A COMPANION TO THE HISTORY OF SCIENCE

Edited by

Bernard Lightman

WILEY Blackwell

This edition first published 2016

Registered Office
John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial Offices
350 Main Street, Malden, MA 02148-5020, USA
9600 Garsington Road, Oxford, OX4 2DQ, UK
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

For details of our global editorial offices, for customer services, and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell.

Library of Congress Cataloging-in-Publication Data applied for.

HB ISBN: 9781118620779

A catalogue record for this book is available from the British Library.

Cover image: Depiction of the Geo-Heliocentric Universe of Tycho Brahe, 17th century. © Andreas Cellarius/Getty Images.

Set in 10/12pt Galliard by Aptara Inc., New Delhi, India

1 2016

Contents

CHAPTER TWENTY-EIGHT

Textbooks

JOSEP SIMON[1]

Were a visitor from a distant planet on a mission to understand the human art of science to land by chance in the *Zócalo* of Mexico City, she would be astonished in detecting, with her extraordinary cognition, the high concentration of textbooks by a Salvador Mosqueira R. in the homes, schools, libraries, and bookshops of that earthly city.

A brief inspection reveals that Salvador Mosqueira R. was an engineer who developed a prolific career as a science teacher and textbook author in the school network of the National Autonomous University of Mexico. His most successful textbooks, *Física General* (*General Physics*) (1944, 21 editions by 1976) and *Física Elemental* (*Elementary Physics*) (1947, 32 editions by 1980), were published by Patria, a company that still specializes in textbooks today. They were recommended by the Mexican ministry of education and circulated widely in Mexico.

Having prepared for her trip by reading the major human output in the genre of companions, encyclopedias, handbooks, articles, treatises and monographs, research reports, laboratory notebooks, conference proceedings, and grant proposals, our visitor's credulity in her authorities would be shaken in contrasting the extensive circulation of Mosqueira's writings with the absence of any mention to it in the aforementioned reference sources.

Mosqueira's *Física General* included a preface by the first president of the Mexican Physics Society and several appendixes by leading physicists working in Mexico on advanced research topics. He also translated several American textbooks that circulated extensively in Latin America, such as Resnick and Halliday's *Physics for Science and Engineering Students*.

The bewilderment of our visitor would not be lessened in realizing that the status of textbooks in the academic circles formed by humans has often been low, helped by the belief that research is clearly distinct to teaching and definitely more socially prestigious. Mosqueira's case might seem exceptional. In fact it is not. But it is illustrative of the hundreds (if not thousands) of case studies on science textbooks which still await their historian. Why should Mosqueira's textbooks be relevant? Should they

A Companion to the History of Science, First Edition. Edited by Bernard Lightman.

concern historians of science or just historians of education or book historians? Are they worth researching for historians worldwide or just for historians of Mexico or for Latin American historians?

Because of his professional profile (teacher not researcher) and his nationality (Latin American not European or American), Mosqueira is unlikely to have a place in the history of science canonical narrative as it is today. Yet, his pedagogical production was likely to have a major role in the making of physics in a rapidly growing nation state. Furthermore, it displays a historiographical potential to deal with the problems associated with the production, circulation, and appropriation of scientific knowledge, locally, nationally, and internationally. This pattern can be extrapolated to other cases of textbook production and use in science.

Expectations

An advantage of textbooks and education as a focus for research in history of science is the truly international character of the problems they raise and their richness as sources. The study of scientific research is still commonly presented—explicitly or implicitly—as a matter of leading centers with national qualities radiating towards passive peripheries (Simon and Herran 2008). It seems more implausible to think that each country has not had its own science education and textbook cultures, regardless of its performance in international scientific research and its visibility in current history of science. While the history of science education displays a number of national contexts which 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 (Simon 2012).

While nineteenth-century France, Germany, and Britain, and twentieth-century US feature prominently in the history of science, here I argue that the national hierarchies, periodizations, and criteria of relevance commonly applied by historians of science to scientific research do not necessarily match the study of science education and textbooks. Textbooks represent an opportunity to reconsider these national biases which should neither apply so forcefully to science education, nor to scientific research. This would require, though, raising the status of textbooks in the history of science, and fairly suggests the need for promoting further communication between historians of science, education, and book culture, respectively, and science education scholars (Simon 2015).

Historians of science have shown a longstanding interest in textbooks, but it has not resulted in more and better studies displaying significant historiographical and methodological contributions. Textbooks are commonly used as a resourceful tool for their collective multiplicity, but they are more rarely considered in their individuality: they are a vast repertoire of sources providing a sense of what knowledge was standard at a certain time, but not historical objects deserving to be considered on their own and able not only to reflect knowledge, but also to transform it. Textbook science has often been subordinated to research science, as historians have dealt preferably with those textbooks produced by prominent researchers, in order to complete the picture, but seldom to reshape it.

The status of textbooks in the history of science is for obvious reasons in contrast with the traditional emphasis on the scientific article and treatise, and the

incorporation in the last decades of new sources such as laboratory notebooks. But, more paradoxically, the status of sources such as popular books and periodicals, which previously enjoyed a similar low standing but recently have become the center of some of the more dynamic developments in the history of science (Topham 2000). This should be an example to follow, furthered by the connections between *popularization* and *education*, but taking into account their major differences, too (Rudolph 2008; Simon 2009).

The study of science education and textbooks presents also an opportunity to break the traditional disciplinary divisions of training in science, and their projection into history of science. The transversal nature of pedagogy should be able to highlight historiographical problems relevant to all the scientific disciplines and their historical narratives (Kaiser 2005b). An example of such potential is illustrated by the generalized impact of Thomas Kuhn's *The Structure of Scientific Revolutions* across the history of science. Kuhn offered a wide range of case studies across the sciences to illustrate his epistemological proposal (Kuhn 1962). Over the years, his premises on textbooks and science education have efficiently permeated major works in history of science (Brush 1976; Warwick and Kaiser 2005).

Past Tenses

Kuhn's work is obviously a product of its time. It reflects particular developments in physics, education, history and philosophy of science, and politics, which need to be assessed in order to understand its virtues and limitations. It presents ideas on education and textbooks which are not particularly revolutionary, since they were and still are quite common, especially in academic circles. In 1951, in his first Lowell lecture, entitled "Textbook Science and Creative Science," Kuhn already contended that the "structure of knowledge in the textbook" masked "the nature of the creative process" by which knowledge is gained (Simon 2013a). Remarkably, this is not a special characteristic of textbook science, but arguably of most scientific writing (Holmes 1987; Myers 1990).

For Kuhn, a special characteristic of science from the early nineteenth century onwards was that education was conducted through textbooks to an extent unknown in other fields of knowledge. Textbooks presented a surprising uniformity in conceptual structure and only differed in subject matter or pedagogical detail according to their level. Textbook science was the driving agent in the transmission of scientific knowledge through education, and it involved indoctrination. Although this level of systematization was not present before the nineteenth century, works that are customarily characterized as "classics," such as the treatises by Aristotle, Ptolemy, Newton, Franklin, Lavoisier, or Lyell, could play a similar role to textbooks in representing "universally received paradigms" (Kuhn 1963; Kuhn 1962).

More than a decade earlier, George Sarton had issued a programmatic call for a history of science based on "The Study of Early Scientific Textbooks," by which he meant *treatises* published before the nineteenth century that constituted the canonical scientific literature in particular periods (Sarton 1948). His aim was to trace "scientific evolution" by examining the changes in textbook content over time (successive editions) and space (translations). He drew a clear distinction between early textbooks and those produced from the second half of the nineteenth century onwards—too

abundant and incorporating new knowledge too quickly to be relevant for his aims.

Sarton emphasized that "a history of science dealing only with the leaders and scouts gives one a wrong view of the whole procession." But he focused on "classics" such as Lavoisier, Huygens, Newton, Franklin, and Euler. He contended that the success of the most popular textbooks "might be due in part to their mediocrity or to their syncretic and accommodating tendencies," instead of antagonizing their readers as the "more original and independent" authors would do (Sarton 1948, 138, 140).

A decade earlier, Gaston Bachelard had considered that contemporary physics textbooks "offer our children a very socialized and immobilized kind of science which [...] comes to be regarded as *natural*. But is not at all natural." In contrast, in the eighteenth century "science books started from nature" because "pre-scientific thought lives in the world. It is not *regular*, [...] it does not live under orders, like the scientific thought trained in official laboratories and codified in schoolbooks [post-eighteenth-century]" (Bachelard 2002, 34, 38).

Bachelard's, Sarton's, and Kuhn's views were similar in their rather basic distinction between *treatises* and *textbooks*, and their periodization of textbook writing around a nineteenth-century turning point. Bachelard and Kuhn endowed contemporary textbooks with a major role in the making of science. Their conception of textbooks as repositories of *normal science*, characterized by dogmatism and adulteration of research science, established a hierarchy analogous to that outlined by Sarton.

Two of Sarton's ideas are particularly striking today. First, there is his view that modern textbooks are too numerous and too quick in their updating of scientific information to be useful for historians of science. By contrast, in the last decades, historians of science have used large sets of nineteenth and twentieth-century textbooks as faithful indexes of change over long time periods. Furthermore, it is common to assume *à la* Kuhn that there is an important delay in incorporating new science in textbooks: *normal science* resists change, and teaching and textbooks are subsidiary to research and research articles. Second, Sarton's assertion that the most popular textbooks are not necessarily the most representative—also shared by Bachelard—is a rough statement in terms of historical sensitivity and current research on science popularization and reading. Nonetheless, it highlights an extant tension in our discipline concerning the criteria which make a source relevant. Is it its intrinsic qualities, or its historically and historiographically contextual values? Is it the status attained by the author and its work among an academic elite which defines the canon, or is it its quantitative number of readers and their qualitative readings?

Demarcation

The lexicographic definitions of *textbook* commonly include all these nuances. Between the mid-eighteenth and mid-nineteenth centuries, the term emerged in different languages to mean a book originally conceived specially for instructional purposes within formal education. The word had its roots in the previous centuries in which a *text*, whether extracted from the Scriptures or written by an author considered classic, was used by students, leaving spaces between lines to insert comments dictated by the teacher.

The practice of note taking in classrooms has a long and rich history which is still underexplored. These practices often led to the shaping of standard texts for teaching and the production of printed textbooks. Thus, they can illuminate the processes by which knowledge was standardized into a textbook. But they also offer an alternative to understand what actually happened in the classroom by unveiling evidence which is often masked in a printed text, offering data on textbook use in the classroom, or informing on pedagogical practices in contexts where textbooks were not central (Blair 2008; Warwick 2003a; Kaiser 2005a; García-Belmar 2006).

During the nineteenth century, in certain countries, the morphology of textbooks had variations in connection to the stratification of school systems targeting different age readerships and educational pathways, but its core definition was preserved. There were also a range of different terms used to refer to a textbook, which varied across languages, but in general indicated its connection with a *course*, its ad hoc teaching and learning purpose, its provision of the first *elements* of a subject, as an *elementary treatise*, or its *manual* quality as designed to be easily handled by young students. Twentieth-century uses of the word as an adjective have denoted both the quality of the standard or, conversely, of an ordinary stereotype.[2]

Beyond the simplicity of a strictly nominalist interpretation, what matters here is that the major features of a *textbook* are its use in teaching and learning, and its authority. Textbooks might be used preferably by the teacher or by the students, in the classroom, in the library, or at home. Books not originally designed for this purpose might acquire this quality by their use. The authority of textbooks is built upon their central role in teaching. Vice versa, the selection of certain books as textbooks is often based on their authority. This authority can come from various sources: the extensive use of a textbook, the approval given to it by a political, scientific, or educational authority, the marketing ability of its publisher, or the reputation of its author.

When Sarton and Kuhn used the word "classics," they were referring both to the scientific reputation of certain authors and to the place that their work had in the canon defined by their contemporaries and by modern historians of science. But the qualities of being a "classic" are also determined by a longstanding interest in a book among a wide range of readers and among publishers (Fyfe 2002; Olesko 2005; Simon 2009). The large readerships commanded by the school context and the cultural impact of schooling across generations, no doubt can endow certain textbooks with the aforementioned quality. Remarkably, this ambiguous term was used in France, after the Revolution (*livre classique*), to designate secondary school textbooks (Simon 2011). The source of authority for science textbooks is not only scientific or historico-scientific, but also pedagogical.

Scholars often use the term *treatise* for books endowed with scientific authority. These were sometimes used for teaching or even designed for that purpose, so that they can be sometimes designated as *textbooks* too. The distinction is relevant, since there are researchers who wrote textbooks and included their own research in them, while other textbook authors have been practitioners mostly or exclusively focused in teaching and writing. Thus, foundational chemistry textbooks such as Antoine Lavoisier's *Traité de chimie* (1789), Thomas Thomson's *A System of Chemistry* (1802), and Jacob Berzelius' *Lärbok i Kemien* (1808–1818), would be clearly different to Nicolas Deguin's *Cours élémentaire de chimie* (1845), Edward Turner's *Elements of Chemistry* (1827), and Nils Johan Berlin's *Elementar-lärobok i oorganisk kemi* (1857).

Nonetheless, all these authors produced textbooks influential because of their wide readerships, and they were all engaged in shaping their discipline through a combination of teaching and research.

Teaching and research have been commonly two connected activities in the working life of science practitioners, but there is a range of options in textbook writing for which contents and form are equally important. As an introductory, comprehensive, standard, or innovative presentation of a subject, a textbook can have a major impact in the shaping of a scientific discipline and this depends both on scientific and pedagogical factors. Hence, textbook writing has been a major activity in scientific practice, and an important source of prestige for its practitioners. But historians of science have often overlooked it in favor of a perception of status built exclusively upon *journal* or *frontier* science.

Summarizing, textbooks have special characteristics that distinguish them from other books, mainly their use in formal teaching and their pedagogical and scientific authority. Several authors have pinpointed the emergence of the textbook as a genre between the late eighteenth and the mid-nineteenth centuries (Choppin 1992; Bensaude-Vincent, García-Belmar, and Bertomeu 2003). In this period the expansion of national systems of secondary education (including science subjects), and publishers supplying that market, contributed to shape a well-defined product. However, a history of science textbooks should not be limited by this periodization. As long as there were texts having a central role in teaching the sciences (e.g., in medieval universities) research on textbooks could not only illuminate a wide range of disciplines across the sciences, but also contribute to a big picture across time. It is undoubtedly worthwhile to study the readers and readings of such classics as Copernicus' *De Revolutionibus Orbium Coelestium*, which has shown that such an abstruse treatise was used in classrooms (Gingerich 2004). But why not engage in similar terms with more humble but more widely read textbooks such as Sacrobosco's *Tractatus de Sphaera* (Gingerich 1988)? Extensive circulation over time and space are *per se* qualities that contribute to the shaping of a book into a *standard* or a *classic*, although historians of science have traditionally been reluctant to accept textbooks into their canon if their authors did not have credentials elsewhere.

Disciplines

In spite of their potential for historiographical transdisciplinarity, the history of science textbooks have been hitherto written in disciplinary niches. Historians of chemistry have led this endeavor, while historians of physics have produced some major case studies and introduced novel approaches to the study of science pedagogy, and textbook-oriented research is currently starting to surface in the history of biology. These are just a few major examples.

In 1919, the Nobel Prize winner in chemistry Wilhelm Ostwald considered that a history of chemistry textbooks would be valuable to solve contemporary methodological problems in science (Haupt 1987). A few years later, Helène Metzger's *Les doctrines chimiques en France du debut du XVIIe à la fin du XVIIIe siècle* used textbooks as main sources to write a history of (chemical) mentalities. In the 1970s, Owen Hannaway contended that the making of chemistry had taken place fundamentally in classrooms and through textbooks and didactic traditions (Hannaway 1975).

Subsequently, Frederic Holmes argued for the complementarity of teaching and research in chemistry (Holmes 1989). In the 1990s the development of a European research project led to the publication of *Communicating Chemistry* (Lundgren and Bensaude-Vincent 2000), a reference work providing a panoramic view on avenues for research in this field.

This edited collection included a general assessment of the historical value of textbooks (Brooke), and case studies which opened a spectrum of possibilities: surveys and preliminary analysis of sources in national context (García-Belmar and Bertomeu; Lundgren; Palló); attempts to problematize the intersections between textbooks and popular books (Orland; Dolan; Knight); exploratory studies of the relationship between lecture notes and textbooks (Bensaude-Vincent); research on textbooks as gendered literature (Pigeard), as sources of practical training (Nieto-Galan), as major agents in the making of disciplines and new theories (Gavroglu and Simoes; Lind; Kounelis), and the intermingling of pedagogical and investigative innovation (Brooks; Nye); textbook writing as an international enterprise (Blondel-Mégrelis); and textbooks at the intersection of historical and educational agendas (Izquierdo).

This collective effort has continued through a long list of publications on nineteenth-century chemistry textbooks led by García-Belmar, Bertomeu, and Bensaude-Vincent (e.g., 2005), a new international collection (Bertomeu, García-Belmar, Lundgren, and Patiniotis 2006), and *L'émergence d'une science des manuels*, a major work that synthesizes a decade of research (Bensaude-Vincent, García-Belmar, and Bertomeu 2003). This book provided a comprehensive picture of the birth of a genre (the general chemistry textbook) in France between the Revolution and the mid-nineteenth century. It analyzed the readerships of chemistry textbooks, the involvement of the state in promoting and controlling textbook production, the rise of a specialized publishing industry through the expansion of chemistry teaching, the pedagogical and scientific decisions that defined the structure and presentation of chemistry, and the place of experiment, theory, and history in textbooks. This comprehensive survey of chemistry textbook literature included reference to classic authors such as Lavoisier and Antoine-François Fourcroy, but also to unknown writers such as Nicolas Deguin and Alexandre Meissas. A major place in this account is given to Louis-Jacques Thénard's *Traité de chimie élémentaire, théorique et pratique* (1813–1816) as a model for textbook writing in French general chemistry.

Similar surveys have been produced for physics. Gunter Lind examined the physics textbook repertoire in German between the eighteenth and mid-nineteenth centuries, and provided case studies of the textbooks by Christian Wolff, Pieter van Musschenbroek, René-Just Haüy, and Karl Wilhelm Gottlob Kastner, around questions such as mathematization, theory, and experiment (Lind 1992). His account is mainly a history of the foundations of physics through the textbooks, which therefore is close in approach to Metzger's history of chemical mentalities, or John Heilbron's *Elements of Early Modern Physics* (1982). A virtue of these contributions is their broad survey of textbook literature and their conceptual analysis. A drawback is their lack of interest in textbooks *per se*, and their consideration of knowledge as an immaterial entity. A proper problematization of their main sources is lacking, justifying why they used textbooks and not other genres of scientific literature for their histories. A similar pattern is found in pioneering works such as those by Stephen Brush, which used large samples of textbook literature to build big pictures of the emergence of scientific

ideas such as the kinetic theory of gases (Brush 1976). More recent additions, resuming a traditional interest in foundational textbooks in topical areas of contemporary physics, follow a similar path grounded in intellectual history, but influenced, too, by recent developments in the study of science pedagogy (Warwick 2003a; Kaiser 2005a) which have made a major impact in the history of science but little contribution to textbook studies.[3] Overlaying these perspectives is a focus which is mainly disciplinary and only secondarily pedagogical. Textbook research requires a more symmetrical balance between both (Olesko 2006; Simon 2013a).

A relevant case, which illustrates the necessity of a more balanced focus and interdisciplinary approach, is that of Adolphe Ganot's best-selling nineteenth-century physics textbooks. Ganot was a science teacher whose work has in general elicited little interest among historians. But his textbooks became standard during the second half of the nineteenth century as an introduction to physics across primary, secondary, university, and informal education worldwide. The study of the production, circulation, and appropriation of these textbooks highlights the blurry boundaries between medical and science education, and between teaching and research in nineteenth-century culture. A "humble" textbook helps us to historicize the making of physics, as a process driven by practices of school teaching and pedagogical writing, book production and distribution, and studying and reading, shaped by persistent international communication. The resulting picture contributes to challenge the standard disciplinary characterization, periodization, and geography of physics in the commonly held historiographical canon (Simon 2011). Textbooks can, therefore, be fruitfully placed at the center of analysis by emphasizing the creativity of textbook writing and its important role in the fashioning of scientific disciplines, the role of readers and the material culture of the book in the making of knowledge, and the changing boundaries between the sciences, teaching, and research. And historians can resort to approaches that transcend the disciplinary boundaries of fields such as history of science, technology and medicine, history of education, book history, and science education. There is life beyond Kuhn for textbook studies.

But the continuities with Kuhn's work are still important in research on biology textbooks. Here, textbook repertoires have been used as a collective source of *normal science* which allows characterizing standard knowledge, and tracking its changes across time, to determine when certain theories were accepted (Brush 2002; Skopek 2011), to identify key changes in the production and circulation of scientific tools (Hopwood 2015), and, more rarely, to characterize the shaping of specialized areas of research (Park 2008). The originality in this disciplinary field resides mainly in its tackling of the science–religion debates (Ladouceur 2008; Shapiro 2013). More generally, it is well known that textbooks can have a major political role as agents at the crossroad of governments, markets, and schools which shape pedagogical and scientific outlooks and cultural and national ideals (Nelkin 1977; Choppin 1992). This fundamental element, which has produced an enormous international scholarship on history and literature textbooks, for instance, has been rarely dealt with in the history of science.[4] Biology, and in particular, evolution, appears to be an area specially prepared to cover this deficit (Shapiro 2013).

Paradoxically, the study of evolution and natural history, which has been the site of chief developments in the study of book culture within history of science, has scarcely contributed to the study of textbooks and (formal) education. The work of James

Secord characterizes the enormous impact of the introduction of book history in our discipline and its framing in the field of *popularization* studies (Secord 2000). Several authors have exposed the interesting connections between popularization, popular and informal education, formal education, and communication at large (Fleck 1979; Whitley 1985; Topham 1992; Secord 2004; Simon 2009). But the specificities of formal education and textbooks against the several types of popularization and popular books are not always properly acknowledged. This is partly connected to national biases in historiographical traditions.

There are clear differences in how science education and its history are tackled in national context. Broadly, continental European and Latin American historians of science have in general shown interest in the study of formal education and textbooks (Roldán-Vera 2003; Bertomeu et al. 2006; Simon 2013b) coupled with an acknowledgement of the historical relevance of state-run educational initiatives. North American historians have increasingly produced relevant work in this field too (Rudolph 2002; Kohlstedt 2010). In contrast, historians of British science have been particularly reluctant to consider the relevance of formal structures of education for the teaching of science.[5]

The political action of the state in nineteenth-century Britain—especially England—was characterized by a reluctance to intervene in the organization of education which contrasts with other national experiences worldwide. But there were relevant actions in this direction, both through private initiatives and indirect, but substantial, government intervention. Historians of British science have rarely dealt with these historical events. Their primary focus on popularization and informal education has contributed to provide new historiographical tools and approaches, but also to overshadow other relevant historical evidence. By extension, the benefits of the international impact of British scholarship on popularization have contributed to reinforce a problem of disciplinary communication which in fact is international (Simon 2011; Simon 2015).

This state of affairs, historical, but historiographical, disciplinary, and cultural too, is one among several problems that have hindered a more vigorous integration of science textbook studies with those on popularization, and the promotion of a higher status for the former. The quest for a better integration of these two germane but distinct areas would have to deal with the convergence of distinct disciplinary agendas as well. Historians of science have in general focused on universities, as the site where research is produced. Historians of education have prioritized instead the study of primary schooling as the place in which society is built through universal access to education (Simon 2015).

Futures

One way to revitalize science textbook studies would involve addressing major targets at the intersection of history of science, history of education, and book history, and seeking fruitful connections with contemporary research in science education, science and technology studies, science communication, writing studies, discourse analysis, and visual studies. Another obvious avenue would consist in contributing alone to the questions which are central to current history of science as a whole. Although we live in a highly stratified academic world and the history of science has become an

increasingly self-referential discipline, these two options might amount to the same thing.

If a new agenda for the history of science could be built on the premise of blurring the boundaries between the making of science and its communication (Secord 2004), education and textbooks should play a prominent role, as their quantitative and qualitative relevance in the communication of scientific knowledge cannot be ignored. The history of science has moved from a history of scientific thought and political elites, to a field which acknowledges that scientific knowledge is socially, politically, and geographically situated, that it has a material culture (in the laboratory but also in the printing workshop), that lay constituencies play a role in its production, and that its products are subject to market forces. At the crossroads of markets, government, and schooling, textbooks embody all these aspects.

The writing of a textbook involves the demarcation of the boundaries of that knowledge which is considered to constitute the core of a subject and the production of a particular form to communicate it, shaped by pedagogical, scientific, political, and economic aims. These choices are key factors in the formalization of scientific disciplines, which beyond their epistemological and institutional structure, in practice can be defined as "knowledge assembled to be taught" (Olesko 2014; Simon 2011). The production of a textbook involves the work of print technicians and the marketing strategies of publishers whose actions are often not limited to providing a physical container and a shop window, but have a direct impact in the shaping of knowledge (Secord 2000; Simon 2011). Local, regional, and national governments have traditionally been a major force in the shaping of textbook content and form, as textbooks have had for several centuries now a major role in the shaping of the cultural, political, and vocational constitution of the youth in schools (Choppin 1992).

As we move towards considering the role of politics and social judgments in the making of scientific expertise in contemporary societies (Collins and Evans 2007), it is too simple to consider that this process is performed by individuals floating free in a society without past, in which the role of education is restricted to (university)-*accredited expertise*, a bold difference between "doing and knowing," and tacitness as the driving force in knowledge acquisition (Olesko 1993; Olesko 2006). Schooling and learning through textbooks had and still have a major role not only in the making of *interactional expertise*, but largely in the building of the worldviews of citizens, what they know, what they do, what they are. The study of textbooks and their use could have a relevant role in our understanding of how expert knowledge is constituted in society.

Worldviews and the role of state governments in the production and control of textbooks are connected to another traditional agency of schooling: nation building. Although national histories are no longer fashionable in the history of science, research is commonly practiced—implicitly or explicitly—in the framework of the nation (Simon and Herran 2008). The study of textbooks can play a relevant part in problematizing the co-construction of science and the nation, the shaping of national identities in science, or conversely to understand the transformation of the nation by cross-national and transnational phenomena.

Research on science textbooks has shown their fitness to produce comparative and cross-national histories, as enterprises which have often transcended the nation through translation and international collaboration and circulation (Blondel-Mégrelis

2000; Simon 2011; Topham 2011; Gordin 2012). The rise of a capitalist economy of the book with the constitution of large publishing houses in the nineteenth century was driven by the production of textbooks for national and international mass education markets in which the expansion of science teaching had an important role (Mollier 1988; Simon 2011). Many of these publishing firms still exist today.

As history of science tries to move (not without difficulties) towards more global narratives, textbooks have an obvious potential for connecting research in local, regional, national, international, and transnational (but unfortunately not extraterrestrial) contexts, over large periods of time, and through research questions which are central to the nature of scientific practice.

Endnote

1 I am grateful to Pepe Pardo, José R. Bertomeu, and Adriana Minor for their generous reading.

2 There is no point in offering here a detailed historical thesaurus in different languages. I have surveyed, though, English, Spanish, French, and German online lexicographic repositories: *Oxford English Dictionary* (www.oed.com/), *Nuevo Tesoro Lexicográfico de la Lengua Española* (http://buscon.rae.es/ntlle/SrvltGUILoginNtlle), *Le Trésor de la Langue Française Informatisé* (http://atilf.atilf.fr/), CNRTL repository of old dictionaries (http://www.cnrtl.fr/dictionnaires/anciens/), and *Wörterbuchnetz* (http://woerterbuchnetz.de/). Further discussion in Bertomeu, García-Belmar, Lundgren, and Patiniotis (2006).

3 But see in contrast Warwick (2003) and Kaiser (2007).

4 An exception is Rudolph (2002).

5 An illustrative example is Secord (2007).

References

Bachelard, Gaston. 2002[1938]. *The Formation of the Scientific Mind: A Contribution to a Psychoanalysis of Objective Knowledge*. Manchester: Clinamen Press.

Bensaude-Vincent, Bernadette, Antonio García-Belmar, and José Ramón Bertomeu. 2003. *L'émergence d'une science des manuels: les livres de chimie en France (1789–1852)*. Paris: Éditions des archives contemporaines.

Bertomeu, José Ramón, Antonio García-Belmar, Anders Lundgren, and Manolis Patiniotis (eds.) 2006. "Textbooks in the scientific periphery." *Science and Education*, 15: 657–880.

Blair, Ann. 2008. "Student manuscripts and the textbook." In *Scholarly Knowledge: Textbooks in Early Modern Europe*, edited by Emidio Campi, Simone De Angelis, Anja-Sylvia Goeing, and Anthony Grafton, 39–73. Geneva: Librairie Droz.

Blondel-Mégrelis, Marika. 2000. "Berzelius's textbook: In translation and multiple editions, as seen through his correspondence." In *Communicating Chemistry: Textbooks and Their Audiences, 1789–1939*, edited by Anders Lundgren and Bernadette Bensaude-Vincent, 233–54. Canton: Science History Publications.

Brush, Stephen G. 1976. *The Kind of Motion We Call Heat: A History of the Kinetic Theory of Gases in the 19th Century*. Amsterdam: North-Holland Publishing.

Brush, Stephen G. 2002. "How theories became knowledge: Morgan's chromosome theory of heredity in America and Britain." *Journal of the History of Biology*, 35: 471–535.

Choppin, Alain. 1992. *Les manuels scolaires: histoire et actualité*. Paris: Hachette.

Collins, Harry and Robert Evans. 2007. *Rethinking Expertise*. Chicago: University of Chicago Press.
Fleck, Ludwik. 1979[1935]. *Genesis and Development of a Scientific Fact*. Chicago: The University of Chicago Press.
Fyfe, Aileen. 2002. "Publishing and the classics: Paley's *Natural Theology* and the nineteenth-century scientific canon." *Studies in History and Philosophy of Science*, 33: 729–51.
García-Belmar, Antonio. 2006. "The didactic uses of experiment: Louis Jacques Thenard's lectures at the Collège de France." In *Science, Medicine and Crime: Mateu Orfila (1787–1853) and His Times*, edited by José Ramón Bertomeu and Agustí Nieto-Galan, 25–53. Canton: Watson Publishing.
García-Belmar, Antonio, José Ramón Bertomeu, and Bernadette Bensaude-Vincent. 2005. "The power of didactic writings: French chemistry textbooks of the nineteenth century." In *Pedagogy and the Practice of Science. Historical and Contemporary Perspectives*, edited by David Kaiser, 219–51. Cambridge: MIT Press.
Gingerich, Owen. 1988. "Sacrobosco as a textbook." *Journal for the History of Astronomy*, 19: 269–73.
Gingerich, Owen. 2004. *The Book Nobody Read: Chasing the Revolutions of Nicolaus Copernicus*. New York: Walker.
Gordin, Michael. D. 2012. "Translating textbooks: Russian, German, and the language of chemistry." *Isis*, 103: 88–98.
Hannaway, Owen. 1975. *The Chemists and the Word: The Didactic Origins of Chemistry*. Baltimore: The John Hopkins University Press.
Haupt, Bettina. 1987. *Deutschsprachige Chemielehrbücher (1775–1850)*. Stuttgart: Deutscher Apotheker Verlag.
Holmes, Frederic L. 1987. "Scientific writing and scientific discovery." *Isis*, 78: 220–35.
Holmes, Frederic L. 1989. "The complementarity of teaching and research in Liebig's Laboratory." *Osiris*, 5: 121-64.
Hopwood, Nick. 2015. *Haeckel's Embryos: Images, Evolution, and Fraud*. Chicago: University of Chicago Press.
Kaiser, David. 2005a. *Drawing Theories Apart: The Dispersion of Feynman Diagrams in Postwar Physics*. Chicago: The University of Chicago Press.
Kaiser, David. 2005b. "Training and the generalist's vision in the history of science." *Isis*, 96: 244–51.
Kaiser, David. 2007. "Turning physicists into quantum mechanics." *Physics World*, 20(May): 28–33.
Kohlstedt, Sally Gregory. 2010. *Teaching Children Science: Hands-On Nature Study in North America, 1890–1930*. Chicago: University of Chicago Press.
Kuhn, Thomas S. 1962. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.
Kuhn, Thomas S. 1963. "The function of dogma in scientific research." In *Scientific Change*, edited by A. C. Crombie, 347–69. New York: Basic Books.
Ladouceur, Ronald P. 2008. "Ella Thea Smith and the lost history of American high school biology textbooks." *Journal of the History of Biology*, 41: 435–71.
Lind, Gunter. 1992. *Physik im Lehrbuch, 1700–1850. Zur Geschichte der Physik und ihrer Didaktik in Deutschland*. Berlin: Springer-Verlag.
Lundgren, Anders and Bernadette Bensaude-Vincent (eds.) 2000. *Communicating Chemistry: Textbooks and Their Audiences, 1789–1939*. Canton: Science History Publications.
Mollier, Jean-Yves. 1988. *L'argent et les lettres: histoire du capitalisme d'edition, 1880–1920*. Paris: Fayard.
Myers, Greg. 1990. *Writing Biology: Texts in the Social Construction of Scientific Knowledge*. Madison: University of Wisconsin Press.

Nelkin, Dorothy. 1977. *Science Textbook Controversies and the Politics of Equal Time*. Cambridge, MA: MIT Press.

Olesko, Kathryn M. 1993. "Tacit knowledge and school formation." *Osiris*, 8: 16–29

Olesko, Kathryn M. 2005. "The foundations of a canon: Kohlrausch's Practical Physics." In *Pedagogy and the Practice of Science. Historical and Contemporary Perspectives*, edited by David Kaiser, 323–55. Cambridge, MA: MIT Press.

Olesko, Kathryn M. 2006. "Science pedagogy as a category of historical analysis: Past, present, and future." *Science and Education*, 15: 863–80.

Olesko, Kathryn M. 2014. "Science education in the historical study of the sciences." In *International Handbook of Research in History, Philosophy and Science Teaching*, edited by Michael R. Matthews, 1965–90. Amsterdam: Springer Verlag.

Park, Hyung Wook. 2008. "Edmund Vincent Cowdry and the making of gerontology as a multidisciplinary scientific field in the United States." *Journal of the History of Biology*, 41: 529–72.

Roldán Vera, Eugenia. 2003. *The British Book Trade and Spanish American Independence: Education and Knowledge Transmission in Transcontinental Perspective*. Aldershot: Ashgate.

Rudolph, John L. 2002. *Scientists in the Classroom: The Cold War Reconstruction of American Science Education*. New York: Palgrave.

Rudolph, John L. 2008. "Historical writing on science education: A view of the landscape." *Studies in Science Education*, 44: 63–82.

Sarton, George. 1948. "The study of early scientific textbooks." *Isis*, 38: 137–48.

Secord, James A. 2000. *Victorian Sensation: The Extraordinary Publication, Reception, and Secret Authorship of Vestiges of the Natural History of Creation*. Chicago: The University of Chicago Press.

Secord, James A. 2004. "Knowledge in transit." *Isis*, 95: 654–72.

Secord, James A. 2007. "Science." *Journal of Victorian Culture*, 12: 272–6.

Shapiro, Adam R. 2013. *Trying Biology: The Scopes Trial, Textbooks, and the Antievolution Movement in American Schools*. Chicago: University of Chicago Press.

Simon, Josep. 2009. "Circumventing the 'elusive quarries' of popular science: The communication and appropriation of Ganot's physics in nineteenth-century Britain." In *Popularizing Science and Technology in the European Periphery, 1800–2000*, edited by Faidra Papanelopoulou, Agustí Nieto-Galan, and Enrique Perdiguero, 89–114. Aldershot: Ashgate.

Simon, Josep. 2011. *Communicating Physics: The Production, Circulation and Appropriation of Ganot's Textbooks in France and England, 1851–1887*. London: Pickering & Chatto.

Simon, Josep. 2012. "Cross-national education and the making of science, technology and medicine." *History of Science*, 50: 251–6.

Simon, Josep. 2013a. "Physics textbooks and textbook physics in the nineteenth and twentieth century." In *The Oxford Handbook of the History of Physics*, edited by Jed Buchwald and Robert Fox, 651–78. Oxford: Oxford University Press.

Simon, Josep (ed.) 2013b. "Cross-national and comparative history of science education." *Science & Education*, 22: 763–866.

Simon, Josep. 2015. "History of science." In *Encyclopedia of Science Education*, edited by Richard Gunstone, 456–9. Dordrecht: Springer Verlag.

Simon, Josep and Néstor Herran. 2008. "Introduction." In *Beyond Borders: Fresh Perspectives in History of Science*, edited by Josep Simon and Néstor Herran, 1–23. Newcastle: Cambridge Scholars Publishing.

Skopek, Jeffrey M. 2011. "Principles, exemplars, and uses of history in early 20th century genetics." *Studies in History and Philosophy of Biological and Biomedical Sciences*, 42: 210–25.

Topham, Jonathan. 1992. "Science and popular education in the 1830s: The role of the Bridgewater treatises." *British Journal for the History of Science*, 25: 397–430.

Topham, Jonathan. 2000. "Scientific publishing and the reading of science in nineteenth-century Britain: A historiographical survey and guide to sources." *Studies in History and Philosophy of Science*, 31: 559–612.

Topham, Jonathan. 2011. "Science, print, and crossing borders: Importing French science books into Britain, 1789–1815." In *Geographies of Nineteenth Century Science*, edited by David N. Livingstone and Charles W. J. Withers, 311–44. Chicago: University of Chicago Press.

Warwick, Andrew. 2003a. *Masters of Theory: Cambridge and the Rise of Mathematical Physics*. Chicago: Chicago University Press.

Warwick, Andrew. 2003b. "'A very hard nut to crack' or making sense of Maxwell's treatise on electricity and magnetism in mid-Victorian Cambridge." In *Scientific Authorship: Credit and Intellectual Property in Science*, edited by Mario Biagioli and Peter Galison, 133–61. New York: Routledge.

Warwick, Andrew and David Kaiser. 2005. "Conclusion: Kuhn, Foucault, and the power of pedagogy." In *Pedagogy and the Practice of Science. Historical and Contemporary Perspectives*, edited by David Kaiser, 393–409. Cambridge, MA: MIT Press.

Whitley, Richard. 1985. "Knowledge producers and knowledge acquirers: Popularisation as a relation between scientific fields and their publics." In *Expository Science: Forms and Functions of Popularisation*, edited by Terry Shinn and Richard Whitley, 3–30. Dordrecht: D. Reidel.