Llinares, S., Krainer, K., & Brown, L. (2018). Mathematics teachers and curricula. In S. Lerman (Editor-in-Chief), & M. Artigue (section editor) (Eds.), *Encyclopedia of Mathematics Education* (2nd ed.). Springer. https://doi.org/10.1007/978-3-319-77487-9_111-5

Steve Lerman
Encyclopedia of Mathematics Education
10.1007/978-3-319-77487-9_111-5

Mathematics Teachers and Curricula

Salvador Llinares[1], Konrad Krainer[2] and Laurinda Brown[3]
(1)Facultad de Educación, University of Alicante, Alicante, Spain

(2)Institute of Instructional and School Development, Alpen-Adria-Universität Klagenfurt, Klagenfurt, Austria

(3)School of Education, University of Bristol, Bristol, UK

Salvador Llinares (Corresponding author)
Email: sllinares@ua.es

Konrad Krainer
Email: konrad.krainer@aau.at

Laurinda Brown
Email: laurinda.brown@bristol.ac.uk

Without Abstract

Definition and Historical Background

The word curriculum has had several meanings over time and has been interpreted broadly not only as a project about *what* should be learned by students but, in the context of teachers and curriculum, as all the experiences which occur within a classroom. These different meanings are grounded in different assumptions about teaching and the nature of interactions of the teacher with ideas that support curriculum guidelines (Clandinin and Connelly *1992*). These different meanings have defined several roles of teachers in mathematics curriculum development that can be described as the history of a shift from teachers as curriculum users to teachers as curriculum interpreters and/or curriculum makers. Whereas the former view assumes curricula to be "teacher-proof," the latter includes teachers' activities like reflecting, negotiating issues of curricula and disseminating to their peers. This shift mirrors acknowledgment of the centrality of the teacher in curricula issues (Clarke et al. *1996*; Hershkowitz et al. *2002*; Lappan et al. *2012*) and viewing teachers as key stakeholders of educational change (Kieran et al. *2013*). These meanings are located along a continuum from a view of curricula as fixed, embodying discernible and complete images of practice to a view of curricula guidelines as influencing forces in the construction of practice.

In the 1970s, Stenhouse (*1975*) defined curriculum as "an attempt to communicate the essential principles and features of an educational proposal in such a form that it is open to critical scrutiny and capable of effective translation into practice" (p. 4). The teacher is central to this translation into practice. A model that is commonly used for analysis in mathematics education sees curricula as located at three levels: the *intended curriculum* (at the system level, the proposal), the *implemented curriculum* (at the class level, the teacher's role), and the *attained curriculum* (at the student level, the learning that takes place) (Clarke et al. *1996*).

Focusing on the implemented curriculum, Stenhouse began the "teachers as researchers" movement. He believed that the "development of teaching strategies can never be *a priori*. New strategies [principled actions] must be worked out by groups of teachers collaborating within a research and development framework [...] grounded in the study of classroom practice" (p. 25). The development of this idea in the mathematics education field illustrated the complexity of teaching and the key roles played by teachers, underlining the importance of teachers' processes of interpretation of curricula materials (Zack et al. *1997*). This role of mathematics teachers in the development of curricula has been highlighted by the recent technological advances favoring cooperative work among teachers in design tasks (e.g., e-textbooks) that have been seen as interfaces between policy and practice. This new position underscores the role of teachers' authority in the curriculum design process (Pepin et al. *2016*). As a consequence, new perspectives are being generated to understand how the relationships between teachers and curriculum change when teachers gain experience through professional learning opportunities (Remillard et al. *2009*).

Different Cultures Shaping Different Forms of Interaction Between Teachers and Curricula

The relation between teacher and curricula depends on internal and external influences. Teachers frame their approach to curricula differently, dependent on their conceptions of different components of curricula and/or through the different structures of professional development initiatives (Remillard et al. *2009*). Locally, teachers' knowledge and pedagogical beliefs are influences as they engage with curricula materials. Furthermore, the content and form of curricula materials influence the ways in which teachers interpret, evaluate, and adapt these materials considering their students' responses and needs in a specific institutional context.

Globally, countries have different curricular traditions shaping different conditions for teachers' roles in curriculum development. Thus, the diversity of cultures and features of each country's system generate different modes of interaction between teachers and curricula, as well as different needs and trends in teacher professional development (Clarke et al. *1996*). However, results from international comparison assessments such as TIMSS and PISA are producing moves of mathematics curricula between countries (e.g., the translation of the Singapore curriculum to different countries due to good scores). This does not, then, reflect the cultural idiosyncrasy in different global regions in the world. The main elements which have been proved to affect the relation between teachers and curricula, are, for instance, the distance that usually exists between the intended curriculum and the implemented curriculum; whatever the level of detail and prescription of the curriculum description, the implemented curriculum remains a subtle composition of the old and the new. In this sense, curricula are related with teacher practice, and curricula change is linked to how teachers continuously further develop or change their current practice, in particular with regard to teaching and assessment and professional development initiatives (Krainer and Llinares *2010*).

Teachers and Curricula Within a Collaborative Perspective

From this view of interaction between teacher and curriculum, curriculum development initiatives are a context for teacher professional development reconstructing wisdom through inquiry. There is a long tradition of teachers developing curriculum materials in collaborative groups.

In the United Kingdom in the late 1970s and early 1980s, Philip Waterhouse's research (*2001*, updated by Chris Dickinson), supported by the Nuffield Foundation, led to the founding of a number of curriculum development organizations called Resources for Learning Development Units. In these units, the mathematics editor (one of a cross-curricular team of editors) worked with groups of not more than ten teachers, facilitating their work on either developing materials related to government initiatives or from perceived needs of teachers themselves. The explicit focus for the teachers was on the development and then production of materials that had been tried out in their classrooms. However, the implicit focus of the editor was on the professional development of those teachers in the groups. Also, in France, since the 1970s, the IREM network has functioned on the basis of mixed groups of academics, mathematicians, and teachers inquiring, experimenting in classrooms, producing innovative curriculum material, and organizing teacher professional development sessions relying on their experience (e.g., www.univ-irem.fr/). In recent views of how teachers interact with, draw on, refer to, and are influenced by curriculum resources, teachers are challenged to express their professional knowledge keeping a balance between the needs of their specific classrooms and their conceptions. In many countries, as mathematics education research has matured, there is increasing development of curriculum materials by teachers themselves working collaboratively and the organization of teacher professional development, for example, Sésamath, a French online association of mathematics teachers to design curriculum materials collaboratively.

Barbara Jaworski, working in Norway from 2003 to 2010, has led research projects in partnership with teachers to investigate "Learning Communities in Mathematics" and "Teaching Better Mathematics" (see, e.g., Kieran et al. *2013*). In Canada, led by Michael Fullan, there is a large-scale project supporting professional development of teachers through curriculum reform in literacy and numeracy based on in-school collaborative groupings of teachers attending a central "fair" to present their inquiry work once a year. This project, *Reach Every Student, energizing Ontario Education*, works on the attained curriculum through the implemented one and has led to Fullan's (*2008*) book *Six Secrets of Change.* In the Latin-American context, the "praxis perspective" adopted in development of curricula in Costa Rica from 2012 to 2015 underlines the role played by different factors such as defining opportunities of teachers' professional development, the strategic role played by the online interaction, and the influence of different forms of assessment on teacher practice.

With the spread of ideas through international conferences, meetings and research collaborations, ideas such as the Japanese "lesson study" have spread widely (Alston *2011*). Lesson study is a professional development process where teachers engage in systematically examining their practice. It is considered to be a means of supporting the dissemination of documents like standards, benchmarks, and nationally validated curricula. These multiple views define distinctive professional development pathways through curricula reforms. These pathways influence teachers' professional identities and work practices. Another example is "learning study" where teachers collaborate (with or without a researcher) with the aim of enhancing student learning of a particular topic (Runesson *2008*). By carefully and systematically studying their classroom teaching and students' learning, teachers explore what students must learn in order to develop a certain capability. Learning study is based on an explicit learning theory (variation theory, Lo *2012*).

Social perspectives on the role of teachers in curricula reforms are being reported by Kieran and others (2013), where the major focus is on the role and nature of teachers' interactions within a group of teachers. From this perspective, teachers are motivated by collaborative inquiry activities (teams, communities, and networks) aiming at interpreting and implementing curricula materials, as a way of

“participation with” (Remillard et al. *2009*, Pegg and Krainer *2008*). These engagements must be understood in light of their particular local and global contexts. Teachers’ learning through collaborative inquiry activities, contextualized in curriculum development initiatives, has allowed the contextual conditions in which curriculum is implemented in different traditions to be made explicit. Pegg and Krainer (*2008*) reported examples of large-scale projects involving national reform initiatives in mathematics where the focus was initiating purposeful pedagogical change through involving teachers in rich professional learning experiences. The motivation for these initiatives was a perceived deficiency in students’ knowledge of mathematics (and science) understood as the attained curriculum. In all of these programs, collaboration, communication, and partnerships played a major role among teachers and university staff members of the program. In these programs, the teachers were not only seen as participants but crucial change agents who were regarded as collaborators and experts (Pegg and Krainer *2008*). This view of teachers as change agents emerged from the close collaboration among groups of stakeholders and the different forms of communications that developed. From all those variables defining the relationships between teachers and curricula, how curricula principles move between cultures have begun to appear as key issues (e.g., comparison and analysis of textbooks from different cultures, Leung et al. *2006*).

Open Questions

The relationship between teacher and curricula defines a set of open questions in different realms. These questions are linked to the fact that the relationship between teachers and curricula is moving, due to a diversity of factors: the increasing autonomy and power given to teachers regarding curriculum design and implementation in some countries at least, the development of collaborative practices and networks in teachers’ communities, the evolution of relationships between researchers and teachers, the explosion of curriculum resources and their easier accessibility thanks to the internet, the impact of international comparisons favoring the moving of curricular principles between cultures, etc. Thus, some open questions are:

1.
What are the implications of the school-based partial transfer of power in curriculum decision-making to teachers based on teachers’ practical, personal reflective experience and networks?

2.
What role do collegial networks play in how ideas about curricula change are shared including when the design uses the affordance of digital curriculum resources (e.g., using electronic communications and online platforms to share the curriculum resources)?

3.
How do new kinds of practices and teaching objectives emerge as a consequence of new resources influencing the relation between teacher and curricula?

4.
How can reform initiatives cope with the balance between national frameworks for curricula (e.g., educational standards as expressions of societal demands) and local views on curricula as negotiated between the teachers of one school?

5.

How does the exchange between cultures influence the curriculum-teacher relationships and how could sociocultural theories explain these influences?

6.
What role do students play in ideas related to curricula (e.g., starting topics based on students' interests, questions, and so on)?

Cross-References

Communities of Practice in Mathematics Education
Curricula Development
Curricular Resources and Textbooks in Mathematics Education
E-textbooks
Learning study in Mathematics Education
Lesson Study in Mathematics Education
Mathematics Curriculum Design and Conceptions
Mathematics Teacher as Learner
Models of In-service Mathematics Teacher Education Professional Development
Professional Development

References

Alston AS (2011) Lesson study research and practice in mathematics education: learning together. Springer, Amsterdam

Clandinin DJ, Connelly FM (1992) Teacher as curriculum maker. In: Jackson P (ed) Handbook of research on curriculum. Macmillan, New York, pp 363–401

Clarke B, Clarke D, Sullivan P (1996) The mathematics teacher and curriculum development. In: Bishop A et al (eds) International handbook of mathematics education. Kluwer Academic, Dordrecht, pp 1187–1205

Dickinson C (2001) Classroom management. Network Educational Press, Bloomsbury Re-write of classic Philip Waterhouse text

Fullan M (2008) Six secrets of change: what the best leaders do to help their organizations survive and thrive. Jossey-Bass, San Francisco

Kieran C, Krainer K, Shaughnessy JM (2013) Linking research to practice: teachers as key stakeholders in mathematics education research. In: Clements MA, Bishop A, Keitel C, Kilpatrick J, FKS L (eds) Third international handbook of mathematics education. Springer, Dordrecht, pp 361–392

Hershkowitz R, Dreyfus T, Ben-Zvi D, Friedlander A, Hadas N, Resnick T, Tabach M, Schwarz B (2002) Mathematics curriculum development for computerized environments. A designer researcher-teacher-learner activity. In: English LD (ed) Handbook of international research in mathematics education. Lawrence Erlbaum Associates, Mahwah, pp 657–694

Krainer K, Llinares S (2010) Mathematics teacher education. In: Peterson P, Baker E, McGaw B (eds) International encyclopedia of education, vol 7. Elsevier, Oxford, pp 702–705
CrossRef

Lappan G et al. (2012) Textbooks, curriculum, technology, students placement, support for teachers and the role of research. Description of survey team 1 at ICME-12 in Seoul. Website: http://www.icme12.org

Leung F, Graf K, Lopez-Real F (2006) Mathematics education in different cultural traditions – a comparative study of East Asia and the west. The 13th ICMI study. Springer, Rotterdam

Lo M L (2012) Variation theory and the improvement of teaching and learning. Gothenburg studies in educational sciences, 323. Göteburgs Universitet, Gothenburg

Pegg J, Krainer K (2008) Studies on regional and National Reform Initiatives as a means to improve mathematics teaching and learning at scale. In: Krainer K, Wood T (eds) The international handbook of mathematics teacher education: Participants in mathematics teacher education, vol 3. Sense, Rotterdam, pp 255–280

Pepin B, Gueudet G, Yerushalmy M, Trouche L, Chazan D (2016) E-textbooks in/for teaching and learning mathematics. A potentially transformative educational technology. In: English L, Kirshner D (eds) Handbook of international research in mathematics education, 3rd edn. Routledge, London, pp 636–661

Remillard J, Herbel-Eisenmann B, Lloyd G (2009) Mathematics teachers at work. Connecting curriculum materials and classroom instruction. Routledge, New York

Runesson U (2008) Learning to design for learning. The potential of learning study to enhance learning on two levels: teacher's and students' learning. In: Wood T, Sullivan P (eds) International handbook on mathematics teacher education: Knowledge and beliefs in mathematics teaching and teaching development, vol 2. Sense, Rotterdam, pp 153–172

Stenhouse L (1975) An introduction to curriculum research and development. Heinemann, London

Zack V, Mousley J, Breen C (eds) (1997) Developing practice: teachers' inquiry and educational change. Deakin University, Geelong