_20

PISA notions of mathematical literacy and mathematical competencies been interpreted and expressed in curriculum reforms?
3. How are mathematics curriculum reforms varied (or similar) in different social, cultural, economic and political contexts such as developing versus developed countries or East versus West? How do selected curriculum components such as content, pedagogy, materials technology and teacher preparation vary from one reform, tradition, country or context to another?
4. How can comparative or meta analyses of curriculum reform processes and implementations shed light on what works or does not work in mathematics curriculum reforms in contemporary societies?

This Introduction will address Questions 1, 3 and 4. Questions 2 and 3 will be a focus of Chap. 21 on the impact of international student assessments. Chapters 22 and 23will return to Questions 1 and 3, analysing selected features of the current and anticipated 'international' mathematics curriculum in different national and other contexts. The Conclusion will examine briefly what has been learned and how might we expect globalisation and internationalisation to continue to impact on the curriculum.

Introducing the Major Theme: Globalisation and Internationalisation

Globalisation is not a new phenomenon. The same term can be used to describe the rapid expansion of trade and accompanying colonisations undertaken by the major European Powers during the sixteenth and seventeenth centuries because of dramatic improvements in navigation and in ship-building technology. We can identify who the main players were – Portugal, Spain, France, the Netherlands and England. Their rapid expansion of trade and colonisation into the new world was truly global, contrasting with earlier trading relationships within Europe, such as through the Hanseatic League.

Globalisation in the late twentieth and early twenty-first centuries has taken on new forms through rapid developments in electronic and digital communication that are now characterised as the *Fourth Industrial Revolution*: four specific technological advances are driving these economic and social changes: near universal access to high speed internet, widespread use of data analytics, rapid refinements in artificial intelligence, and availability of cloud internet storage (WEF, 2018). These changes have accelerated the pace and nature of globalisation and internationalisation. Their impact on education and mathematics education remains unclear. The education sector and school systems inevitably move at a much slower pace than industry and the wider society.

Social and economic realities are important in supporting the processes of globalisation and internationalisation. Both terms are constructs that need to be discussed concretely with reference to their specific social and economic drivers.

Definitions and Distinctions

The two terms internationalisation and globalisation have distinct meanings and continue to evolve. Globalisation is more frequently presented as an *outcome* or *consequence* of economic, social and political processes. Its rate of progress is tied increasingly to interconnectivity and speed of communication, especially to evolving global markets which impact on all countries. Some trans-national industries may have a vested interest in globalisation. Some international agencies may be pursuing global goals, but these same agencies rely for their support on national governments and agencies which are not about to lose their identities. In this sense, globalisation may be a *context* in which international actions take place (Larsen, 2016), and the directions of these actions may be modified and shaped by global conditions.

On the other hand, internationalisation, while not a universally endorsed agenda, can be viewed as a *strategic* or *purposeful direction* pursued by individuals, groups and social institutions, national and international agencies. Internationalisation refers to the intentional *actions* of these entities as they actively seek to cross national borders in pursuit of social, economic, political or cultural benefits (Mitchell & Nielsen, 2012). Some writers view Internationalisation as a *driver* or engine facilitating globalisation. Equally, international agendas can be *shaped* by globalisation or global trends globalisation when it refers to conditions influencing various areas of human activities (e.g. trade, education) worldwide. In this sense, internationalisation may be thought of something that institutions *do*, while Globalisation is something that *happens to* institutions (e.g. Larsen, 2016). This distinction is central to this chapter.

According to Cai and Howson (2012), globalisation stands for a process of integration of regional entities (e.g. economies, societies, cultures) through an increasing global network of trade, transportation, communication, and collaboration. As a response to globalisation, apart from focusing on acquiring certain knowledge and skills and developing problem-solving abilities, the mathematics curriculum should also be concerned with fostering cross-cultural communication and collaboration, all supporting the development of creativity and innovation. The same authors refer to internationalisation as denoting a process whereby companies and institutions produce products and services that can be, relatively effortlessly, adapted to the needs of specific local contexts and markets.

Skovsmose (2007) refers to processes of globalisation as an outcome or a result of global processes, drawing attention to the following points which support the positions taken by the above authors and the position taken in this chapter: the processes of globalisation are facilitated by information and communication technologies; globalisation, especially in its current form, is linked with a free-growing capitalism; the processes of globalisation do not follow any simple predictable route (in contrast to Internationalisation which is seen as an institutional response to global trends).

In the ensuing sections of this text, we will take a retrospective view on the New Math movement of the 1950s and 1960s and take some lessons from its significant role as an international curriculum. Next, we will look at the influence of ICMI Studies since 1986 as exemplifying international trends in mathematics curriculum reform. These two sections allow us to look at emerging models of Internationalisation through, for example, new curriculum platforms. The final section of this chapter will introduce key ideas to be examined in ensuing chapters; namely, TIMSS and PISA as vehicles for international curriculum reform; how definitions of numeracy and mathematical literacy continue to evolve internationally and also are subject to global influences; and, finally, the emergence of computational/algorithmic thinking (CT/AT) in the school curriculum as a global phenomenon.

Retrospective on New Math – What Has Been Learned?

Many papers at ICMI 24 referred to the New Mathematics ("New Math") movement in the 1950s and 1960s and focused appropriately on its key role in the development of new ideas for the mathematics curriculum. In the *Globalisation and internationalisation and their impacts on mathematics curriculum reforms* theme, we discuss the New Math movement as an instance of internationalisation. Our brief discussion asks: What form did it take and how was it spread? Was its eventual demise somehow a consequence of internationalisation of the mathematics curriculum? What can be learned from that era to support ongoing curriculum reform? For a more detailed discussion and evaluation of the New Math movement, readers can refer to the various contributions assembled in Theme A *Learning from the past: driving forces and barriers shaping mathematics curriculum reforms*.

The widespread adoption of New Math in the 1950s and 1960s is a good example of internationalisation, as a process by which ideas, programs and textbooks are adopted or adapted for use across different countries. Adopting countries, however, were free to opt into New Math to the extent that they wished (Kilpatrick, 2012). This process was accompanied by the development of texts and other resources which could be taken up or adapted according to local conditions. Each country retained its own specific assessment procedures. In each country, the extent of inclusion of New Math content had to fit with the constraints of the existing curriculum. According to Niss (2018), some countries such as the USA and France were strong adopters. On the other hand, many countries in Eastern Europe chose not to adopt the New Math. In other countries, such as England, the adoption of New Math fell somewhere between these two extremes.

Two related forces appeared to drive the push to introduce the New Mathematics curriculum in the 1950s. Post-World-War-II, high school graduates seemed to be underperforming in mathematics after they left school, and business and industry were calling for reforms. Mathematicians, according to Niss (2018), claimed to have the solution. They argued that students could be made (led) to understand mathematics better, and that current woes were a result of school mathematics courses being developed with little reference to what mathematicians understood mathematics to be.

In 1952, after ICMI was reconstituted as a commission of the International Mathematical Union, ICMI focused its attention during the 1950s and 60s on the reform of mathematics following the New Math movement. The then president of ICMI, Marshall Stone, actively supported the importation of New Math into Latin America with funding provided by the USA. Inter-American Conferences on Mathematics Education (CIAM) were established in 1969 to support this agenda professionally and financially. In its time, the New Math movement enjoyed strong international credentials and the support of national and sub-regional organisations.

The principal drivers of the New Math were professional (pure) mathematicians who supported the 'internationalisation' of the reform. They sought collaborators – including many mathematics educators – who would be associated with this international movement (Nadimi & Siry, 2018) in a supporting role. During its relatively short life New Math was adopted in varying degrees in different countries by mathematicians, educators, and curriculum agencies. However, it is very unfair to compare Internationalisation in the 1950s and 1960s with that of today where communication is immediate and where curriculum materials, resources for teaching and assessment can be supported digitally in ways unimagined by the proponents of New Math.

What can be learned from that experience about what works and does not work in mathematics curriculum reforms? The patterns of distribution and dissemination used at the time were inevitably top-down. Niss (2018) argues that New Math worked well for elite students who could see the connections. But when the collapse came, all the good things were thrown out as well. New Math, as a creation of pure mathematicians, appeared to have few mechanisms of regeneration and review; and was impervious – less receptive might be a better term – to other currents within mathematics and mathematics education, including those emerging from new technologies. As subsequent ICMI Studies show, other areas of mathematical inquiry, such as statistics, modelling and applications, and computer assisted algebra, were easily able to claim a space in the school curriculum.

ICMI Studies as Exemplars of Internationalisation

Clear evidence of responsiveness to international trends and developments can be found in the twenty-five ICMI Studies, demonstrating that the mathematics curriculum is continually developing and open to new questions. ICMI studies have made a strong contribution in the questioning of curricula, that is, in raising questions about what has to be taught at school (in specific domains, levels, etc.) and how, and raising these questions internationally, beyond the specific political, cultural and economic tradition of each country.

Space does not permit an examination of all ICMI Studies, but several are discussed here, starting with ICMI Study 1 starting in 1985 with the theme *The influence of computers and informatics on mathematics teaching*. This important theme was returned to in 2006 by ICMI Study 17, *Technology revisited*. (The ICMI Studies series can be found at: https://www.mathunion.org/icmi/digital-library/icmi-studies/icmi-study-volumes.)

ICMI Study 6 (1992) examined emerging models of assessment in mathematics at a time when many school systems internationally were introducing new forms of assessment to better reflect changing purposes of schooling and a broader appreciation of what it means to know and do mathematics.

ICMI Study 18 (2008) *Teaching statistics in school mathematics* was jointly sponsored by the International Association for Statistics Education. The inclusion of statistics in all years of the mathematics curriculum for basic education is now an almost universal trend, moving the teaching and learning of statistics away from a focus on calculation to a focus on the examination and interpretation of data. The increasing use of technology and the utilisation of real-world 'big data' continue to transform statistics education. Finally, ICMI Study 14 (2007), *Modelling and applications in mathematics education*, is a further instance of how the school curriculum has responded to global changes.

Other ICMI Studies are also driven by changing goals for school education, new demographic patterns for secondary education, and consequent changes in the relationship between schooling and society. For example, ICMI Study 20 (2010), *Educational interfaces between mathematics and industry*, conducted jointly with the international Congress on Industry and Applied Mathematics, represents a clear attempt to examine the relationship between mathematics and the world of work. This study looked outside university settings and extended the scope of ICMI Study 2 (1988), *Mathematics as a service subject*.

Beside reconsidering teaching particular topics (e.g. algebra, geometry, proofs – ICMI Studies 9, 12 and 19, respectively) and improving teacher professional development (ICMI Studies 15, 25), ICMI Studies also have focused on topics relating to gender equity, linguistic diversity and different cultural conditions. The inclusion of these topics is further evidence of the relevance and impact of changing social conditions and priorities on the mathematics curriculum, and illustrate a growing interdependence between regions, states, countries and different cultural areas of the world.

Is There an Emerging International Curriculum or Curricula?

It might be thought that the New Math movement signalled a last attempt towards a truly international curriculum. However, *Cambridge mathematics* (Jameson et al., 2018) can be presented as case study of a local example showing what might be possible in a digital age and what has been learned since the New Math movement. It is presented as one instance of possibly many international curriculums. Essentially, it represents a transformation to a global digital platform for curriculum design by an organisation known internationally for its mathematics textbooks, and examinations conducted internationally by the related *Cambridge Examinations Board*.

Cambridge mathematics is supported by Cambridge University Press, the University's faculties of mathematics and education, and Cambridge Assessment. A flexible and interconnected digital framework supports mathematics curriculum design globally to help local teachers to educate students aged 3–19 years. Its design process is intended to be transparent, collaborative and research- and evidence-informed, and aims to support teachers to develop new mathematics programs and to review their current programs, *without necessarily adopting the texts and assessment systems associated with Cambridge University Press and its related Examinations Board* (our emphasis).

Cambridge mathematics claims *not* to be a top-down international curriculum; but concerned to support local adaptations. Its framework is designed, we are told, to support local teachers and school systems. Seven components or features of its digital platform are designed around a *Mathematics Framework* or 'content spine' to which the other elements are linked. In the summary below, these seven components are *grouped* according to the six *elements* that Niss (2018) considers to be necessary for a successful national or international curriculum reform (*goals*, *content*, *materials*, *forms of teaching*, *student activities*, and *assessment*):

(*goals*)

- to champion and secure access to a quality maths education for all;
- to collaborate to use its position in maths education, to show leadership and to develop an authoritative voice.

(*content*)

- to develop a coherent Cambridge Mathematics Framework for all ages and types of learner with a strong distinctive approach, led by academics and educationalists and supported by a strong research base.

(*materials to support teachers and students*)

- to develop and make available world class teaching and learning materials.

(*enhancing forms of teaching and teacher development*)

- to support an infrastructure to enhance the quality of teacher education and continuing professional development.

(*assessment*)

- to develop forms of assessment that support the development of powerful mathematical reasoning.

(*related values and goals*)

- to develop an approach that is recognised and valued by parents, young people, teachers, institutions and governments.[1]

The first three elements of the Niss (2018) vector were present in the New Math, but the latter three were not so evident. One lesson that has been learned from the New Math movement is that the mathematics curriculum cannot be static. Any international curriculum movement, like *Cambridge mathematics,* needs to have in-built mechanisms for regeneration and review, which permit schools, teachers and school systems to form a connected, coherent, evidence-based program for teaching and learning mathematics. Departing from a top-down model, any international reform should enable teachers to select resources and to engage in their own professional learning. Any digital platform must be designed to promote progressive iterations and multiple solutions to meet different global and local conditions. Any candidates for an internationalised – not necessarily uniform – mathematics curriculum must build on affordances from the new technologies and learn lessons from the past.

Internationalisation or Uniformity? Local Factors, Cultures and Beliefs

The idea that an international mathematics curriculum is emerging may have some traction if one 'zooms out' and looks at commonalities of topics as they might be presented through national curriculum documents. But 'zooming out' has problems because it ignores local cultural factors and conditions. Teaching practices and classroom norms are rarely considered when one 'zooms out', and these present major forms of variation. Likewise, the impact of local and national assessment practices.

How are mathematics curriculum reforms varied (or similar) in different social, cultural, economic and political contexts? The research of Guberman and Abu (2018) shows that it in Israel, a relatively small country, a common national curriculum is implemented quite differently in Bedouin and Israeli schools, despite common teacher training programs. Lessons in the Bedouin sector are more traditional in structure (they end with a summary of class activities and a homework assignment), whereas lessons in the Jewish sector often end with independent work. However, this same research showed that teachers in both sectors insist that students master a specific set of procedures in class and learn how to use them when necessary.

[1] Source: http://www.cambridgemaths.org/images/cambridge-mathematics-symposium-2018-framework-update.pdf

The results point to broad similarities, probably tracing to shared training, curriculum, and materials, and to differences, such as stronger teacher responsibility for learning in the Bedouin sector and more independent thinking and conduct in the Jewish sector. These tendencies in both directions probably trace to stronger adherence to tradition in the Bedouin sector. The results emphasise, among other things, the importance of comparing and contrasting teaching practices within countries as well as among them.

Azrou (2018) identified difficulties in implementing an imported French mathematics curriculum in Algerian primary schools, where local teachers were given a curriculum to implement with very little professional development. In 2009, teachers in Algerian primary schools were informed that every child in the first grade should pass to the second grade, following a similar reform applied in French primary schools. Teachers interpreted this instruction as requiring that children who do not pass their exams and whose scores do not reach some required level should nevertheless pass to the second grade. To comply with a ministry instruction, teachers and administrators agreed that children should all pass to the second grade regardless whether they passed their exams or not at the first grade.

The original intent of this directive was to support all children so that they all reach their learning objectives and that no one would be left behind, allowing all children to proceed to the second grade with complete and strong basis. Even if the correct intention of this change had been explained, teachers needed to learn about the strategies that would make this possible, including how to work effectively with children experiencing difficulties. Teachers needed also to be shown the means, instructions, and assistance to organise their classes so that they can find time to assist children in need.

These studies – by Guberman and Abu, and by Azrou – show that school education and, particularly, teaching and learning mathematics are not free from locally embedded assumptions about teacher education and continuing professional development. There will also be local differences in the support offered to teachers in schools, the local organisation of schools and many other factors that can hold back or re-shape the implementation of any new change.

Looking Ahead

In this final sub-section, there are four areas of focus and issues to be examined in the following chapters of this Part.

1. *TIMSS and PISA as vehicles for curriculum reform*

One may consider TIMSS and PISA studies as examples of educational internationalisation since these studies have, in their different ways, promoted an internationally accepted ‘core’ of mathematical knowledge and skills to be acquired. It is important, however, to note that TIMSS and PISA are projects to assess and compare the current state of educational systems, not the elaboration of a transformed mathematical curriculum. Since 1995, every 4 years, TIMSS has assessed students' knowledge of mathematics and science in fourth and eighth grades (https://timssandpirls.bc.edu/timss-landing.htm). PISA, which commenced in 2000, has been repeated every 3 years measuring fifteen-year-old school pupils' performance on mathematics, science, and reading (http://www.oecd.org/pisa/).

TIMSS has assessed students' mathematical knowledge for several subject domains and three cognitive domains, mostly by using traditional school tasks. PISA assessed students' mathematical literacy for several content domains and different task contexts, mostly by using non-traditional tasks including real-life questions. Despite these differences, both studies aim to provide participating countries with comparable data to improve their education policies and outcomes. This is usually done through applying components of these studies (e.g. assessment tasks or key ideas) in curriculum reforms undertaken.

Unlike the New Math, TIMSS and PISA enjoy government sponsored participation and a consequent acceptance of regulatory mechanisms co-ordinated internationally to ensure comparability of reporting across participating countries. New countries seeking to join PISA and TIMSS are required to meet the same rigorous conditions for implementation required by their respective international agencies.

In some countries, PISA's framework for mathematical literacy (OECD, 2013) has been a platform for curriculum reform, the development of new national assessment formats and the consequent need for teacher professional learning. For example, in 2005 and 2007, Japan in its national assessment of student performance created a special section consisting of PISA-style questions which may have been previously merged with other test questions. Having a special section on real-life questions allowed the government to report on this section, encouraging schools to appreciate the importance of having students use and apply mathematics in real-life contexts (Namikawa, 2018).

2. *Evolving definitions of numeracy and mathematical literacy*

PISA's definition of mathematical literacy (OECD, 2013) has been influential in the development of national curriculum standards aimed at improving teaching and learning. The subsequent chapter in this book shows how numeracy – sometimes referred to as mathematical literacy – has emerged as a driver for curriculum reform in many international contexts. They trace the emergence and interpretations of numeracy and mathematical literacy and compare their relationship to curriculum reform processes in four countries Australia and Ireland have adopted a cross-curriculum approach. In Japan mathematical literacy is intended to be fostered through the process of reforming the mathematics curriculum.

In a fourth example discussed by Goos and O'Sullivan, South Africa's government in 2006 introduced a new subject called mathematical literacy (Math Lit), centred around real-world problems and not around formal algebra, being an alternative course to the standard pure mathematics course, mathematics (general grades 10–12) in the further education and training (FET) phase of school. Although Math Lit has greatly increased participation in mathematics in the final 3 years of school (about 60% of students take this course), students who have completed this course may be left with the unintended consequence of having a matriculation certificate that does not qualify them undertake university studies in mathematics or science (Jojo, 2019).

Other ‘frameworks’ not necessarily related to international assessments have influenced curriculum reform, for example, *Common core state standards: Mathematics* (CCSSM, 2019) and NCTM’s (2010) *Principles and standards for school mathematics*. There is also a need to compare and connect the numeracy framework of the international *Programme for international assessment of adult competencie*s (PIAAC; OECD, 2019) with that of PISA to look backwards to examine what is happening in schools.

International forums such as the Asia-Pacific Economic Cooperation Agency (APEC, 2016, 2017) and the World Economic Forum (WEF, 2018) have sought to present a global economic perspective on mathematical literacy. To prepare better *students and workers for the yet-to-be-defined jobs of tomorrow* (our emphasis) and for supporting economic growth, APEC (2017), for instance, developed a list of data science and analytics (DSA) competences, including: enhanced skills in data presentation and visualisation; versatile applications of data analytics methods; computational thinking and use of algorithms; all of which are aimed to extend current boundaries and prevailing definitions of mathematical literacy. The World Economic Forum report, *The future of jobs* (WEF, 2018), also links the surging demand for these kinds of competencies to specific technological (ICT) advances. To add some urgency to this perspective, APEC (2018) has predicted that the global shortfall of highly skilled workers in ICT-related fields may be as large as to be 40 million by the early 2020s.

3. *Emergence of Computational/Algorithmic thinking in the mathematics curriculum*

Despite the lack of a widely accepted definition of computational/algorithmic thinking – which may simply be described as thinking involved in applying, modifying, and designing algorithms by using various computational tools – this thinking is an emerging educational notion. There are four reasons why the emergence of CT/AT in education can be viewed as a clear instance of the impact of globalisation and internationalisation. First, there is an increasing reliance on digital technology whose application often combines local and global contexts; in healthcare, biology, manufacturing, education, security, legal processing, the arts and music, to name a few.

Second, there is an increasing use of algorithmic techniques, including artificial intelligence, to deal with various real-world challenges that are not limited to local contexts – none more evident than in the recent *coronavirus* pandemic. Third, there are raised parental and societal expectations concerning a better, technology-assisted education of children that combines local and global contexts. Finally, with computational mathematics in various forms now widely used in undergraduate university courses, there is a mounting case for a better alignment between school courses and those at university.

Raised parental and societal expectations have been stimulated by the involvement of the private and non-government sector in providing online resources for free that are available to students from a young age without the formal mediation of the official school sector. Two examples of such resources, used by millions of young students worldwide, are: *Hour of Code*, promoting computer science (https://code.org/hourofcode/overview), and *Scratch* from MIT Media Lab supporting visual (block) programming language (https://scratch.mit.edu/). *Scratch* also features in many on-line resources to support computational thinking starting in the primary school, such as those provided by the non-government Sadosky Foundation (2018) in Argentina.

One rationale for including CT/AT in school education is based on the importance of developing computational thinking skills in children and young people to enable them to solve (real-world) problems using various computational tools. A second rationale is undeniably a response to changed economic conditions; namely the importance of fostering computational thinking to boost economic growth, fill job vacancies in ICT, and to prepare for future employment (Bocconi et al., 2016). There is no hard and fast separation between these two rationales. The kind of thinking processes advocated in the first rationale are clearly related to life and work contexts of the twenty-first century that are highly influenced by technology use.

Stephens (2018) reported on the expanding number of countries incorporating CT/AT into the curriculum of their elementary and middle school years. These developments, together with those taking place outside formal school hours clearly challenge and expand accepted definitions of mathematical thinking, reasoning and problem solving. CT/AT is not the same a coding; still less is it based on memorisation of procedures. Enlarging the role for CT/AT in the school mathematics curriculum must build upon, connect with, and enhance the way students think about and do mathematics. For a clearer anticipation of the role of CT/AT in the school mathematics curriculum of the twenty-first century, work is required on all six components that Niss (2018) specified for any major curriculum reform. Especially relevant are resources to support student activities, teacher resources, and assessment.

4. *Future visions of the impact of internationalisation and globalisation on school mathematics curriculum*

As twin global drivers, globalisation and internationalisation, remind us that the directions of curriculum reform are complex. Mathematicians and mathematics educators are important players, but reforms are sometimes responses to broader agendas and changing social contexts that have been outlined in this chapter. Failing to respond in an intelligent and timely way risks repeating past mistakes and missing opportunities to make a difference. The last chapter of the theme *globalisation and internationalisation and their impacts on mathematics curriculum reforms* considers how the issues so far considered are likely to play out in the future. In this short chapter we consider what has been learned about the influence of TIMSS and PISA and what might be expected in the near future; we re-examine how our understandings about numeracy and mathematical literacy continue to evolve; and, finally, we present five recommendations regarding the future inclusion of computational (algorithmic) thinking in the curriculum.

Acknowledgement The research done by D.M.K. was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (contract no. 451-03-68/2022-14/200018).

References

APEC. (2016). *Leaders' statement*. Asia-Pacific Economic Cooperation Agency. https://www.apec.org/Meeting-Papers/Leaders-Declarations/2016/2016_aelm

APEC. (2017). *Data science analytics*. Asia-Pacific Economic Cooperation Agency. https://www.apec.org/Publications/2017/11/Data-Science-and-Analytics-Skills-Shortage

APEC. (2018). *Human resources development working group*. Asia-Pacific Economic Cooperation Agency. https://www.apec.org/Press/News-Releases/2018/1109_dare

Azrou, N. (2018). Imported reforms: The case of Algeria. In Y. Shimizu & R. Vithal (Eds.), *School mathematics curriculum reforms: Challenges, changes and opportunities. Proceedings of the twenty-fourth ICMI Study conference* (pp. 429–436). International Commission on Mathematical Instruction.

Bocconi, S., Chioccariello, A., Dettori, G., Ferrari, A., & Engelhardt, K. (2016). *Developing computational thinking in compulsory education: Implications for policy and practice*. Publication Office of the European Union. https://ideas.repec.org/p/ipt/iptwpa/jrc104188.html

Cai, J., & Howson, G. (2012). Toward an international mathematics curriculum. In K. Clements, A. Bishop, C. Keitel, J. Kilpatrick, & F. Leung (Eds.), *Third international handbook of mathematics education* (pp. 949–974). Springer.

CCSSM. (2019). *Common Core state standards for mathematics*. National Governors Association Center for Best Practices, Council of Chief State Officers. http://www.corestandards.org/Math/

Guberman, R., & Abu Amira, A. (2018). Practices in teaching a reformed math curriculum in the Jewish and Bedouin (Arab) sectors of Israel. In Y. Shimizu & R. Vithal (Eds.), *School mathematics curriculum reforms: Challenges, changes and opportunities. Proceedings of the twenty-fourth ICMI Study conference* (pp. 445–452). International Commission on Mathematical Instruction.

ICMI. (2017). *ICMI Study 24 Discussion Document*. Available in the *Proceedings of ICMI Study 24* (pp. 571–587). International Commission on Mathematical Instruction.

Jameson, E., McClure, L., & Gould, T. (2018). Shared perspectives on research in curriculum reform: Designing the Cambridge mathematics framework. In Y. Shimizu & R. Vithal (Eds.), *School mathematics curriculum reforms: Challenges, changes and opportunities. Proceedings of the twenty-fourth ICMI Study conference* (pp. 531–538). International Commission on Mathematical Instruction.

Jojo, Z. (2019). Mathematics education system in South Africa. In G. Porto (Ed.), *Education systems around the world* (p. 11). IntechOpen https://doi.org/10.5772/intechopen.85325

Kilpatrick, J. (2012). The new math as an international phenomenon. *ZDM: The International Journal of Mathematics Education, 44*(4), 563–571. https://doi.org/10.1007/s11858-012-0393-2

Larsen, M. (2016). Globalisation and internationalisation of teacher education: A comparative case study of Canada and greater China. *Teaching Education, 27*(4), 396–409.

Mitchell, D., & Nielsen, S. (2012). Internationalization and globalization in higher education. In H. Cuadra-Montiel (Ed.), *Globalization: Education and management agendas*. London, UK.

Nadimi, C., & Siry, C, (2018). Implementing an international reform into national school system: The story of new math reform in Luxembourg. In Y. Shimizu & R. Vithal (Eds.), *School mathematics curriculum reforms: Challenges, changes and opportunities. Proceedings*

of the twenty-fourth ICM1 Study conference (pp. 397–404). International Commission on Mathematical Instruction.
Namikawa, Y. (2018). Curriculum reform of Japanese high schools and teacher education based on literacy. In Y. Shimizu & R. Vithal (Eds.), *School mathematics curriculum reforms: Challenges, changes and opportunities. Proceedings of the twenty-fourth ICM1 Study conference* (pp. 461–466). International Commission on Mathematical Instruction.
NCTM. (2010). *Principles and standards for school mathematics*. National Council of Teachers of Mathematics.
Niss, M. (2018). National and international curricular use of the competency based Danish "Kom project". In Y. Shimizu & R. Vithal (Eds.), *School mathematics curriculum reforms: Challenges, changes and opportunities. Proceedings of the twenty-fourth ICM1 Study conference* (pp. 69–76). International Commission on Mathematical Instruction.
OECD. (2013). *PISA 2012 assessment and analytical framework*. Organisation of Economic Co-operation and Development. https://doi.org/10.1787/9789264190511-en
OECD. (2019). *Programme for the international assessment of adult competencies (PIAAC)*. Organisation of Economic Co-operation and Development. http://www.oecd.org/skills/piaac/
Sadosky Foundation. (2018). *Ciencias De La Computacion: Para El Aula – Manual para docentes*. Sadosky Foundation. (In Spanish) http://program.ar/descargas/cc_para_el_aula-2do_ciclo_primaria.pdf
Skovsmose, O. (2007). Mathematical literacy and globalisation. In B. Atweh, B. Barton, M. Borba, N. Gough, C. Keitel, C. Vistro-Yu, & R. Vithal (Eds.), *Internationalisation and globalisation in mathematics and science education* (pp. 3–18). Springer.
Stephens, M. (2018). Embedding algorithmic thinking more clearly in the mathematics curriculum. In Y. Shimizu & R. Vithal (Eds.), *School mathematics curriculum reforms: Challenges, changes and opportunities. Proceedings of the twenty-fourth ICM1 Study conference* (pp. 483–490). International Commission on Mathematical Instruction.
WEF. (2018). *The future of jobs*. World Economic Forum. http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf