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A PARTIAL IMAGE OF SCIENCE AND SCIENTIFIC ACTIVITY CONVEYED BY LIFE AND EARTH TEXTBOOKS AT QUALIFYING SECONDARY LEVEL.

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ABSTRACT

Today's science education plays a central role in shaping tomorrow's citizens. Its aim is to develop a solid scientific culture in individuals, enabling them to make informed decisions on science-related issues. The aim is not only to pass on scientific knowledge, but also to train citizens who can use their scientific knowledge productively in their everyday lives.

Science teaching is directly conditioned by school teaching practices, but also by the conceptions that textbook authors have built up of aspects of science and scientific activity. So how do textbooks approach the image of science and scientific activity?

This work presents a content analysis of life and earth sciences textbooks, with the aim of identifying the image of science and scientific activity conveyed by these textbooks. Textbooks analyses focused on the following aspects of science: empirical, provisional, inferential, creative, theory-based and social, as well as on the myth of the "scientific method", the nature of scientific theories and the relationship between science and society.

A total, 2 textbooks were analyzed. These textbooks are widely used in Moroccan schools. Analysis of the way in which the different aspects of science are dealt with in these textbooks reveals a partial representation of science that does not reflect the reality of science and scientific activity.

This analysis is incompatible with the national discourse on teaching science reform, which aims to develop scientific literacy among learners, requiring scientific knowledge and knowledge about scientific knowledge (metacognition).

Current strategies for reforming science curricula in Morocco must target the way in which the image of science and scientific activity is reflected in life and earth textbooks.

INTRODUCTION

Science teaching is of crucial importance as a fundamental component of tomorrow's civic education. Indeed, its aim goes beyond the simple transmission of scientific knowledge (concepts) to also encompass the methods and processes of scientific research. By integrating these aspects, it aims to create scientifically aware and competent citizens, ready to meet the challenges of modern society.

The aim of our study is to identify the nature of the science transmitted through life and earth textbooks. We adopted a qualitative approach to analyzing the content of life and earth textbooks.

We formulate the following hypothesis: Through their texts, images and pedagogical approaches,

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textbooks convey a partial and ill-formed image of science and scientific activity.

Comparable didactic studies are rare in Morocco, with only a few works focusing on the analysis of environment-related content in secondary SVT textbooks (Agorram et al., 2010; Hamouchi, Essafi & Hajjami, 2010, Hamouchi, 2015). For this reason, we believe it is relevant to look at the analysis of these Moroccan textbooks, which have been little studied from a didactic point of view.

It is in this context that we will share the results of a study of a sequence dealing with the nature of genetic information in two life and earth sciences textbooks at the qualifying secondary school level, following the steps outlined in figure 1.

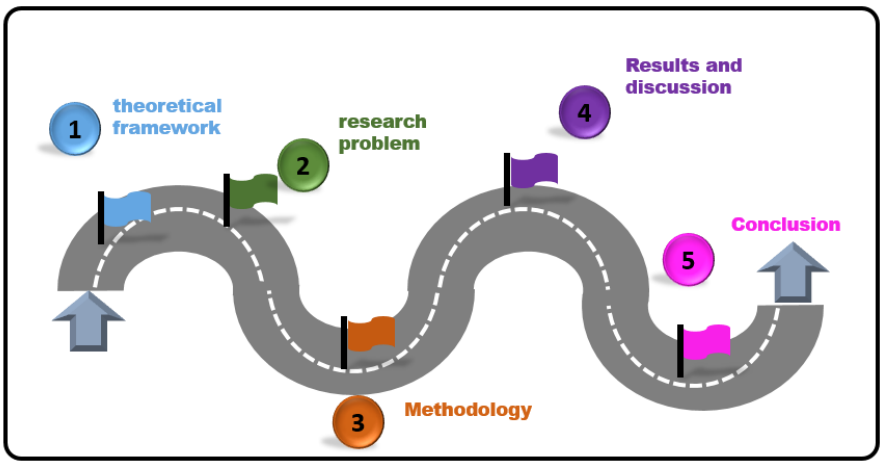

Figure 1: Stages in the research process

THEORETICAL FRAMEWORK

1-1 THE TEXTBOOK AND THE NATURE OF SCIENCE

Numerous articles underline the importance of textbooks for teachers' professional culture (Gérard & Roegiers, 1993; Bruillard, 2005; Lebrun, 2006). Teachers frequently regard the textbook as an essential tool for preparing lessons. It is seen as a "safeguard" for the curriculum, a tool for implementing the program, an aid to progression, a bank of tools, exercises, homework, definitions, a documentary resource, etc. The textbook is also seen as an essential tool for preparing lessons.

In this way, textbooks contribute to the transmission of scientific knowledge. By conveying an implicit or explicit image of science, they play a vital role in the development of the scientific mind. Authors' conceptions influence the textualization of the image of science to be conveyed in textbooks. To convey an authentic image of science and scientific research, textbook authors need to be aware of the nature of science according to contemporary epistemology.

1.2 THE NATURE OF SCIENCE: WHAT IS IT?

The nature of science, or more commonly known as NOS, often emphasizes the importance of identifying epistemological foundations that are both valid and useful for science education (Izquierdo & Adăuriz-Bravo, 2003). These foundations are "valuable" because they are a relevant part of the curriculum for achieving the goals of a genuine scientific culture, and "useful" because they represent an effective tool for developing scientifically literate citizens capable of steering the development of countries.

1.3 WORKS ON THE NATURE OF SCIENCE

This field of research covers a wide range of issues and concerns both students and teachers, as well as curricula and textbooks. Various surveys conducted mainly in Anglo-Saxon countries (Lederman, 2007; Schwartz, Lederman & Lederman, 2008) show that students' and teachers' conceptions of the nature of science are most often inconsistent with contemporary conceptions of the scientific enterprise (seghir 2023). For example, many students believe that theories can simply be "read" from the world, that scientific claims can be definitively proven, and

that theories have not yet achieved the privileged status of facts or laws.

Teaching what textbooks generally call "the scientific method": a linear sequence of steps suggesting that scientists follow a single, fixed process to develop laboratory experiments that directly and definitively test hypotheses can compound these misconceptions (Tania Lombrozo & Anastasia Thanukos & Michael Weisberg 2008).

According to studies of teaching textbooks, whether through the approaches chosen, the vocabulary used or the historical elements introduced, convey a reductive and distorted image of science (Abd-El-Khalick, Waters & An-Phong, 2008; Leite, 2002; Wang & Schmidt, 2001). Little research has been carried out on this topic in Arab countries. Moreover, there is no research examining the place and nature of NOS in secondary school life and earth sciences curricula in Morocco.

This research can therefore make an important contribution to the current understanding of the issue in the Moroccan context.

PROBLEMATIC

The current state of textbook content in Morocco is of great interest, especially at a time when the National Charter for Education and Training (COSEF, 1999) has initiated a number of initiatives aimed at reforming curricula, updating programs and textbooks, based on the White Paper (Commission de révision des curriculums pédagogiques marocains, 2002) and introducing socioconstructivism and the Competency-Based Approach (Approche par Compétences, APC) into Moroccan schools

This major reform of the Moroccan education system, launched at the beginning of the 21st century, has several ambitious objectives:

-Improve the quality of education.

-Increase the efficiency of the school system.

Reduce school failure and drop-out rates.

The textbook can be analyzed as a vehicle for the construction of scientific knowledge and the transmission of an image of science and scientific activity. The present work focuses on the interactions between science and the nature of science, during the construction of scientific concepts, using textbooks as an aid to program implementation.

The research we have undertaken on SVT textbooks aims to examine the way in which they take charge of the image of science and scientific activity. We set out to answer this question.

What explicit or implicit aspects of the nature of science and scientific activity are conveyed by textbooks on topics related to genetics?

METHODOLOGY

3-1 STUDY CORPUS

This work looks at the content and teaching approach proposed in Moroccan school textbooks, using as an example the story of the discovery of genetic information in the 2nd year of the baccalaureate qualifying secondary school (students aged 16 to 18). Our analysis focused on two textbooks (Al jadid and Fi Rihab) (Figure 2), which are the life and earth sciences textbooks for the 2nd year baccalaureate class currently operational within the potential Moroccan curriculum. As for the prescribed curriculum, it presents an institutional mechanism responsible for creating programs and presenting various pedagogical orientations enabling their implementation in the classroom (Perrenoud, 1993).

Figure 2: Study corpus (Al jadid and Fi Rihab).

3-2 ANALYSIS METHOD

In this article, we have adopted the definition and aspects of NOS according to the work of lederman (1992) and Abd-El-Khalick (1998), which served as the basis for the analytical framework used in this study.

In line with our choice of educational aim ("Formation d'un scientifique, éducation citoyenne") and in comparison with the work of Erduran and Dagher (2014) ,Maurines et al (2017), we have produced an analysis grid focusing on 4 dimensions of the nature of science and scientific activity (Table1).

Table 1: The 5-dimensional analysis grid for the image of science and scientific activity used in the textbook analysis.

Analysis dimensions	Analysis sub-dimensions	Explanation of the dimension targeted by the textbook analysis
General characteristics of science	***Refutable,provisional and uncertain***	science is evolving, moving and unstable (Bachelard, 1967)
	Partially subjective	Scientific work can be influenced by researchers' personal knowledge, beliefs, conceptions, experiences, choices and expectations (Bachelard, 1967; Fourez, 2002), which diminishes the objectivity of their work.
The myth the scientific method	***Approach and methods***	scientific approaches. They may not systematically include a laboratory experiment (Boujaoude & Santourian, 2010.
	Ruptures and evolution	The construction of scientific knowledge is never linear, and follows a complex path with backward steps and forward "leaps", unpredictable hazards, failures and successes (Kuhn, 1970).
Scientific community	***Characteristis of community members***	Science is a human, socio-constructivist enterprise, not an isolated one. Research results need to be communicated and published using a common, conventional language (Boujaoude & Santourian, 2010).
	Collective construction of knowledge	
	Community relations	
Society	***Science's impact on society***	Science is a human endeavor; it affects and is affected by the various components of society (politics,economics,religion,philosophy,industry,technology, etc....) (Lederman, Abd-El-Khalick, Bell & Schwartz, 2002).
	Society's impact on science	
Attitudes	***Creativity and imagination***	The production of scientific knowledge involves human creativity, in the sense that scientists invent explanations and theoretical entities such as models.

These dimensions of analysis enable us to examine the richness and complexity of the image of science and scientific activity reflected in both documents and teaching situations.

3-3 SELECTING CHAPTERS AND SECTIONS FOR ANALYSIS

The analyses focused on the chapters or sections dealing with genetics, as these parts of the program deal historically with the development of genetic theories, providing a suitable context for exploring certain scientific aspects. Moreover, these chapters focus mainly on unobservable entities, resulting from the complex interplay between properties and relationships that are both macroscopic (observable) and microscopic (unobservable).

Although the Nature of Science (NOS) is not a clearly defined learning objective in Life and Earth Sciences (L&E) textbooks, it can be assumed that students and teachers form a perception of science through these textbooks. . The hypothesis being that these manuals contribute - implicitly - to drawing an image of NOS likely to be perceived by teachers and students.

The topics of the textbooks analyzed were carefully examined for key terms relevant to NOS, including: "inference", "laws", "models", "observation", "scientific method", "scientific thinking", "scientific process", "scientific theory", "scientific law", "social", "society", and so on.

We counted the number of sentences evoking a dimension and related it to the total number of sentences in each of the two manuals.

The coding of the corpus using the 5-dimension grid is shown in the extract from the coding table 2.

Table 2: ***extract from the coding table.***

Example of sentence	**Based on chargaff's results, the search for possible DNA structures began. this is why Franklin confirmed the double structure of DNA in 1953.**	**The laws governing the transmission of genetic traits remained mysterious and difficult to understand for many years, until the results of Mandel's experiments came to light.**
Explicit Discourse		
Implicite	X	X
Discourse		
Characteristics		
Méthodes		
Community	X	X
Society		
Attitude		

RESULTS AND DISCUSSION

4-1 THE IMPLICIT OR EXPLICIT NATURE OF THE DIMENSIONS OF ANALYSIS OF THE IMAGE OF SCIENCE AND SCIENTIFIC ACTIVITY IN SVT TEXTBOOKS.

Figure 3 shows that for both manuals, explicit discourse on the nature of science is almost non-existent and implicit discourse on science concerns only a few dimensions of science.

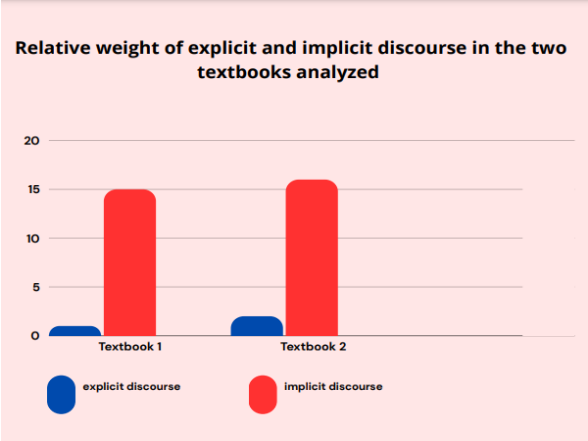

Figure3: relative weight of explicit and implicit discourse in the two textbooks analyzed.

Figure 4 shows the percentage of references to the 5 dimensions of science in the two textbooks. The majority of the dimensions of science are not covered by these textbooks, with the exception of the community dimension, which appears in sentences indicating that each discovery is based on previous discoveries, leading to a collective construction of science.

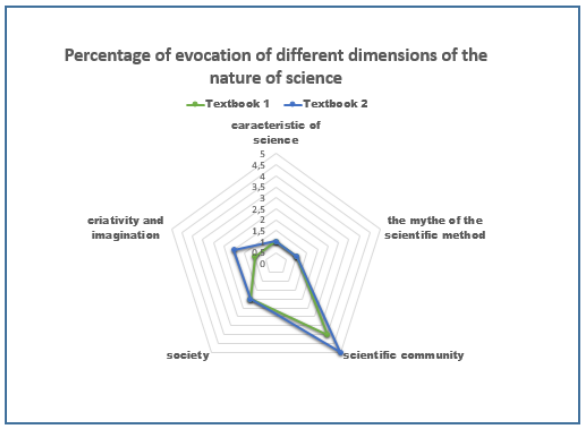

Figure 4: Percentage of evocation of different dimensions of the nature of science

4-2 HIGHLIGHTS OF TEXTBOOK IMAGES OF SCIENCE AND SCIENTIFIC ACTIVITY.

A reading of the texts in the textbooks reveals two types of discourse in relation to science and the nature of science:

An explicit discourse on science when it deals explicitly with the fundamental characteristics, methods and principles of science. This can be found in official documents, science policy statements or expert speeches. But in the textbooks analyzed, this discourse is almost absent.

An implicit discourse on science that can shape perceptions and attitudes towards science in a more indirect and unconscious way. In the textbooks analyzed, we found that only the community dimension is implicitly addressed in a few activities. The activities in life and earth textbooks emphasize the empirical aspect of science, proposing practical and experimental activities and envisaging logical intellectual activities (reasoning, demonstrating, arguing), yet the faculties of creativity and imagination are not emphasized by these programs.

Even the life and earth programs place scientific practices within a history (the history of the discovery of the nature of genetic information). This is a conceptual history rather than a history of the human enterprise, which is punctuated by innovations and creativity, marked by the evolution of social organization, and marked by conflicts, wars, and rivalries, but also by periods of cooperation, trade and cultural exchange.

Life and Earth Sciences (L&E) curricula seem not to include certain important notions, such as the scientific revolution and its various attempts, the link between science and an intellectual, social and cultural tradition, the influence of the social and historical environment on scientific ideas, and the fact that science is a controversial field.

CONCLUSION

The main interest of the research we have just presented is to have contributed to clarifying the textbook's interest in aspects of the nature of science and scientific activity.

The choice of 5 dimensions for analyzing aspects of the nature of science and scientific activity seems to us, in the light of the results obtained, to be pertinent. It makes it possible to identify the choices made by the authors of the textbooks and opens the way for new choices when developing future textbooks.

The results indicate that efforts to develop scientific literacy and critical thinking among secondary school learners need to pay particular attention to the representation and treatment of science and scientific activity in textbooks. In the latter, there is a total absence of explicit treatment of NOS in these two textbooks, which poses difficulties for learners' understanding of science.

Given these results, it is crucial to find ways of changing this vision. The idea is to offer teaching aimed at building knowledge about NOS, so that students are able to think about current science and how it works, and thus have a "meta" discourse on the scientific activities in which they are usually engaged during science lessons.

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