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# Curriculum Resources and Textbooks in Mathematics Education

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Typically, curriculum resources including textbooks are seen to reside at the interface between policy and practice (e.g., Valverde et al. 2002), as they translate policy (the intended curriculum) into practice (the enacted curriculum). More recently mathematics teachers increasingly rely on digital resources to prepare their lessons and to design their mathematics curriculum, and students use such resources in class and to complement their courses. These materials are said to become key tools for teachers; as in many countries (e.g., France, the Netherlands, the United Kingdom, the United States), teachers are increasingly encouraged to (re) design the curriculum in planning their instruction.

In the next section we define curriculum resources; in particular we distinguish digital curriculum resources from educational technology. In the subsequent section, we discuss the design and "use" of mathematics curriculum resources by teachers (and students). In the last section, we develop further perspectives.

## Definition of Curriculum Resources

We define mathematics curriculum resources as all the material resources that are developed and used by teachers and students in their interaction with mathematics in/for teaching and learning, inside and outside the classroom. Hence, curriculum resources would include the following:

Text resources (e.g., textbooks, teacher curricular guidelines, websites, worksheets, syllabi, tests)
Other material resources (e.g., manipulatives, calculators)
Digital-/ICT-based curriculum resources (e.g., interactive e-textbooks)

Leaning on work by Pepin et al. (2017a), we distinguish digital curriculum resources including e-textbooks, from instructional technology (e.g., digital geometry software), in the sense that:

> It is the attention to sequencing—of grade-, or age-level learning topics, or of content associated with a particular course of study (e.g., algebra)—so as to cover (all or part of) a curriculum specification, which differentiates Digital Curriculum Resources from other types of digital instructional tools or educational software programmes. . . . Of course, Digital Curriculum Resources make use of these other types of tool and software: indeed, what differentiates them from pre-digital curriculum programmes is that they are made accessible on electronic devices and that they often incorporate the dynamic features of digital technologies. (p. 647)

Seen this way, it makes the study of curriculum resources, whether digital or non-digital, and student and teacher interaction with such resources, a crucial ingredient of teacher education and professional development.

There are other "nonmaterial" resources used by teachers to design their curriculum, for example, social resources (e.g., direct and/or web-based conversations with colleagues) and cognitive resources (e.g., conceptual frames that are used, for example, in professional development sessions to develop particular competencies). These two further categories are not addressed in this text.

## Design and "Use" of Mathematics Curriculum Resources

In this section we provide a condensed overview of the relevant issues and literature organized under two headings: (1) research about the design and the quality of curriculum resources and (2) research about the use of and interaction with resources, including their adaptation and transformation by users, in particular teachers.

### Design and Quality of Curriculum Resources

In terms of "text/paper" curriculum resources and textbooks, Fan et al. (2013) have developed a framework for classifying the literature in textbook research. They identified four categories, among them "textbook analysis and comparison" (p. 635). This category makes up 34% of empirical studies on mathematics textbooks in their survey ($n = 100$). According to this survey, textbook analyses (and comparisons) can be subdivided into five categories, i.e., studies focusing on (1) how different mathematics content or topic areas have been treated in textbooks; (2) cognition and pedagogy; (3) gender, equity, and values; (4) comparison of different textbooks internationally; and (5) methodological matters and frameworks for textbook analysis.

Leaning on the literature, we can distinguish three primary frameworks to inform the analysis of digital curriculum resources. The first is the Digital Typology created by Choppin et al. (2014), in which they outlined three categories for the analyses of digital curriculum resources: students' learning experiences, curriculum use and adaptation, and assessment systems. In the second framework, Choppin and Borys (2017) analyze digital curriculum resources in terms of four perspectives (private sector perspective, designer perspective, policy perspective, and user perspective) that inform the design, development, and dissemination of curriculum resources. In the third framework, Pepin et al. (2016) distinguish between three types of e-textbooks (according to their model of development and their functionality): integrative e-textbook, evolving or "living" e-textbook, and the interactive e-textbook.

All these studies, more or less explicitly, raise the issue of the quality of curriculum resources and in turn can be reinterpreted as contributions to quality studies (e.g., Gueudet et al. 2013). The issue of quality and evaluation is particularly developed in studies concerning digital resources, as the profusion of online resources has created a need for quality criteria. Moreover, it has become

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evident that quality and design issues are interrelated. Digital means lead to the development of new design modes and to new possibilities of teacher collaborative work around the design of curriculum resources. Research on curriculum resources needs to address questions, such as who are the designers and in which ways does the designer/group of designers impact on the quality of resources?

### The "Use" of Curriculum Resources

In this section, we address issues related to the "use" of resources, which include the interactions of teachers and students with resources.

We consider here the interactions between teachers or students and resources from the perspective of mediated activity. This leads to the consideration of a two-way process: (1) the resource's features influence the subject's activity and learning (for teachers, this can lead to policy choices, drawing on resources as a means for teacher education); at the same time, (2) the subject shapes his/her resources, according to his/her knowledge and beliefs. In short, the "use" of curriculum resources is recognized as a two-way interactive process (as acknowledged, e.g., in the Documentational Approach of Didactics).

Davis and Krajcik (2005) have coined the term "educational curriculum materials," emphasizing the importance of educative curriculum materials for teacher learning (in their case in science education). This is also acknowledged in mathematics education, although there is scarce research on this topic (e.g., Pepin 2018).

Considering the shaping of resources by teachers (or students), the ways teachers (or students) use, adapt, or transform the resources depend to a large extent on their knowledge and beliefs (see, e.g., Gueudet et al. 2012, or Pepin et al. 2013, or Remillard et al. 2009). The ways students "use," for example, a calculator is said to depend on their knowledge about the calculator and its affordances but also on their knowledge of the mathematics. The same holds true for textbooks: in order to find support for solving an exercise, some students will read the course materials, whereas others will search for worked examples. Similarly, two teachers will use the same textbook differently. A teacher can focus on the worksheets, or the provision of exercises, while another will consider the same book as curriculum guide. The notion of "implementation fidelity" is often used to denote that teachers align their lesson design with the textbook. At the same time, studying how the same teacher enacts the same (e.g., algebra) content of one textbook in two same grade classrooms, notable differences can be found. Thus, it can be said that curriculum resources offer personal possibilities for adaptations, and teachers have always adapted and transformed resources: selecting, changing, cutting, and rephrasing.

However, the main difference with digital resources, such as e-textbooks, is that these adaptations are technically anticipated and supported with specific technical means (Pepin et al. 2016). Considering teacher interaction with digital curriculum resources, Pepin et al. (2017b) defined mathematics *teacher design capacity* as consisting of three main aspects: (1) a clear goal orientation of the design (e.g., in terms of aims and content of learning), (2) a set of design principles/heuristics (e.g., a set of robust but flexible guidelines about how to address the design task), and (3) reflection-in-action type of understandings (e.g., the ability to collect information and adapt the initial design to circumstances during instruction). They developed this model for mathematics teacher design capacity when interacting with digital (and non-digital) curriculum resources.

In terms of interaction with digital curriculum resources, most teachers have now access to a profusion of freely available educational resources. However, teachers often find it difficult to analyze and choose from the profusion of materials available to fit their educational goals and classroom contexts. Pepin et al. (2017a) identify a number of practices/uses of digital curriculum resources, both by students and by teachers. There are at least three features that make it beneficial for teachers to work with digital curriculum resources: (1) their flexibility in terms of adaptation and redesign, for personal lesson preparation as well as collective design work with colleagues, at a distance or working together in professional development sessions; (2) the possibilities for personalization and differentiation, so as to attend to students' individual needs, for example, in providing particular tasks/activities or individual feedback on tasks; and (3) the many assessment features that allow "easy" access to different aspects of student learning.

In terms of student interaction with digital curriculum resources, we note that the interactive features of digital curriculum resources seem to be most useful with formative assessment practices, which help students (as well as teachers) to "feed forward" that is to drive the next learning (instructional) steps (e.g., Pepin et al. 2017a). At the same time, Ruthven (2018) points out that the general adaptivity of such digital resources is one of the biggest advantages, in particular with respect to personalized (diagnostic) assessment. Indeed, the adaptivity feature appears crucial for finding new pathways and sequencing of problems by students and in terms of assessment for leaving room for misunderstandings and amendments.

## Future Research Perspectives

Viewing curriculum resources as essential tools for teachers to accomplish their goals has been accepted for a long time. However, the vision of the teacher-tool relationship has changed and needs to be explored in more depth. Moreover, considering the evolution of resources available for teachers and students, this opens up new directions for research. It leads in particular (1) to view the teacher as a designer of his/her resources. Based on the interpretation of teaching as design, and teachers as designers, existing research emphasizes the vital interaction between the individuals/teachers and the tools/resources to accomplish their goals, an accomplishment inextricably linked to the use of cultural, social, and physical tools. This not only questions our conceptualization of "curriculum resources," but it also opens the door for many new avenues of researching mathematics curriculum resources and their interaction with the "learner," may it be the teacher or the student.

Linked to this, (2) it questions the nature of curriculum resources that are to be "teacher-educative." What kind(s) of curriculum resources does a group of teachers need for learning to take place? What is their nature, what are the criteria for educative curriculum resources? National policies for the design and use of curriculum resources are starting to take these evolutions into account, in particular by collecting users' comments on websites (e.g., dedicated websites for particular textbooks).

Furthermore, analyzing the quality of available resources, contributing to the design of resources (to be used by students and teachers), and proposing teacher development programs drawing on collaborative resource design and educative resources are important issues, which need to be addressed by research in mathematics education.

## Cross-References


▶ Communities of Inquiry in Mathematics Teacher Education
▶ Communities of Practice in Mathematics Education
▶ Cultural Diversity in Mathematics Education
▶ Design Research in Mathematics Education
▶ Didactic Transposition in Mathematics Education
▶ Documentational Approach to Didactics
▶ Information and Communication Technology (ICT) Affordances in Mathematics Education
▶ Instrumentation in Mathematics Education
▶ Learning Environments in Mathematics Education
▶ Manipulatives in Mathematics Education
▶ Mathematics Teacher Education Organization, Curriculum, and Outcomes
▶ Mathematics Teachers and Curricula
▶ Professional Learning Communities in Mathematics Education
▶ Teaching Practices in Digital Environments
▶ Technology and Curricula in Mathematics Education
▶ Technology Design in Mathematics Education

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