Chapter 10
Textbooks: A Tool to Support Geosciences Learning

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10.1 Introduction

10.1.1 Textbooks for Earth Science Education

Textbooks are used mainly by students; therefore, ideas should be crystal clear. According to Hedley and John (2000), scientific contents included in textbooks should take into account the following points:

- What are science textbooks publishers doing to choose contents and make teaching easier?
- Is there a single text that can be considered as a standard textbook? If so, when was it published?
- Do students need help when learning or do textbooks attract students?
- Are textbooks different depending on the country where they are published?
- What makes a textbook a success and what role does it play in the dissemination of science?

In this chapter we didn't aim at answering these questions. However, based on Hedley and John (2000), we wonder to what extent the authors are aware of the

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students' needs. Is there any pedagogical intention in those textbooks that provide information in a more systematic way?

Beyond the curricular guidelines defined by the educational policies of each country, the geological content of textbooks can be analyzed from the point of view of a set of key ideas structuring the basic concepts that students and any citizen should be aware of.

We highlight proposals such as the project Earth Science Literacy Principles (2009) (http://www.earthscienceliteracy.org) sponsored by the National Science Foundation and the American Association for the Advancement of Science, as well as the document "Alfabetización en Ciencias de la Tierra" (Pedrinaci et al. 2013) developed by the joint effort of almost all Spanish scientific societies related to geology and teaching.

We can see that the main aim in these textbooks is to promote the knowledge of geosciences, that is, knowledge that allows students to understand the world around them and to take responsible and informed decisions allowing them to act independently and responsibly.

But the truth is that the knowledge of geosciences is clearly of minor interest compared with other natural sciences, although this knowledge is a fundamental part of the scientific culture of citizens and, therefore, of their general knowledge. The lack of references or explicit contents on geosciences does not mean that these are not implicitly present in textbooks.

10.1.2 A Tool to Support Learning, Its Role in the School Environment

Regarding teaching resources, Earth Science together with other sciences has been dominated by textbooks which, according to several studies (Valentin and Lopez-Guerra-Ramos 2013), have been considered the most widely used resources in teaching practices (this is why they are so important in the teaching/learning process).

Based on the activities proposed in textbooks, Occeli and Valeiras (2013) point out an important lack of scientific research, selection and organization of information, and interpretation of results. The small number of experimental activities, lack of group activities, or activities appropriate to students' diversity is also evident in textbooks.

In our particular case, the relevance of these materials is especially significant, as it entails knowledge in compulsory education as well as in teacher training.

10.1.3 Common and Specific Features

In secondary schools, specialist teachers usually teach the different curriculum subjects. In the case of Science, a single science teacher normally teaches the whole science curriculum to 11–14-year-old students (including Biology, Chemistry, and Physics with some elements of Earth Science, Environmental science, and Astronomy). This means these students are normally taught Science by specialists in Biology, Chemistry, and Physics. There is a shortage of science teachers, particularly of Geology teachers; in fact in some schools in Spain, almost all Science is taught by Biology specialists.

As discussed above, it is well known that teachers use textbooks as the most important teaching resource in nonuniversity educational levels, so the manner in which the books present geoscientific contents is a determining factor of subsequent geoscientific education in this educational level.

Textbooks, through their thematic units, present an organized set of contents and establish a sequencing thereof. Modern textbooks provide definitions, descriptions, applications, illustrations, examples, activities, and exercises with the dual function of guiding the action of teachers and constituting a source of reference for students.

In addition to the themes developed in the texts of Geology, it is essential to analyze: the editorial design, illustrations, educational activities, type of exemplification, additional readings, analog models, or experiments.

A textbook is a product arising from the joint work of the authors of the texts, illustrators, photographers, designers, publishers, etc. Its effectiveness in the learning process depends on its quality, rigor, and attractiveness, but also on the methodology to be employed by the teacher.

Textbooks can be an extraordinary vehicle for significant learning of Earth Sciences, but also a source of conceptual or procedural errors to be studied. In practice, the authors, according to their training and experience, propose, summarize, or expand geological contents targeting them to the specific situation of the course. On the other hand, geology contents in geological textbooks for compulsory education is not regularly updated, so new paradigms are included belatedly (as happened, e.g., with plate tectonics), and this is one of the reasons why younger students lag behind in Geosciences.

But these reflections are worthless if we fail to understand that changing the way Geology is taught must have an impact on the methods applied to its teaching (Fermeli et al. 2011, 2012). It is obvious that we must commit to a teaching change aimed toward more active and efficient teaching formulas that involve geology students and teachers in a new learning approach. In this scenario, textbooks have and will have a key role.

10.1.4 Natural Sciences or Biology and Geology: An Usual Marriage of Convenience

Although the knowledge of geosciences is important in all citizens' everyday life, in most countries, Geology does not exist as a separate subject in compulsory education. So there are few specific textbooks of Earth Sciences. Their content is often part of Natural Science or Biology and Geology textbooks. In a context in which geology has a very limited curricular presence and is very often taught by teachers with little geological training, textbooks acquire an even more important role.

Previous investigations show that, at the lower levels, Geology is studied as a discipline included in a generic sciences subject, and a single teacher normally teaches all subjects to one class.

At the intermediate levels, there are two possibilities:

- "Horizontal approach": in countries like Spain and Portugal, the approach is the typical of Natural Sciences, where a subject includes several scientific disciplines: Biology (the most relevant), Geology or Earth Sciences, Chemistry, and Physics.
- "Vertical approach": the case of Greece, where Geology is combined with Geography, which it is closely related to.

Finally, in the higher educational levels of some countries, such as Portugal, there is an important presence of Geology in school curricula of secondary school. But in most countries, the geological concepts are spread over other disciplines they are vaguely related to.

Therefore, Geology is included, indirectly, in other subjects and educational activities such as environmental education. The result is that the reduction of geological subjects in secondary schools plus the significant gaps in the training of teachers who deliver these subjects has a negative effect on education.

In summary, we recommend modifying and updating the contents that make up the current geological textbooks of, at least, secondary schools and the way in which these contents are taught in order to make them more attractive to students. Geosciences should become a separate subject in secondary schools. We are certain that Geology answers questions from the scientific point of view and is not superficial at all. The planet Earth and the changes that have occurred on it over time do not constitute isolated specific facts but instead make up a body of scientific knowledge that should be spread throughout society.

10.2 Overview of the Textbooks from Brazil, Spain, Italy, and Portugal

Recently, we concluded a doctoral research project (Souza 2015) that resulted in the proposal of benchmark procedures related to the processes of production and use of scientific illustrations in textbooks discussing themes related to Earth Sciences. This

Fig. 10.1 Exhibition of textbook collections studied

proposal was supported by the analysis of 119 textbooks (Fig. 10.1) from Brazil, Spain, Italy, and Portugal that included an investigation of the editorial process of these books, based on the analysis of questionnaires completed by 54 editors, authors, and illustrators from the aforementioned countries. The data thus obtained provided us with a general understanding of: (1) the complex editorial process of preparing textbooks, (2) the didactic structure of the works, and (3) the role played by illustrations in educational contexts for Earth Sciences.

The production of a textbook is subject to several factors that, to a large extent, ultimately define the didactic function. One broad factor is the educational structure, including the institutional curriculum grid, established in the country for which the book was created. The presence of certain courses in the curriculum grid can be indicative of how much the system and therefore the government value certain areas of knowledge. Thus, we believe that the presence or absence of specific courses in the study of Earth Sciences reveals the political and strategic decisions taken by different countries regarding the teaching of topics related to this area of knowledge. Table 10.1 shows the courses that address Geosciences in secondary schools in Brazil, Spain, Italy, and Portugal.

In Italy, the Natural Science course includes the scientific areas of Biology, Chemistry, and Earth Sciences. However, each of these areas has specific books, a method that influences the content distribution strategy and the way in which pictures are used. In Portugal's curriculum grid, Geology is offered in conjunction with

Table 10.1 Content-bearing disciplines of Earth Sciences in the countries studied

Secondary education system	Courses
Brazil	Biology
	Physics
	Geography
	Chemistry
Spain	Natural Sciences (ESO[a])
	Biology and Geology (ESO)
	Natural Sciences (ESO)
	Biology and Geology (bachillerato)
	Science for the contemporary world (bachillerato)
Italy	Natural Sciences[b] (science high school).
Portugal	Biology and Geology
	Geology

[a]ESO: Compulsory Secondary Education
[b] Biology, Chemistry, and Earth Sciences

Biology during the first 2 years and separately during the third year. In Brazil, Geoscience topics are studied within nonspecific courses such as Physics, Chemistry, Biology, and Geography. Of the four countries surveyed, Spain is most devoted to teaching Earth Science courses directly, with two courses being taught in compulsory secondary school and three in "bachillerato" for students who choose that course of study.

10.2.1 The Publishing Process: Factors, Phases, and Agents

One finding from the study of Geoscience training in the countries previously mentioned was the predominance of printed textbooks over other tools available for knowledge transfer. This reality is highlighted by a dynamic and competitive market shared by different publishers. While some of the publishers have a long history in textbook publishing, others have appeared in recent decades. In the specific case of Brazil, one factor is the increasing penetration of multinational publishing companies.

Despite the supremacy of printed textbooks over other educational tools, another finding was that the educational environment in these countries requires constant change in textbooks to the extent that a publication only remains commercially attractive for a short time, 3–4 years on average. The legal factors that encourage publishers to make frequent changes in textbooks are regular law changes leading to changes in the educational system, particularly changes in the curriculum grid; the need to add scientific and technological innovations to the content and production processes of some textbooks; the possibility of including new pedagogical theories into the content development process; the requirement to introduce new basic skills; the will to promote linguistic adjustments; the opportunity to perform aesthetic improvements; and the frequent changes in national university entrance examinations, particularly in Brazil. It is obvious that these circumstances determine the publishing process and materially affect the qualitative characteristics of the textbooks produced.

The study of the conditions of textbook production showed that these publications are the result of a complex process involving many professionals focused on specific tasks. The production of Earth Science books was a good example of this process, as Earth Sciences is clearly one of the areas in which most professionals interact. Another finding was that, in most cases, the various professionals involved in the different steps of textbook production do not have the opportunity to communicate, do not participate in the changes made to their work, and do not even have control over those changes.

The textbook editor is responsible for designing the book based on existing law as well as educational, pedagogical, technological, and market requirements. Thus, the editorial management team and the marketing department design the general features of the work without ever losing sight of other textbooks in circulation that show characteristics similar to those defined for the project in question.

Once the design is complete, the guidelines of the educational product are communicated to the editors of each specific area of knowledge. These individuals, together with the graphic designers, are tasked to turn the project design into reality. At this stage, the content of the final work is defined; the textbook's graphical parameters, the project implementation schedule, and a sample chapter are created.

The next step consists in choosing the author or authors responsible for drafting the textual content. This choice, according to some editors, is a very delicate part of the process and is based on essential requirements for those authors: (1) they should be experts in the field of knowledge about which they write, to ensure that the writing is done with all due rigor; (2) they should know how to use a didactic approach appropriate to the target readers' age(s); and (3) they should have the ability to write content that is clear and consistent with current orthographic rules.

Based on the project content and editorial design guidelines, the authors develop the textual content that will be the textbook's backbone. Some editors see the authors' understanding of the editorial guidelines as one of the most complicated parts of the process and report that sometimes multiple meetings are required before the content produced by the author approaches what the editors have in mind.

Once written, the draft is sent to the area editor for correction. At this point, the editor may count on the help of a professional "style corrector," whose job is to detect and correct any grammatical errors and problems in textual organization. One interesting finding of the study was that the editors interviewed mentioned that they frequently do not return the draft to the author after this step. Instead, the editors themselves make the changes they deem necessary, whether those are ensuring that the vocabulary is appropriate for the target audience, simply substituting words to make the text more understandable, or even deeper changes such as including new data or removing data due to the lack of reliable sources demonstrating the data's veracity or adequacy. The editor is also responsible for commissioning illustrations, photographs, charts, graphs, and any other graphic representation required for the work. Such graphical elements are an integral part of Earth Science textbooks. No consensus exists on how to request graphic representations (such requests may occur in written or verbal form), but there is consensus regarding the images produced by the illustrator or photographer – all the image features, such as size, type of illustration, colors used, and image enhancements, are decided and defined by the project executive editor and team.

After receiving the textual content and graphic representations, the executive editor begins the complicated task of making the material submitted fit within the layout prepared for the book, page by page. Once again, the textual content is limited by the number of characters available on the pages allotted to each specific subject, and the space for each image is also predefined by the project's parameters.

Before the volumes are printed, the textual content and related images go through a review process that may be internal or external to the editing company. Thus, unlike academic publications, didactic publications are not subject to strict external reviews. We found this fact puzzling, as didactic publications reach an audience immensely greater than that of academic and scientific articles. After review the volumes are printed. After printing, the textbooks are stored and then distributed to bookstores. At the same time, the sales team works on marketing the books so that they may reach their final destination, the classroom.

The production process described above shows that despite small innovations in each new book, textbooks are generally not designed to be very different from products currently available on the market. The editors interviewed stated that they use existing books as parameters when drafting new projects. This choice explains to some extent the similarity that exists in the aesthetics of textbooks, the uniformity in the geoscientific themes developed, and, quite often, the use of the same or very similar illustrations to represent a conceptual idea.

The European Earth Science textbooks we reviewed have essentially the same didactic structure, which is well balanced in terms of conceptual development, validation of learning exercises, and activities related to theoretical research and practice (i.e., simulations and experiments). Brazilian textbooks, on the other hand, emphasize conceptual development and preparation for university admission examinations (the latter emphasis being indicative of access to higher education). In Brazilian textbooks, practical activities are limited to online surveys. Table 10.2 below provides an overview of the educational structure of the European and Brazilian textbooks examined.

10.2.2 Analysis of Earth Science Textbook Content

The textbook analysis revealed the existence of six types of graphic representations used for the development of geoscientific themes: (1) traditional illustrations (figurative drawings created by an illustrator), (2) maps (cartographic representations),

Table 10.2 Overview of the didactic structure of textbooks in Brazil, Spain, Italy, and Portugal

	Structure of the textbook		
Country	Concept	Exercises	Practical activity
Spain	Texts	Diagnostic Issues	Theoretical research activities involving texts, tables, charts, maps, photographs, schematics, internet, traditional illustrations
Italy	Schemes	Content comprehension exercises (essay questions and multiple choice)	Field activities (observation and practice)
Portugal	Tables	Interdisciplinary Issues that demand associate knowledge of other areas of knowledge	Computer simulations
	Maps	Self-assessment	Practical activities in the laboratory and/or home that require use of different instruments and materials: books, book, computer, rocks, guides, loader-, maps, internet, calculator and easy access materials (bottles, wood, clay…)
	Summaries	Questions in English	
	Illustrations		
	Abstracts		
	Glossaries		
	Texts in English		
Brazil	Texts	Content comprehension exercises (essay questions and multiple choice)	Theoretical research activities involving texts, tables, charts, maps, photographs, schematics, internet, traditional illustrations
	Schemes	Issues of preparation for University (prevalence)	Research and group discussion
	Tables		
	Maps Summaries		
	Illustrations		
	Abstracts		

(3) photographs, (4) schematic representations (schematic models, cycles, processes, phenomena, etc.), (5) reproductions of works of art, and (6) graphics (representation of data, generally numeric, or interrelated variables through lines, vectors, surfaces, etc.).

With that information, we examined a sample of five books to determine the percentage distribution of the use of each type of representation in the development of the ten geoscientific themes (e.g., key ideas) listed by the Spanish geological community in “Alfabetización en Ciencias de La Tierra” (Pedrinaci et al. 2013). These key ideas were described as indispensable to the training of a citizen who is “literate” in Earth Sciences when finishing secondary education. Below we show the content (key ideas) considered essential to secondary education by the geological community of Spain:

- Key Idea 1: the Earth is a complex system where rocks, water, air, and life interact.
- Key Idea 2: the origin of the Earth is linked to the solar system’s origin, and the Earth’s long history is recorded in the materials it is made up of.

- Key Idea 3: the materials of the Earth originate and change continuously.
- Key Idea 4: water and air make the Earth a special planet.
- Key Idea 5: life evolves and interacts with the Earth, resulting in mutual modifications.
- Key Idea 6: plate tectonics is a global theory and an integral part of the Earth.
- Key Idea 7: external geological processes modify the Earth's surface.
- Key Idea 8: mankind depends on planet the Earth for its resources and must handle them in a sustainable way.
- Key Idea 9: some natural processes represent risks to mankind.
- Key Idea 10: scientists interpret and explain the workings of the Earth based on repeated observations and verifiable ideas.

Figure 10.2 presents the distribution of the key ideas for the textbook sample examined. Despite the differences in structure of the educational systems of Spain, Italy, and Portugal, the three systems had one fact in common: they use specific disciplines and books to teach Earth Science topics. The analysis of the distribution of content in each individual collection revealed that each country's collection contained almost all of the key ideas and sub-ideas. This fact indicated a practically homogeneous distribution pattern and use of content that allowed for the analysis of European textbooks as one large group in addition to the analysis by country.

Taking into account the fact that speech analysis allows for multiple ways to read a text/image, analyses must be based on a specific reference. Thus, when faced with a certain form of materiality, whatever its nature, we are actually faced with the reality that this materiality uses as a reference (Ducrot 1984). This concept was significant for the investigation of our subject, since the illustrations in the context of plate tectonics were analyzed according to established concepts from the aforementioned document "Alfabetización en Ciencias de La Tierra."

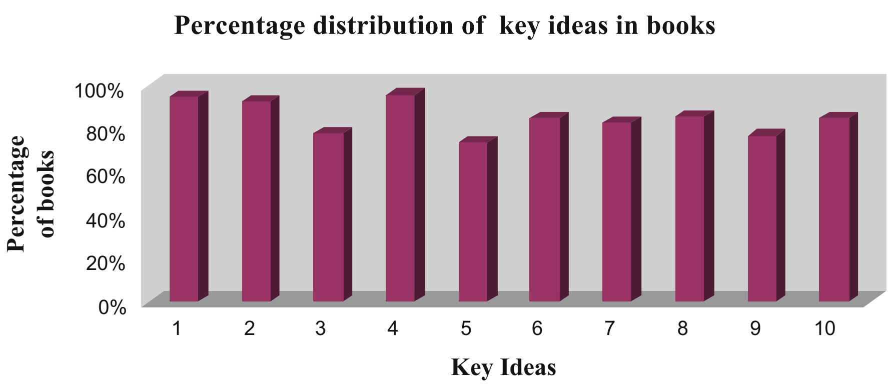

Fig. 10.2 Presence of the key ideas in the sample of books investigated

10.2.3 Illustrations in Geoscience Textbooks in Brazil, Spain, Italy, and Portugal

Contextualizing the phenomena, materials, and complex processes related to the dynamics of the Earth is an arduous task for researchers and professionals involved in developing geoscience textbooks. This process is determined by the specificities of geological phenomena and methods established in an area of study. The wide temporal span (ranging from seconds to millennia) over which events and natural processes are analyzed and the wide spatial spectrum (from micrometric spaces to astronomical scales) over which certain processes are studied are particular features of the study of geosciences that can make contextualization challenging.

How can a textbook represent time, space, and other dimensions in a way appropriate to the epistemology of Earth Sciences? This dilemma is one of the major challenges in this area of knowledge since it requires the use of written content and a significant number of graphic representations. Studies have shown the vital role played by illustrations for the acquisition of scientific concepts (Cassiano 2002) and for the extension of knowledge in certain topics of this kind (Kress and Ogborn 1998; Lemke 1998; Jiménez 1997). On the other hand, a fair amount of research exists that discusses the obstacles associated with using graphic representations in teaching to depict general scientific concepts (Mayer 2001).

The previous discussion highlights the importance of illustrations, both to the structuring of geoscience models and the learning process associated with each of these models. However, we must consider that the creation of textbooks requires formulating and choosing forms of graphic representations that, when associated with textual content, should work according to the epistemology of geosciences. Therefore, we can speculate that the function of such illustrations is strongly related to their conditions of production, which, as already discussed, involve a complex editorial process divided into distinct productive steps, each of which includes the participation of several professionals of different specialties.

Are there any criteria that underpin the choice of the type of graphic representation best suited to the development of a certain theme? Do scientific language and its representation criteria serve as a parameter when preparing illustrations? Which procedures ensure harmony between illustrations and textual content? These are some questions related to the conditions of production of graphic representations that certainly influence its discursive behavior.

10.2.4 Analysis of Illustrations in the Context of Planet Earth's Internal Dynamics

Plate tectonics, considered as a global theory and a central theme in geological studies, has many aspects linked to processes that occur inside planet Earth. How can we describe and represent processes that are not and never will be observable? This question helps us understand why most of the current knowledge about the planet Earth's internal dynamics is bound to the interpretation of graphic representations of various types (including graphics, maps, schematic representations, etc.), all of which require deliberate editorial procedures capable of producing illustrations whose interpretation, in educational contexts, approximates the epistemological references of Earth Sciences.

Thus, using the concepts described in the aforementioned document "Alfabetización en Ciencias de La Tierra" as a reference, we investigated the discursive function of different types of illustrations representing plate tectonics. This analysis revealed a number of inconsistencies, presented in Table 10.3, which were grouped into three main categories: (1) technical/aesthetic issues, (2) problems generated by the use of scientific language, and (3) problems of conceptual misconception inducers.

Based on the discursive analysis of the illustrations, three questionnaires were prepared and made available online that included specific questions for publishers, authors, and illustrators from the countries surveyed.

The main objective of this stage of the study was to study the editorial process of the illustrations through the experience and vision of each of the three major professions involved in the process. Table 10.4 summarizes the three categories of problems identified in the analysis of the questionnaires.

The analysis of how illustrations operate in the context of plate tectonics and the analysis of the questionnaires submitted to publishers, authors, and illustrators provided input that we were able to use to link many of the epistemological distortions, found in the functioning of illustrations, to the problems identified in researching their production conditions, i.e., problems that arise from the complex editorial process for including illustrations. Based on these links and the suggestions provided by the professionals who completed the questionnaires, we created a "best practices" proposal to improve the editorial process of selecting illustrations for use in the educational context of Earth Sciences.

Table 10.5 summarizes the compilation of "best practices" suggestions specifically for the steps of the editorial process. In turn, Table 10.6 categorizes our suggestions on the didactic use of each type of illustration in textbooks that discuss issues related to Earth Sciences.

We believe that if these "best practices" suggestions are implemented, they can contribute to a more precise editorial process and result in illustrations that, when used in educational contexts, may lead to readings (interpretations) that are closer to the epistemology of geosciences. This improvement is essential to ensure that the set of actions that comprise the teaching/learning process is capable of producing, by the end of upper secondary school, students who are literate in Earth Sciences as defined in "Alfabetización en Ciencias de la Tierra."

Table 10.3 Categorization of problems concerning the discursive functioning of the illustrations

Problem	Overview
1. Technical/aesthetic	1.1. The brightness, contrast, and sharpness make it difficult to view what is intended
	1.2. The dimensions of the image do not allow the perception of essential details of illustration
	1.3. The quality of the stroke, color, and shading make it difficult to understand the phenomenon/process
	1.4. Some satellite images or images taken from the web lack good visual definition
	1.5. The lack of 3D perspective makes it difficult for the student to understand the illustration
	1.6. Inadequate choice of type of illustration to represent a phenomenon and/or process
2. Use of the language scientific	2.1. Lack of title
	2.2. Footer with inaccurate data
	2.3. Lack of scale
	2.4. Lack of or incomplete caption
	2.5. Inaccurate dimensions
	2.6. Lack of quote of the illustration in the text
	2.7. Lack of identification of physical quantities related to orthogonal graphics
	2.8. Lack of identification of the units of measurement associated with physical quantities in orthogonal graphics
	2.9. Confusion between physical quantity and unit of measure
	2.10. Lack of resources that enable accurate reading of data in orthogonal graphics
	2.11. Lack of technical information of the work reproduced
	2.12. Scientific conventions in the construction of line graphs are not respected
3. Inducing conceptual misconceptions	3.1. The position and/or angle at which the illustration was generated does not meet expectations generated by the text and/or footer
	3.2. Lack of reference to the illustration in the text
	3.3. Stand-alone illustrations, without any kind of wording (comments, questions, or explanations), that help reading
	3.4. Lack of tools (text box, arrow, magnifying glasses, etc.) that make it easier to read the illustration
	3.5. Text boxes positioned imprecisely
	3.6. Too much information in a single illustration
	3.7. Mix of graphic and image
	3.8. No representation of relative motions
	3.9. Lack of proportionality between parts of the illustration
	3.10. Misuse of iconic symbols
	3.11. Lack of temporal events organization
	3.12. Lack of consistency in the standard illustrations of a single work
	3.13. Illustration that by itself is not able to convey the intended meaning

Table 10.4 Categorization of problems related to the editorial process

Steps	Deficient processes
1. Planning	1.1. Lack of clarity concerning the project objectives
	1.2. Time schedule for project implementation inadequate
	1.3. Insufficient budget for the development of the project
	1.4. The review process of the work is insufficient
2. Implementation	2.1. Limitations due to the layout
	2.2. Technical limitations and insufficient illustrator training
	2.3. Lack of good references and originality for the preparation of illustrations
	2.4. Workflow truncated due to the lack of standardization in the process of producing the illustrations
3. Review	3.1. Deficient communication between the professionals involved in the development of the project
	3.2. Problems related to commissioning the illustrations

Table 10.5 Suggestions of "good practice" for the steps in the publishing process

Steps	Suggestions for "best practice"
1. Planning	1.1. Definition of didactic-pedagogical features of the project
	1.2. Definition of the professional profile of the illustrators from the characteristics of the project
	1.3. Proposed schedule compatible with the needs and proposals of the project
2. Implementation	2.1. Improvement of existing communication channels
	2.2. Improving working conditions and the flow to carry out the project
3. Review	3.1. Considering the crucial role of the author in the process of revision of the work
	3.2. Ensuring that the work is reviewed internally and externally outside the publishing house

10.2.5 New Formats

Progress in information and communications technology made in recent decades has led us to the digital age. Textbooks have not been oblivious to this revolution. Besides the traditional formats of printed textbooks, new electronic formats have broken into the publishing industry in the last 10 years.

The first attempts to use new technologies led to the publication of educational materials in CD format (added as supplements to books or sold separately). These products quickly gave way to digital resources compatible with a wide variety of devices (computers, tablets, smartphones, etc.) that today are offered by most of the publishers.

To simplify the analysis, we can distinguish between two types of formats:

- Electronic textbooks. They are downloadable electronic files designed to be read on a screen. They do not usually provide much more than paper printed versions.

Table 10.6 Suggestions of "good practices" for the use of geoscientific illustrations in textbooks

Illustration type	Suggestions of "good practices" for the use of illustrations
Photos	1.1. Direct image reading through textual commands
	1.2. Ensure that the photograph meets the expectations generated by the text
	1.3. Use of photographs as a complement to other type of graphics
	1.4. Add tools that facilitate reading to photograph
Schematic representations	2.1. Be precise when using additional reading resources (text boxes, dimensions, caption, etc.)
	2.2. Care of aesthetic aspects (brightness, contrast, stroke, color, 3D perspective, etc.)
	2.3. Keep illustrations consistent throughout the work
	2.4. In specific cases, use a scheme as a complement of other types of graphic representation
Graphs	3.1. Direct reading the chart from textual commands
	3.2. Use scientific language standards in the preparation of charts
	3.3. Avoid merging traditional illustration with graphical representations
Maps	4.1. Direct reading the map from textual commands
	4.2. Use language standards in the preparation of cartographic maps
	4.3. Keep maps consistent throughout the work
	4.4. Take care of the conditions of viewing the map, especially in the case of images copied from the web
Traditional illustrations	5.1. Produce illustrations that are easily associated with situations and concrete phenomena
	5.2. Use tools that facilitate the reading of the illustration
	5.3. Avoid illustrations that make fun of natural disasters and risks associated
	5.4. In specific situations, use the traditional illustration as a complement of other graphical representation
Reproduction of works of art	6.1. Use works of art in contexts in which they can be easily associated with situations and concrete phenomena
	6.2. Always provide technical information about the work of art reproduced

However, they offer some advantages over classic textbooks: lower price, immediate availability from any device, and some additional utilities. Among the most common ones, we can cite the search of words, the enlargement of some details, or the existence of web links.

- Multimedia textbooks. They are published products enriched with interactive and multimedia resources. These kinds of support differ from simple electronic versions of textbooks, as they can provide audio, video, activities, exercises, and self-evaluation tests. Multimedia textbooks are based on hypermedia approaches offering links to information that is not necessarily sequential. These products are often not simple textbooks. Many are actually educational platforms or courseware that teachers can customize and modulate at will. Thus, a teacher can change the order of the learning units, create assessment tests, produce his or her own resources, create and assign work for groups of students, etc.

Over the past 5 years, almost all publishers of the countries analyzed (Spain, Italy, Portugal, and Brazil) have included electronic textbooks and multimedia e-books on subjects in geosciences into their catalogue.

It must be admitted that static PDF content from simple e-books provides no advantages, but no one can deny the great flexibility and accessibility of multimedia textbooks over paper-based texts. And yet, some researchers (Woody et al. 2010) argued that e-books were no more appealing to students. However, this perception has probably evolved quickly, and the native digital generation has already changed habits, and multimedia books have improved their attractiveness. Nevertheless, recent studies (Bagarukayo et al. 2012) in undergraduate students claim that no significant differences are observed regarding the interest in the subjects or the ability of solving problems and other skills while using multimedia e-books versus traditional textbooks.

The present reality is that printed textbooks still dominate the educational publishing market in Europe and the USA. Nowadays, digital textbooks represent a small percentage of educational book sales. However, all the studies predict a significant increase in this offer.

It may be that the medium does matter to students. Perhaps what is relevant is that the use of the resources provided by new technologies is a change in the approach of teaching and learning. Teachers have in digital textbooks a much more powerful tool. The educational activities in digital learning environments lead to the figure called "2.0 teacher." Following Manuel Area (2012), it is clear that this new teacher must become, among other things, a manager of digital environments in a "content filter" and a developer of materials using all the resources that the Internet offers us.

Either way, multimedia textbooks are particularly interesting for some aspects of the teaching of Earth Sciences. Even though these new formats are not specific for Geology, not many disciplines can benefit so strongly from the possibility of providing to textbooks real images and videos or display graphics and animations that illustrate materials, morphologies, and processes over time. Apart from digital textbooks, we cannot forget to mention the vast panorama of resources offered by the Internet that are now essential for teaching Earth Sciences: blogs, wikis, news, institutional websites, repositories of videos, movies, podcasts, multimedia presentations, animations, text documents, digital libraries, maps, satellite imagery, aerial photography, apps, etc.

10.3 Solving FAQ on Geoscience Textbooks

FAQs (frequently asked questions) compile the questions and answers of those assumptions that can generate the most common doubts in some contexts. This is probably a good way to summarize some conclusions on textbooks and their use by teachers and students. This approach allows some general considerations and also others that are specific to the Earth Sciences.

10.3.1 How Important Is the Textbook?

90 % of science teachers use the textbook, and its use accounts for 95 % of class time; it is often the textbook that determines the curriculum (Dall'alba et al. 1993). Whatever the format, textbooks are a tool for curricular mediation. Therefore, either developing or choosing a textbook carries a great responsibility.

10.3.2 How Do I Make or Choose the Best Geology Textbook?

Beyond aesthetics, the list of quality indicators for a textbook is very wide. Caldeira (2005) gives us "ten commandments" criteria for evaluating science textbooks. Taking his idea and applying it to the books of Earth Sciences, a good book should:

1. Adapt content and curriculum guidelines concerning content and skills corresponding to the level of education that is necessary with sufficient depth and conceptual breadth.
2. Introduce a treatment in accordance with current knowledge and contain no scientific nor text or illustrations impropriety.
3. Have a logical narrative structure and language that is clear and appropriate for students.
4. Reflect the evolution of scientific knowledge through the use of the history of research in Earth Sciences.
5. Clarify the connections science-technology-society with a strong emphasis on relations with the geological hazards, natural and energetic resources and environmental problems.
6. Promote the removal of alternative conceptions, with special attention to the most common misconceptions regarding the origin of rocks or fossils, the immutability of the relief, the catastrophism, the geological time, the water cycle, the evolution of the species, etc.
7. Contain illustrations (photographs, diagrams, maps, charts, drawings, etc.) consistent with the wording that are properly referenced, clear, and well sized, with adequate figure captions and legends.
8. Integrate diversified activities of experimentation and observation in both classroom and laboratory, as well as in the field, to facilitate a practical approach to concepts and procedural aspects of geology.
9. Include exercises, questions, glossary, related or extension texts, and information of websites or links to multimedia content.
10. Promote students' interest in learning geosciences.

In any case, the most important aspect is to check that the textbook chosen best suits our goals and teaching methodologies.

10.3.3 Why Do Textbooks Change so Often?

Advances in Earth Sciences research are not so fast as to justify a frequent change in textbooks. However, it is clear that the textbooks for the preuniversity levels change from time to time in all subjects. Obviously, the publishing market adapts its offer to curriculum changes that the experts define and are approved by the government. Also, of course, it promotes the publication of new works that collect the most current treatments, new teaching approaches, or design changes. But what is the shelf life of a textbook? It is usually very short. Some have come to speak of "planned obsolescence" of textbooks. In order to correct in part the limited life span of textbooks, some countries have regulated that textbooks and other instructional materials adopted by an institution cannot be replaced by others for a minimum period of 4 years.

Digital books probably have lower production costs and allow introducing changes in an easier way, thus ensuring a longer shelf life.

10.3.4 Should We Study the Book or Study with the Book?

Many teachers use the textbook as the main reference to plan and conduct their classes, select activities or exercises, etc. The usefulness of a textbook, however good it is, will always depend on the use made of it. Del Carmen (2001) points out that the book is "the key element in the educational process and, in most cases, the only reference and working material for teachers and students."

Studying the book, page by page, is of course the simplest way to use it. Studying "with the book" is giving it the role of mere learning counselor. In classes of Earth Sciences, it is essential to go beyond the theoretical treatment and traditional rote. We should aim at a more research-based teaching method that gives a greater weight to posing questions, looking up of textual or multimedia information, experimentation, observation, and description of the materials and processes.

Some authors suggest that the best indicator of how we teach is how we evaluate. "Tell me how you evaluate and I will tell you how you teach and therefore … how your students learn." Whether "studying the book" with "studying with the book," we must ask ourselves how we assess our students' knowledge, skills, and abilities in geosciences.

10.3.5 And What if I Have not Studied Geology?

A great number of teachers who teach subjects of Earth Sciences are not geologists and, having been trained in related disciplines (Biology, Chemistry, Geography, Environmental Sciences, etc.) have received scant geological training. As explained above, in many countries, the geological contents are associated with other disciplines. Although textbooks that reflect the curriculum guidelines develop balanced geoscientist aspects, it is quite common for teachers who do not master them to tend to minimize some of them or even fail to teach them.

We must lose the fear of Geology. Surprisingly, when non-geologists discover the Earth Sciences they can transmit their knowledge to students with extraordinary passion. Beyond the textbook (paper or digital), it is necessary to complement the training through courses, workshops, and field trips and find learning resources to improve our classes. Among them, we highlight the collaborative website Earthlearningidea (www.earthlearningidea.com) where we find ideas (translated into ten languages) designed to become practical resources for teachers and trainers of Science published the Earth.

10.3.6 Books on Paper or Digital Books?

Clearly, one of the advantages of digital textbooks over the paper formats is that they bring us the full potential of multimedia. What we mean by digital textbooks is digital learning environments that go beyond simple PDF versions of their printed counterparts. A good digital textbook should include resources in different digital languages: text, audio, video, pictures or animations, links to websites, self-correcting exercises, etc. For the teaching of Earth Sciences, books with interactive digital resources can be very attractive.

The disadvantages of digital books are as follows:

- It is a product that is still being developed; therefore, there is not much to choose from yet.
- Although this option may appear to have a smaller cost than the printed book, it may require the purchase of reading devices (hardware), software, access and network maintenance, virus control, etc. available to all students in the classroom at home cost.
- It is not clear that students prefer them.

The choice of a digital learning platform necessarily implies that we have to teach how to adapt to new tools and means that ICT offer us.

10.3.7 Can You Study Without a Book?

The book is a working tool but not the only one. Schools and teachers can choose not to follow this path, creating their own training materials to suit the curricular guidelines.

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