

## STEP FORUM

## Education and Textbooks

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**ABSTRACT:** Education and textbooks have traditionally been standard objects of research in the history of science, technology, and medicine. However, they have often remained marginal in the formulation of large historiographical questions. In the last decades, the work of some historians of science has challenged this state of affairs. STEP has promoted a distinctive focus on education and textbooks, compared to other scholarship cultures such as the Anglo-American. This essay reviews its work in this field and stresses the potential of education and textbooks to produce interdisciplinary research in local, national, and international perspective.

In the contemporary world, a wide array of information and communication technology (ICT) initiatives promoted by for-profit and nonprofit organizations feature educational technologies as the answer to all the ills of so-called underdevelopment. The introduction of computers and ICT in today's education is often presented as a revolution, because they connect with students' growing digital culture, they can potentially contribute to reshaping teaching and learning practices, and they might be able to replace a wide array of previous pedagogical tools, such as blackboards, textbooks, student and teacher notebooks, and laboratories. This utopian message has found adherents in governments that conceive educational reforms as the way to increase their competitiveness in the capitalist world market.<sup>1</sup> As such, it specifies (and proposes to solve) a problem that applies

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1. The preamble to the Education Act implemented in Spain in 2013 stated that "The educational level of citizens determines its ability to compete successfully . . . representing a commitment to economic growth," and that "Information and Communication Technologies will be an essential piece to produce the methodological shift

practically everywhere. However, this problem is particularly relevant for understanding the making of science, technology, and medicine (STM) in national contexts such as those represented by the group STEP (Science and Technology in the European Periphery). In these countries, the teaching of STM has historically occupied an important space in national efforts but has not always translated into internationally leading research. For historians in the periphery of Europe, the study of science, engineering, or medical education has thus been a particularly relevant subject of analysis, whereas other regional and national communities of researchers have tended to favor the study of research or popularization practices.

Social research has shown that technology alone does not guarantee educational improvement, that investment in science education does not automatically lead to increases in technological production and innovation, and that technological growth does not necessarily induce educational expansion and social equality. The standard discourse that connects science, education, technology, and development is characterized by a simplistic technological determinism which is extremely profitable in political terms but is intellectually meager.<sup>2</sup> This discourse has held sway, almost everywhere, since at least the nineteenth-century worldwide expansion of secondary education and science teaching, thus predating the introduction of computers in education.<sup>3</sup> We can find it, for instance, behind the proliferation of physics cabinets and chemistry laboratories in the secondary education institutions created between the nineteenth and twentieth centuries all around Europe and the Americas, and the development of a huge international market that shaped the French, German, and British precision industries in international perspective.<sup>4</sup>

Despite loud claims within the ICT industry, the game is not over for conventional technologies of education such as textbooks, which still have a major role in pedagogical practice nearly everywhere. In spite of being subject to constant criticism, textbooks have been central to education since at least the late eighteenth century. With the power of hindsight, it is thus particularly relevant to examine the role played by the medium of textbooks

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required to improve educational quality” (Jefatura del Estado, “Ley Orgánica 8/2013”). Analogous statements can be found in other countries, e.g.: Barack Obama, “47—Address Before a Joint Session of the Congress on the State of the Union” (USA); Ministerio Nacional de Educación, *Revolución educativa* (Colombia); Gobierno de la República, *Plan Nacional de Desarrollo* (Mexico).

2. María Belén Albornoz, Mónica Bustamante Salamanca, and Javier Jiménez Becerra, *Computadores y cajas negras*, 29–57; Anita Say Chan, *Networking Peripheries*, 173–96; Claudia Goldin and Lawrence F. Katz, *The Race*.

3. Graeme Gooday, “Lies, Damned Lies and Declinism”; Terry Shinn, “The Industry, Research, and Education Nexus”; HELF, *Higher Education Looking Forward*.

4. Josep Simon, José R. Bertomeu-Sánchez, and Antonio García-Belmar, “Nineteenth-Century Scientific Instruments”; José R. Bertomeu Sánchez and Antonio García Belmar, *Abriendo las cajas negras*; P. Brenni, “The Evolution of Teaching Instruments.”

in the making of science and technology education, and the ways this pedagogical tool was conceived, adapted, and transformed in different historical contexts, interacting with other pedagogical technologies in the process.

### Educational Opportunities

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An advantage of textbooks and education as a focus of research for historians of STM is the truly international character of the problems they raise and their richness as sources. Every nation has had an educational and textbook culture regardless of whether it had a flourishing research culture or not. While the history of STM education reveals a number of national contexts that were able to internationalize their textbook production better than others, this does not diminish the relevance of certain local or national textbook cultures over others.<sup>5</sup> Nineteenth-century France, Germany, and Britain and the twentieth-century USA feature prominently in the history of STM due to their contributions to technological, scientific, and medical research. However, the national hierarchies, periodizations, and criteria of relevance commonly applied by historians to research do not necessarily match the study of education and textbooks. Textbooks represent an opportunity to reconsider these national biases, which may not apply to education, nor to research.<sup>6</sup>

The study of textbooks and education cautions us to be wary of the deep embedding of diffusionist ideas, not only in our geopolitical conceptions but also in our most common perceptions of hierarchies in the production of knowledge. The status of textbooks in STM history stands in contrast to the traditional emphasis on the article and treatise, and the incorporation in the last decades of new sources such as laboratory notebooks and popular books and periodicals, which previously enjoyed a similar low standing but recently have become the center of dynamic historiographic developments. The low status of textbooks as source material for the history of STM is connected to knowledge hierarchies that are historically contingent and thus have to be problematized. In this context, the research agenda of STM scholars working on education and textbooks has been particularly shaped by the impact of Thomas Kuhn's *The Structure of Scientific Revolutions*. Kuhn's ideas about education were the received views of his time and prevailed in academic circles. While he attracted attention to the major role of education and textbooks in the making of science, his stress on indoctrination left little room to consider them as creative tools, as more recent educational research has done.<sup>7</sup> Hitherto, scholars have had to live with this

5. Anders Lundgren and Bernadette Bensaude-Vincent, *Communicating Chemistry*; José R. Bertomeu Sánchez et al., "Scientific and Technological Textbooks"; Josep Simon, "Cross-National and Comparative History."

6. Josep Simon, "Cross-National Education."

7. Josep Simon, "Physics Textbooks and Textbook Physics."

paradox when researching the history of textbooks and pedagogical practices.<sup>8</sup> While it is usual to think that knowledge is produced through research and then diffused from top to bottom through education and popularization, the study of textbooks and education has shown that research and teaching are often connected and that education and textbooks also contribute to shaping original knowledge. A new approach is necessary, which would reconsider the status of textbooks and education in the history of STM by promoting further communications between this field, the history of education, book history, and current educational research.<sup>9</sup>

These efforts for interdisciplinary cross-fertilization are in substance not bound to any national context. However, they have been commonly driven by an appreciation of education as a major activity in science—not just a byproduct of research—that has been more usual in the academic cultures of countries having developed state-run educational systems at a national scale in the nineteenth century. Work on education and textbooks developed by scholars based in continental and, in particular, peripheral European countries such as those represented in STEP has often been in contrast, for instance, to a higher prioritization of work on science popularization that has characterized research on British science in the last two decades. In addition, historical research on education and textbooks in the so-called peripheral countries of Europe has often had to focus more on the phenomena of appropriation than on the processes of production, although always emphasizing that the appropriation of scientific or pedagogical knowledge is also knowledge production.

### Cross-National Knowledge

It was between the late eighteenth and the first half of the nineteenth centuries, with the expansion of secondary education, that the textbook rose to prominence. The textbook, a volume or volumes designed for instructional purposes and covering a whole subject in a systematic way, became central in classroom practices and in the organization of education at the national level.<sup>10</sup> The rise of a pedagogy centered on textbooks was not obvious. Teachers had to afford textbooks a place, one that was already occupied by other pedagogical objects associated with well-established teaching and learning practices. Oral and written practices had coexisted in pedagogical spaces for centuries, and the interaction of the two had produced teaching and learning tools that played the role of mediating objects.<sup>11</sup> In

8. Kathryn M. Olesko, “Science Pedagogy”; David Kaiser, *Pedagogy*; Josep Simon, “Textbooks.”

9. John L. Rudolph, “Historical Writing on Science Education.”

10. Bernadette Bensaude-Vincent, Antonio García Belmar, and José R. Bertomeu Sánchez, *L'émergence d'une science des manuels*; Josep Simon, *Communicating Physics*.

11. Françoise Waquet, *Parler comme un livre*.

the decades preceding the nineteenth-century generalization of textbook learning, certain teachers expressed their reservations about having to use a standard textbook written by others, instead of teaching with their own notes, whether in manuscript or print. The practice of note-taking in classrooms has a long history that goes back at least to the early modern period and was kept alive long after the rise of textbooks.<sup>12</sup> Textbooks also had to find their place in the framework of the complex debates about the role and uses of experiments in the teaching and learning of the experimental sciences.<sup>13</sup> Textbooks were new pedagogical technologies, and their adoption was not simple.

As far as any novel technology is concerned, the standardization of textbook-centered education depended heavily on users.<sup>14</sup> By the mid-nineteenth century, however, the production and use of textbooks was already a lucrative business in most countries. Textbooks for secondary education played a major role in the rise of the publishing industry as a capitalist enterprise. The introduction of new technologies of printing, new techniques such as stereotyping, the design of new factories integrating all trades of the book production business, and the establishment of more efficient modes of communication and distribution (such as railway transport) were relevant factors for the expansion of publishing in national and international perspective.<sup>15</sup> But this expansion cannot be fully understood without taking into account the demand created by a new educational context (secondary schooling) developed nationally, including for the first time the teaching of science and technology to mass audiences.<sup>16</sup>

In this context, countries like France and Germany, which had developed large-scale systems of education early, were able to export their textbooks abroad, in their original language or through translations. The international circulation of textbooks often followed the same paths as those of students who traveled to the major STM centers in Europe to complete their training. When returning to their home countries, these students, in collaboration with local, national, and international booksellers, were commonly responsible for the appropriation of foreign textbooks into their local cultures of science, technology, medicine, and education through translation and adaptation.<sup>17</sup>

These phenomena of knowledge production, circulation, and appropriation, which involved teachers, researchers, textbook authors, booksellers, and printers, have often been portrayed as diffusion processes of centers

12. Ann Blair, *Too Much to Know*; Antonio García Belmar and José R. Bertomeu Sánchez, "Palabras de química."

13. Antonio García Belmar, "The Didactic Uses of Experiment."

14. Nelly Oudshoorn and Trevor Pinch, *How Users Matter*.

15. Jean-Yves Mollier, *L'argent et les lettres*; Simon, *Communicating Physics*, 91–170.

16. Bensaude-Vincent, García Belmar, and Bertomeu Sánchez, *L'émergence d'une science des manuels*; Simon, *Communicating Physics*.

17. Ana Simões, Ana Carneiro, and Maria Paula Diogo, *Travels of Learning*.

radiating toward peripheries. However, in spite of the obvious national asymmetries that characterized science, technology, medicine, and education in the nineteenth century, these phenomena were more symmetrical than presumed. The circulation of foreign students through centers of research and teaching such as Paris, Giessen, London, or Edinburgh—to name a few—was part of a larger culture of scientific and educational travels across national borders that played a key role in the making of STM between the eighteenth and nineteenth centuries.<sup>18</sup> The presence of foreign students had a significant impact on the intellectual and material development of the local cultures of science, technology, medicine, and education in those centers. Furthermore, international students had a major role in the shaping of representations of these centers as places embedded with homogeneous qualities characterizing national models of science, technology, medicine, or education. The same applies to the production of textbooks in the broad fields of STM, very often a genuinely international venture, which cannot be grasped by traditional STM history approaches that are constrained by local and national perspectives.<sup>19</sup> Despite the prevailing popularity of homogeneous national pictures, a rigorous analysis of case studies and sophisticated uses of comparative history show that it is rather difficult to make generalizations at a national level.<sup>20</sup> In short, to a certain extent, centers were built at the peripheries.<sup>21</sup>

### Textbook Power

As objects for historical research, textbooks encapsulate a wide range of elements. They embody a course syllabus and a pedagogical and narrative rationale linked to particular institutional and educational contexts, and they are addressed to captive readers. They present a comprehensive picture of a subject. Thus, textbook analysis is a major way to characterize disciplines or professional fields of inquiry. Successful textbooks are regularly reissued to find new customers, since formal education can provide—when based on a textbook-centered pedagogy—a regular supply of purchasers to authors and booksellers. Hence, the study of textbooks allows us to characterize the shaping of whole fields of knowledge over long periods of time. Textbooks are often reissued to meet changes in educational curricula and policy but also in scientific and technological disciplines and in

18. This topic is still largely unexplored. Simões, Carneiro, and Diogo, *Travels of Learning*; Stephan Curtis, “Swedish in Name Only”; Yoshiyuki Kikuchi, “Cross-National Odyssey of a Chemist”; Yoshiyuki Kikuchi, *Anglo-American Connections*.

19. Marika Blondel-Mégrelis, “Berzelius’ Textbook”; Simon, *Communicating Physics*.

20. In spite of recent calls for transnational histories of STM, most research still has a focus that is local and—explicitly or implicitly—embedded within national contexts.

21. Antonio García Belmar and José R. Bertomeu Sánchez, “Constructing the Center from the Periphery”; Simon, “Cross-National Education”; A. J. Angulo, “The Polytechnic Comes to America”; Geert Vanpaemel, “The German Model.”

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medical specialties. Textbooks have a major political role as agents at the crossroads of governments, markets, schools, and communities of STM practitioners, shaping pedagogical and scientific outlooks and cultural and national ideals.<sup>22</sup> These intersecting roles make textbooks powerful, but they also constrain their design and their intended uses through parameters that are distinct from those characterizing other processes of communication such as, for instance, popularization and informal education.<sup>23</sup>

Research on STM textbooks has therefore proceeded in a wide range of avenues: national surveys of textbook publications aimed at defining a discipline and characterizing scientific, technological, or medical practices in local or national contexts; studies on the intersections between teaching and research and between formal education and popularization; inquiries on the role of gender in STM teaching and research; investigations of the use of textbooks as reference works in laboratory and workshop training and as major tools in the shaping of research schools and styles of thinking; research on textbook content discussing the relative importance of theory, practical knowledge, and history within a subject; diachronic analysis of textbooks as indices of the introduction of new ideas and theories; synchronic pictures of the shaping of disciplines in comparative international perspective; critical discussions on the distinctive and creative practices of textbook translation; and exemplary case studies on the role of textbooks in the production of STM knowledge across national borders.<sup>24</sup>

The rise of textbooks in nineteenth-century education might be considered a revolution, because they had a major role in driving the mass production, circulation, and use of print culture, reshaped teaching and learning practices, and complemented and very often ruled over other pedagogical tools, such as blackboards, student and teacher notebooks, and laboratories. These other technologies of education were often subordinated to textbook learning, but they were never completely replaced by textbooks alone. Of course, like any novelty in the mass educational market, textbooks were big business too. Although there were some countries that led the international production of STM textbooks, this was not the exclusive business of economically affluent countries. The production of textbooks and the expansion of education in STM took place practically everywhere in the world.

These historical lessons are surely useful for reevaluating the role that

22. Antonio García Belmar, José R. Bertomeu Sánchez, and Bernadette Bensaude-Vincent, "The Power of Didactic Writings."

23. The diversity of these agents also contributes to defining a variety of sources for the study of education and textbooks such as government reports and laws, school syllabi, authors' correspondence, publishers' archives, pedagogical research publications, exercise books, library and publisher catalogs, readers' response records, student and teacher notebooks, examination copies, teaching collections and their inventories, and teaching visual aids.

24. Simon, "Textbooks."

ICT is playing in today's education and for building a more comprehensive and mature perspective on educational technologies and the relations between science, technology, medicine, and education in international perspective. This will require, however, a deeper and more reflexive consideration of the historical contingency of the epistemological and geopolitical categories commonly used by historians to characterize the making of knowledge. At this stage, asymmetries and differences will not be used merely as markers of historiographical status but, instead, as opportunities for the development of fruitful case studies across social, cultural, and geopolitical scales. Directing our efforts toward producing a more integrative analysis of the design and use of technologies for education can offer relevant benefits for the history of technology. These technological insights would also be able to illuminate other fields, such as the histories of science, medicine, and education, respectively. Moreover, they could have an impact on current practices and future policies of scientific, technological, and medical education.

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