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Educational styles and contents of illustrations in Tunisian texts in geology: A critical textbook analysis from the didactic perspective

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Abstract

This paper presents a comparative analysis of two textbooks. The comparisons relate to three topics: earthquakes, biological crises and the formation of mountain ranges. This research falls within the theoretical framework of constructivist teaching and is based on the process of learning. The present approach is based on a methodology founded on indicators that help to identify the educational styles (informative, injunctive, persuasive and participative) of textbooks. Illustrations are also analysed, comparing the scientific message relating to geologic time. Our studies show that the informative style range, which promotes transmission of knowledge as cumulative results, could lead authors to dismiss the real objectives of scientific content. The absence of persuasive and injunctive styles limits scientific dogmatism and breaks with an authoritarian style education. The trend in the new geology curriculum towards using the participative pedagogies remains limited and may not help learners to develop their autonomy in constructing knowledge.

Key words: Didactic, Textbook, Educational styles, Grid of analysis, Illustrations

Introduction

The textbook is a familiar part of the classroom; such a ubiquitous tool that we sometimes forget to consider its nature and its function. We denounce its price and especially its weight, cluttering up satchels and straining generation after generation of students' backs. Currently, students are increasingly agents of their own education and school can provide them with the means to build their own knowledge.

The following analysis of two textbooks will focus primarily on their educational function, asking: What is the quality of these tools? What knowledge is conveyed to learners? However, in our education system, it is recognized that textbooks conform to the formal curriculum. The textbooks examined deal with natural phenomena taught to students: earthquakes, formation of mountain ranges and biological crises.

There has been extensive research on textbooks (Grosbois & al., 1992; Baalmann et al., 1996; Perrier, 1997; Abrougui & al., 2006; Boughanmi, 2007); however, this study is concerned with research related to the node concept: geological time. It is very interesting to take into account the sense that this takes on when joined to other concepts.

Abrougui & al. (2006) and Mouelhi (2007) have worked on program analysis, the conceptual approach inherent to the textbook, the study of images (or illustrations) and content or narrative examples. What types of content are treated fairly in geology and biology textbooks? We chose a textbook for the second secondary year (students aged 15-16) and a textbook for the third year (students aged 16-17) in experimental sciences because we teach more geology then biology in this level. To relate our analysis to the general question about the role of geologic time in understanding natural phenomena, we also chose only some subsections in which notions and concepts are treated, illustrated or explained.

As the approach is didactic, a portion of the textbook and its scientific content will be analysed. However, given the rapid development of information technologies and communication, it is important to consider the future of the textbook: its form and content. This investigation aims to categorise how notions and concepts are presented through analysing different messages conveyed by teaching-learning life and earth sciences. This study will focus on how notions and concepts of geologic time and geological space are treated in two Tunisian textbooks. In the process of these theoretical and methodological investigations, it was discovered that the concept of geological time is imperfectly understood in students' explanations of natural phenomena. Since 1968, there has been major progress in scientific knowledge relating to the global tectonic context, which has led to a better understanding of the earth. After presenting the chapters to be investigated, their content and images will be analysed. This will be followed by the analysis of the research problem in a return to the theoretical framework of problematization, followed by a critical constructivist reflection on the textbook.

Sections analysed

It will not be possible to analyse all aspects of the two textbooks examined here. This paper will therefore examine a few subsections that focus on the three phenomena mentioned earlier. These subsections are:

- Second year textbook (T1): geology section
- Third year textbook in experimental sciences (T2): geology section, noting that the biological crises are a part of this section.

The analysis is primarily critical, but will also verify the conformity between the textbook and the official curriculum.

The geological section includes, inter alia, the natural phenomena, earthquakes, formation of mountains and biological crises. As mentioned above, these phenomena were taught to students in the second year of high school during the academic year 2004-2005. The same section was transferred to a higher level that is taught as part of the third year experimental sciences curriculum during the academic year 2006-2007. In the past, the topic of biological crises was not included in the high school curriculum. Recently, the topic of biological crises has been included in the textbook for third year experimental sciences. The two geological sections are analysed in order to compare the textbooks.

Topics analysed

The choice of topics depends on the research problem. This research is focussed on the spatial and temporal dimension and its role in understanding certain geological phenomena: earthquakes, formation of mountain and biological crises. However, given the relationship between the two disciplines of geology and biology, the most important topic has been chosen. Topics were analysed through analysis grids. The explanations concerning earthquakes and the formation of mountain ranges depend on plate tectonic theory. The study of biological crises links biology and geology. In a broader context, life, the earth, time and space are key scientific concepts in this analysis. The various subjects treated in the geology section are given in the following table.

Table 1: Pages analysed in second year textbook

Topic	Geological phenomena	Chapters, sections or paragraphs
The earth's structure	Earthquakes	Work in progress Understand Test our achievements
Plate tectonics	Formation of mountains	Work in progress Understand Test our achievements Stratigraphic scale
	Biological crises	Not taught at this level

Each chapter deals with a problem-situation presented to students and teachers. The analysis of each situation-problem is assumed to be a significant contribution to understanding the construction of problems in life and earth sciences. It will, therefore, study each situation-problem as a didactic concept impregnated with epistemological reflections. In the second year textbook, each chapter includes the section 'work in progress' (Table 2) with questions to which students and teachers discover the answers gradually. What is the difference between dealing with 'work in progress' or a 'problem-situation'?

Each textbook chapter is divided into sections headed: 'Reflection', 'Understanding', 'Test our achievements' and 'Information'. Some of the scientific questions posed may not be within students' reach and may not be understood by students even after studying the whole chapter. Teachers may know the answers, but the purpose of these questions is to engage students in scientific inquiry and thinking. When beginning the chapter, most students could not give an outline response to a question such as: "What is the internal structure of the earth?" The 'Understanding' section is devoted to scientific explanations using texts and illustrations. These will be analysed later in this paper. The 'Test our achievements' section contains exercises.

Table 2: Pages analysed in third year textbook

Topic	**Geologic phenomena**	**Chapters, sections or paragraphs**
Dynamic earth and biological evolution	**Geological scales**	The geological timetable How to date fossils
	Earthquakes	Seismology, an investigative tool The oceanic expansion, a particular seismicity The theory of tectonics to explain earthquakes, volcano distribution Plate tectonics cause of seismic and volcanic activity
	Formation of mountain ranges	Plate tectonics to explain the formation of mountain ranges Tunisian Atlas Orogeny of Tunisian Atlas
	Biological crises	Biological evolution marked by periods of crisis A mysterious disappearance The relationship between biological evolution and geological evolution

The organisation of the third year experimental science textbook differs from the second year textbook. There are an increased number of sections: Objectives, Problem-situation, Prerequisites, Activities, Synthesis, Exercises and Research. It is important to note this hierarchical organisation even if the usefulness of certain elements is doubted. If the aim is to develop students' autonomy in the explanation of natural phenomena, it could be questioned why the research elements should be placed at the chapter's end. Using the available tools (geological maps, media and magazines, the Internet) to

research a particular topic, even before starting, could allow students to understand more easily in class. This work would be considered a prerequisite and therefore this prerequisite section could be placed before 'Problem-situation'. It remains to be seen whether it is really a situation-problem and not a mere 'mode'. The following analysis will provide some answers. In the second textbook, the majority of the illustrations are in colour.

From this brief overview, this analysis will use a grid to focus on the content of each textbook (text and illustrations) while limiting the analysis to geology sections relating to the principal question of our research. How is time used to explain natural phenomena?

Methodology and analytical grid

The analytical grid is a set of criteria on which this analysis is based. It responds to different criteria for analysis of textbook contents. The analytical framework outlined above will be adapted to the objectives of this paper. The purpose of the grid is to describe the textbook, to assess its level of compliance with curricula, and to formulate a decision on the quality of the scientific content. The analytical framework used was developed by BIOHEAD CITIZEN[1]. The collective grid was developed and approved in Algeria and Malta. It was developed for use in environmental and health education, but was later simplified to be applicable to other subjects, such as sexual education. For the purposes of this research, we have adapted the grid to the geology topic.

Educational style grid

Prudent use of this grid for each topic (environmental education, health education, sexual education) is essential when the aim of education is to change the learner's attitude. It is not always easy to envision what a learner thinks. This investigation will aim to apply the grid to scientific contents, but the role of geology plays in society cannot be denied. The grid hinges on a technical identification of different educational styles; it is thus constructed to identify types of approaches advocated by textbook publishers or authors. This analysis will be limited to the authors' approaches in each textbook; further work may examine the use of the textbook by students and teachers. The grid distinguishes four educational styles for categorising textual content. Each sentence in a text can be referenced to one of the following styles depending on the degree of information, participation and problematization. The styles and their educational indicators, as formulated by Abrougui, Abdelli & al. (2007), are outlined below, taking into account the specific topics covered in this paper.

Informative style

[1] European research project involving 19 countries Biohead-Citizen, Biology, Health and Environmental Education for better Citizenship, (STREP CIT2-CT-2004-506015, EC, Brussels, FP6, Priority 7), coordinated by Graça Carvalho (Portugal), Pierre Clement (France) and Franz Bogner (Germany).

Sentences provide information only: data and facts. There is no problematization, no demand for reflection, no inquiry focus.

Injunctive style

Sentences have an injunctive or imperative style, for example: “You must do this…, this way, because science shows…”. The message or style used is informative, with instructions or guidelines to be applied. The information transmitted is dogmatic. The aim of this approach is to transmit as much knowledge as possible. The problematization may be present in the textbook, but solutions are imposed without scientific arguments and discussion.

Persuasive style

These sentences provide solutions in qualifying language (using the conditional, presenting different arguments), for example: “You can conclude…; you need to do this…; Note the advantages of this solution or accept the disadvantages if you choose that solution.”

In this case, the problematization is obviously present, along with an argument that may focus on one specific solution and an emphatic suggestion for proposed actions, which also serve as a justification.

Participative style

These sentences include several points of view or several solutions. They lead students to ask questions, to express their own ideas. In this style, problematization is almost always present and is sometimes discovered by the students themselves. It may lead to a discussion or debate in a class in which the most positive outcome action would be chosen and prepared by the students. For each phenomenon (earthquakes, formation of mountain ranges or biological crises), the relative importance of each educational approach will be analysed. It will be noted that in most cases the style is Informative (A). When it is not (A), accurate citations, arguments or illustrations will be provided.

To simplify the use of the grid, Abdelli & al. (2007) have summarised educational styles, as shown in the following table.

Table 3: Grid of educational styles and their indicators

Educational style	Style and Sentence Structure
Informative (A)	**Descriptive, informative**
	Phrases with facts, data
Injunctive (B)	**Imperative, injunctive**
	“You must do this… or do that… Because that is the way, because that is how… because science shows…, because religion says that…”
Persuasive (C)	**Persuasive**
	“You can conclude this… You should do this… or do this… ” “There are advantages to this solution.” or “There are serious drawbacks in not choosing this solution.”

Participative (D)	**Participative**
	Presenting several points of view. Several solutions are proposed. Asks for the ideas of students, their suggestions

Educational styles in the second year textbook

As explained earlier, the contents of the textbooks have been examined in order to identify and locate styles B, C and D, giving examples and citations. The rest of the content will be considered Type A.

Table 4: Educational styles in 2nd year textbook

Educational style	Significant quotes, examples, arguments, illustrations
(A)	The rest of the content
(B)	p. 44 - What is the internal structure of the world? - How could this be clarified? - What can be deducted? - Table 1: what can be deducted? - Table 2: what can be deducted? p. 47 exercises 1 (see, what do you think, what can we conclude)
(C)	p. 50: exercise 2 (graph, calculate the speed of the wave) p. 53: Questions + images: - The distribution of continents and oceans: is it stable or changing? - How can … be explained? - How are mountain ranges formed?
(D)	p. 64-66 Exercise 1: Geological information that can be drawn regarding the merits of the South Atlantic. Exercise 2: Explain the movement of the four plates shown Exercise 3: Analyse this profile. Describe the structure of rift?

Of twenty-four pages analysed, fifteen contain some type of scientific information; a transmission of knowledge without any incentive for reflection. These are mostly definitions, explanations of scientific concepts, and analysis illustrations. In most cases, scientific knowledge is given in the form of results. The presence of the two educational styles - injunctive and persuasive- provides and opportunity for science based inquiry. Limiting these kinds of styles in the manual avoids the obligation of the user manual to be locked in the interest of textbook authors. The fact that science is true and irrefutable should not be transposed as a combination of results in the textbook.

The authors are trying to develop a participatory style with images, tables and/or explanatory text, followed by questions of interpretation or deduction from application exercises. Usually, the questions deal with interpretation of a geological map. We are not sure that students will be able to remove elements of answers after the course.

Broadly speaking, the informative style overrides other educational styles. The textbook seems to be for the teacher and not for pupils. The transmissive speech limits the

development of creative scientific inquiry among sstudents. Scientific knowledge taught in the form of information and cumulative results dictated to the student does not develop their autonomy, agency and critical thinking – a key aspect of scientific thinking.

Educational styles in the third year textbook

What types of educational styles are promoted after the reforms made in the program? Note also that, although the subject has not changed, the age of the targeted students has. In addition, biological evolution was added to the curriculum. Previously, it was not taught at any level. As note above, this chapter was a gapin the life and earth sciences curriculum. Therefore if nowadays, the subject is taught, in which educational styles have the authors of the curriculum chosen to present it?

The analysis below is presented in three tables. What types of educational styles are favoured after the reform? In the following tables the privileged educational styles are summarised. We can't put in the table all examples that we find so limit it to a few data.

Table 5: Educational styles in third year textbook (pp. 274-295)

Style	Significant quotes, examples, arguments, illustrations
(A)	The rest of the content
(B)	p. 279: activity: + text illustrations - Locate in document 6 the epicentre and the hypocentre. p. 284: activity: curve Draw conclusions on the structure of the earth. p. 285: activity: doc 17 - Appoint document from different parts of the mantle. p. 286-287: Activity - Analyse, show clear... - How can we explain that among all circles of the earth, only the outer core is in liquid? p. 290-291: activity: + chart patterns - From the document, indicate the chemical composition of the mantle.
(C)	- Propose a hypothesis explaining the birth of these waves. p. 281: activity: curve - What can we deduce? p. 281: activity: curve - Propose a hypothesis to explain these sudden changes.
(D)	p. 278: problem-situation p. 295: Exercises

The following table summarises the privileged educational styles in the chapter on plate tectonics.

Table 6: Educational styles in third year textbook (pp. 296-325)

Style	**Significant quotes, examples, arguments, illustrations**
(A)	Remainder of content
(B)	p. 300: activity: 9-12 + patterns portrait of Wegener - Indicate the composition of Gondwana.

	- Geographical: What evidence can be used to try to validate this theory? p. 301: activity: geological map texts + distribution patterns of fossils in Africa and America - Less evidence for the theory of continental drift p. 303: activity: drawings, texts What relationship can be drawn between the expansion of oceanic and continental drift? p. 306: Summary of activities: Write a summary of the expanding ocean (mechanism and evidence) theory proposed by Harry Hess (in the 40s).
(C)	p. 304: activity: cutting board + - Propose a hypothesis explaining the variation in thickness of the sea floor. - Write a summary that explains the formation of the Tunisian Atlas.
(D)	p. 297: problem-situation p. 325: exercises

The following table provides an analysis on the textual dynamics of the earth and biological evolution. This part is added to the program of the third year experimental sciences in 2006. It was previously taught at any grade level.

Table 7: Educational styles in the 3rd year textbook (pp. 326-349)

Style	**Citations significatives, exemples, arguments, illustrations**
(A)	Remainder of content
(B)	p. 330: text + patterns - Using your knowledge of genetics, discuss both theories presented. p. 331: + patterns information Compare Ichtyostéga fish and amphibians. p. 334: Compare the degree of kinship between mammals. p. 336: + texts curves By the exploitation of documents, link the content of oxygen in the atmosphere and the variation of biomass
(C)	p. 335: patterns of continents during the primary era + patterns habitats of old red sandstone Explain how the movement of continents as a result of plate tectonics has an effect on biological evolution: the separation of the continents fosters increased biodiversity and reduced assembly biodiversity. p. 337: + text document Formulate a hypothesis to explain the observed peak of iridium layer of black clay at the end of the Cretaceous. p. 341: + text documents Propose a hypothesis for the extinction of dinosaurs. p. 342: + text documents Offer hypotheses to explain the extinction of plants and the origin of fossil coal.
(D)	p. 327: problem-situation, p. 347: exercises, p. 349: research

Styles B and C (injunctions and persuasive) are prevalent in the third year experimental sciences textbook, in the form of suggestions provided to learners. The informative style dominates the pages analysed. The tendency to give more participatory style scale has resulted in the multiplicity of activities offered to readers and particularly to students. The activities presented involve more styles and persuasive injunctions and offers the students some chance for self-reflection. The participatory style was also more evident

in this new program; each chapter begins with at least one-problem situation. There are also exercises at the end of each chapter and a chapter search. This shows the willingness of the authors to further engage the learner in the process of acquiring knowledge.

Comparative analysis of preferred educational styles

The following table compares the styles of the two educational textbooks.

Table 8: Comparison of preferred styles in the textbooks

Educational style	Textbook 1 (T1)	Textbook 2 (T2)
(A)	Dominant	Not dominant
(B)	Present	Present
(C)	Present	Present
(D)	Not much present	Not much present

The informative style most dominant in the themes analysed; however, this dominance is reduced in the third year experimental sciences textbook. The participatory style used in Textbook 1 (T1) is more evident in Textbook 2 (T2). The injunctive and persuasive styles are still present in T2. However, it is important to note the effort to proliferate activities for learners. By the second year, these activities are summarised in a few sentences. In the new program, it appears that the authors are aware of the role of student autonomy in knowledge building. Nevertheless, the participatory style remains weak in other Tunisian textbooks (Abrougui & al., 2007). It would be attractive to encourage more students in the development and construction of their own knowledge, and to limit transmission. However, transmission always reappears in the informative style. Are there other methods for presenting science than cumulative results?

The transition from the predominance of the informative style to the participative style in the new geology topic, and the absence of other styles, reflects an orientation toward problematization and a tendency to promote student autonomy and reflection. It seems that the author's initiative in the textbook engages students in the teaching-learning activity. However, the predominance of the informative style reflects the conception of the transmission of combined scientific findings, and does not develop the pleasure of invention in the learner. It is important to note that encouragement of participation in activities is needed (especially in T2), but sometimes such activities result in a solution and not necessarily in autonomy of reflection and explanation.

The analysis presented in this paper is informed by a constructivist approach, which involves the construction of a scientific problem by the learner. It is regrettable to see that the informative style overrides other styles in activities designed for students. The emergence of the didactic concept of the 'problem-situation' in T2 favours the trend toward a participative style. Nevertheless, it is not enough to simply promote the

participative style, as is done remarkably well in the textbook; it is also necessary to engage the learner in problematization.

Analysis

The study of the curriculum reform and textbook content reveals that authors are convinced of the usefulness of student participation and autonomy in the development of knowledge. However, as this analysis shows, this awareness is limited to developing knowledge text. The use of the educational styles grid has shown that lessons do not seem to be problematized or directed towards facilitating learners to critique scientific content and problematize their own knowledge. The implementation of activities (informative style and participative style) in the curriculum is important in the process of the acquisition of knowledge. However, these activities remain largely focused on scientific content and geology appears to be divorced from its socio-economic context. For example, there did not seem to be any importance given, in either of the textbooks, to the prediction of earthquakes.

Analysis of illustrations

This analysis takes into account all the illustrations in both textbooks, using a typology of images based on construction process and message content (Bardin, 1993; Clement, 1996; Mottet & al., 1995; Mottet, 1996). This will include an analysis of the nature of the illustrations, the types of illustration that dominate, the degree of abstraction of various illustrations, and the messages conveyed by these images.

Examples and explanations

Following the study of key concepts and textbook illustrations, there is a focus, through a more detailed analysis of the entire corpus, on the types of examples and explanations used by the authors. To do so, a system of classification has been developed, in the attempt to answer the following questions:

- What kinds of examples are dominant?
- What is the nature of the explanations given for each example?
- What are the messages implied through the examples and explicative models chosen?
- What are the messages conveyed by the illustrations?

The methodology of biological image types (Abdelli & al., 2007) has been adapted to the geological and biological context of this project.

Illustrations from both textbooks related to the theme of geology will be analysed, using the grid developed by Abrougui & al. (2006), while effecting changes related to the specific nature of geology images. Two image types were selected for this analysis:

Images classified by their construction process

Bertin (1975), Clement & al. (2007) have identified two kinds of images: graphic images and figurative images. Abdelli, Abrougui & Clement (2008) notes that graphic images give form to existing data or interpretations: equations, experimental results, models and other conceptualisations. Figurative images, conversely, have a direct relationship with the objects or phenomena interpreted, even though the relationship involves more or less sophisticated equipment, with transcoding signals in a wide variety of iconic signs.
Sub-categories (Abdelli & al., 2007) will be used for the analysis of images and to reformulate definitions according to the specific message of the geological image.

Graphic images

The classification of images in this category is based on the nature of the data used to build them. Note that there is a distinction between two sub-categories:

- Empirical data images: tables, histograms, curves, geological maps
- Scientific conceptualisation images: non-figurative pictures or diagrams (seismograms, structural, geological model of the earth)

Figurative images

As Abdelli & al. (2007) claims, figurative images are linked either to visual areas (coding iconic visual signals) or to areas not visually transcoded (transcoding iconics by processing signals in a wide variety of visual signals). Included in this category are:

- Macroscopic images (eye, photos, satellite photos, films, X-rays, ultra-sounds)
- Microscopic Images (optical microscope, electronic microscope). For these images, specifically those illustrated by photographs or diagrams and drawings.

Images classified according to the content of their message

In addition to the process of image construction, image content will also be analysed. First, what each illustration represents will be specified; then, a few categories that seemed, a priori, relevant will be identified:

- Images representing or associated with geological time
- Images representative or dealing with geological phenomena
- Images of extinct species

The role of the image in explaining geological phenomena will also be investigated, by questioning:

- Whether or not the image represents geological time
- Whether the image explains a theoretical geological concept

- Whether it connects time and space in explaining natural phenomena

Table 9: types of illustrations in second year textbook

Scientific conceptions / **Image type**			**Included illustrations**						**Total** (24 pages analysed) (area analysed 12720 cm ²)		
			Geological Time (representative or not of geologic time)		**Geological space** (two dimensions, three dimensions)		**Theory** (explanation of a phenomenon or a geological event)				
			Number	Surface ($cm^{2)}$	Number	Surface ($cm^{2)}$	Number	Surface ($cm^{2)}$	Number	Surface ($cm^{2)}$	Surface (%)
Figurative Images	**Macroscopic**	**Photo**			1	243.1	7	580.55	8	823.65	6.47%
		Diagram or drawing									
	Microscopic	**Photo**									
		Diagram or drawing									
Graphic images	Diagram or non-figurative image		5	231.43			20	862.09	25	1093.52	8.59%
	Empirical data (table, graph, curve, map, scale)		1	147	5	487.32	15	644.1	21	1278.42	10.05%
Total		Number	6		6		42		**54**		
		Surface ($cm^{2)}$		378.43		730.42		2086.74		**3195.59**	
		Surface (%)		2.97%		5.74%		16.4%			**25.11%**

A quarter of the total pages analysed are devoted to illustrations. Macroscopic figurative images include mainly photos; these account for 6.47% of the illustrations. These images represent images such as volcanoes erupting, a house destroyed by an earthquake, a satellite photo of the planet earth, photos of scientists (Wegener, Le Pichon). Microscopic patterns do not appear in this textbook except for crystallography images. Graphic images represent 18.64% of the total pages analysed; 8.59% are diagrams or non-figurative images and about 10% provide empirical data (tables, graphs, curves, geological maps). In terms of content and illustrations of what essentially concerns this research problem, namely the usefulness of spatial and temporal concepts in the teaching-learning of geology, the number of illustrations is minimal. Six images contain at least one concept that refers to the notion of geological time. Six images also highlight space in geology. The authors seem to give more importance to the illustrations used to explain geological phenomena. It seems the authors do not consider the concepts ‘time’ and ‘space’ to be of paramount importance. The following section will analyse the third year textbook in terms of its illustrations.

Table 10: Types of illustrations in third year textbook

Scientific message / **Kinds of Images**			**Included illustrations**						**Total** (75 pages analysed) (area analysed 39750 cm ²)		
			Geological time (representative or not of geologic time)		**Geological space** (bi-dimensional map)		**Theory** (explanation of a phenomenon or a geological event)				
			Number	Surface ($cm^{2)}$	Number	Surface ($cm^{2)}$	Number	Surface ($cm^{2)}$	Number	Surface ($cm^{2)}$	Surface (%)
Figurative Images	**Macroscopic**	Photo					38	1781.48	38	1781.48	4.48%
		Diagram or drawing	1	72.9			4	382.6	5	455.5	1.14%
	Microscopic	Photo					1	179.2	1	179.2	0.45%
		Diagram or drawing									
Graphic Images	diagram or non-figurative image		12	1623.79	2	182.4	31	2931.35	45	4737.54	11.91%
	Empirical data (table, graph, curve, map, scale, geological, phylogenetic tree)		12	1121.62	7	714.08	23	1951.75	42	3787.45	9.58%
Total		Number	25		9		97		**131**		
		Surface ($cm^{2)}$		2818.31		896.48		7226.38		**10941.1**	
		Surface (%)		7.09%		2.25%		18.17%			**27.56%**

The study of geology in the third year textbook is not confined to the study of the structural model and plate tectonic theory; in addition, the relationship between the dynamics of the earth and biological evolution are investigated. As result, the total number of illustrations is considerably higher. There is a single photo showing the microscopic components of a crystal rock. 43 macroscopic images, of which 38 are photographs, are mainly devoted to theoretical explanations of certain geological phenomena. 87 graphic images can be identified in the unit, including 45 representing 11.91% of the pages analysed. These documents are also extremely varied and generally represent geological maps, scales or curves. Approximately 25 images represent or indicate geologic time in their contents. The concept of space is present in only about 2% of the total area devoted to illustrations, whereas illustrations used in theoretical explanations account for 18%. To explain the evolution in the textbooks, their illustrations will be compared.

A comparative study of textbook illustrations

The following tables compare illustration typologies and content.

Table 11: Comparison of illustration typologies

			Second year textbook		**Third year textbook**	
			Number of illustrations	Surface %	Number of illustrations	Surface %
Figurative images	Macroscopic	Photo	8	6.48%	38	4.48%
		Diagram or drawing			5	1.14%
	Microscopic	Photo			1	0.45%
		Diagram or drawing				
Graphic images	Image of scientific Diagram or non-figurative image		25	8.59%	45	11.91%
	Empirical data (table, graph, curve, map, scale, geological, phylogenetic tree)		21	10.05%	42	9.58%
Total			**54**	**25.11%**	**131**	**27.56%**

This analysis will focus on a comparison of the two geological topics discussed. First, the types of illustrations will be compared, followed by their contents. It appears the textbook has changed in both form and content. In terms of proportionality, illustrations occupy one fourth of the pages analysed in each textbook. In both books, graphic images (images or conceptualisations of empirical data) are diverse. It seems that authors favour this type of illustration; given the role such illustrations play in the explanation of geological phenomena. Figurative images do not exceed 7% of the

surface analysed in either book. The development of technology and particularly of digital photography encourages the more widespread use of pictures, especially satellite images, which can help in explaining the concept of 'space' in two or three dimensions. There is a notable absence of microscopic photos; these are very useful in detailing the chemical composition of rocks. In conclusion, it could not be said that the textbook has evolved significantly in terms of image types, but it is noted that all the images used in the third year textbook are full colour, which allows for better readability.

Table 12: Comparison of the contents of illustrations

		Second year textbook		**Third year textbook**	
		Number of illustrations	Surface (%)	Number of illustrations	Surface (%)
Contents of illustrations	Geological time representative or not of geological time	6	2.97%	25	7.09%
	Geological space (bi-dimensional map)	6	5.74%	9	2.25%
	Theory (explanation of a phenomenon or a geological event)	42	16.4%	97	18.17%
Total		**54**		**131**	**27.56%**

To better highlight the evolution in the textbooks, it is interesting to compare illustrations based on the scientific conceptions they convey. It is noted that the number of illustrations depicting temporal and spatial concepts increased in the third year textbook. This is due to the higher proportion of images compared to the total number of analysed pages and also to the increased importance the authors give to the concepts time and space. Some authors are aware of the educational work carried out at the Higher Institute of Education and Continuous Training (HIECT); others are not. The new generation of authors has received solid training in didactics and pedagogy. The concepts relating to images have increased, which depict the complementary between what is drawn and its scientific content. Such complementary enables students to memorise concepts and to eliminate ambiguity in a way that the image alone cannot accomplish.

Analysis

The pictures or illustrations and the text of a textbook are inseparable. Illustrations are the elements that have most evolved in textbook design. In terms of their goals, these images are different from aesthetic images. Illustrations are useful in those parts of a text dealing with information about experiences not encountered in everyday life or in the school environment. They provide students with more suggestive and more accurate representations of unknown elements of the outside world, including human activities and geological landscapes. The complementary between drawings, photos and

diagrams is crucial, because certain photos do not show the important details. A diagram is often more effective at clarifying the text than a photo. Some decorative photos are attractive, but they should not mask the lack of substance in the text.

Despite some notable exceptions, the scarcity or absence of well-trained illustrators poses problems for good textbook illustrations. An illustrator cannot be expected to be all things: a good draughtsman, a specialist in the discipline and an educator. Close collaboration is therefore necessary between the illustrator and the author of the textbook. The author provides detailed information on the characteristics of the illustrations required by the textbook. In addition, the illustrator should take into account the requirements of the educational objectives of the textbook. One of the objectives of the Education and Training Ministry is to improve the education system, especially the contents of scientific teaching, which are changing very quickly. This guideline prompts us to reflect on the textbook and its future.

Conclusion

The knowledge content presented in the textbooks occupies an increasingly limited space. Contrary to what one might think, imparting knowledge is not the main priority in the textbooks; it is not the presentation of knowledge that inflates textbooks. Reduced to their disciplinary content, thick textbooks for the second or third year would not total one third of the total number of pages (Boughanmi, 2009). Textbooks reserve a great deal of space for decorative illustrations, documents (text or images), with explanatory diagrams (figures, curves, diagrams, charts), and finally for different kinds of exercises. In life and earth sciences, the document, written or figurative, is often intended to show, to identify and to point out. Documents, which contribute to the development of knowledge, are not always distinguished from texts or images whose function is merely illustrative, even decorative. As result, it is very difficult for a student to possess the key to understanding the place and role of each element and the essential from the accessory. It is important to promote students' autonomy and give them the opportunity to criticise the course and express themselves through increasingly constructivist activities. The textbook seemingly offers, indeed, all the elements necessary for the construction of knowledge. It could therefore replace the teacher because it contains not only knowledge but also its development. Our analysis illuminates only the specific purpose it set out to study: the scientific content.. It is therefore important to remember that the dominance of the informative style in an educational context must lead authors of textbooks to think about its real objectives. Not to use a participative style shows that scientific discussion is limited to a transmission of science declarative knowledge. The participative style can develop the auto-reflexive methods of students to explain some scientific problems and transpose these methods to other similar situations. Scientific activities should not exclude the social constructivist aspect of science. This approach will engage students in thinking about the usefulness of what they acquired in the classroom. Such participative style could be linked to other dimensions as well as socio-economic considerations of geology.

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