

PLATE TECTONICS “INTEGRATIVE CONCEPT” IN THE MOROCCAN CURRICULUM OF SECONDARY SCHOOLS

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ABSTRACT: Teaching earth sciences is particularly delicate and apparently problematic, however, it's a domain for which the expectations of all the actors of the Moroccan pedagogic community should be strong and immense, especially if we take into consideration the wide surface of the country called "The Paradise of the Geologist". Morocco has rich immense geologic zones and sites. This country is characterized by its great scientific and economic importance, and its diverse natural resources, which means that it's a rich site in terms of natural pedagogic materials. Yet, it's a scientific domain in which knowledge and paradigms change quickly, especially with the modern techniques used in the fields of study regarding the possible solutions of scientific problems that have a geological order. All these necessitate a permanent revision and reconstruction of the curriculum which influences the conceptions and values that these official pedagogical documents may convey in an explicit or implicit way. In this research, we analyse the evolution of programs, dealing with the themes linked to the tectonic plaques -integrating concept-, starting from 1967 till today. The objective of this analysis is to identify the approaches with which the programs treat the topics of geology in secondary school, and to know the conceptions and implicit and explicit values which structure the choices made by these official curricula.

Key words: Earth Sciences, plate tectonics, conceptions, curricula.

INTRODUCTION

Geology is deemed a difficult discipline, rejected and abhorred by learners (G. Gohou 2001; J. & N. Dodick Orion 2003), and its teaching in Morocco seems to be problematic for both Moroccan learners and teachers. It seems that learners are not sufficiently interested in this discipline and rarely directed towards the jobs available in this field of study. Besides, didactic works concerned with the teaching and learning of geology are rare compared to the teaching of other experimental scientific disciplines such as physics and biology. Albeit our country is named "The Paradise of Geologists" and is characterized by a large area that is rich in huge outcrops and geological sites of great scientific importance and natural resources, teaching geology does not take an important place in the secondary curriculum.

The choice of our study focus has been well motivated by the fact that the course of geology and concepts of earth sciences are among the most difficult scientific aspects learners learn, given the relationship that discipline has with the time and space. In geology class, it is difficult or almost impossible to conduct experiments in their real dimensions, we can achieve that level of mini kits on very specific time scales, which requires more caution when interpreting the results of these experiments, while emphasizing the spatial and temporal conditions that are different from reality. Thus, simplification of experimental models requires strict criticism of the realized projections. The earth sciences are distinguished from the life sciences with all these features that can be incredibly an obstacle in teaching and learning, and make the best approaches for treating geological concepts, chosen by the program and curricula makers.

For all these reasons, we considered important to investigate for the underlying roots of the difficulties encountered in the teaching and the learning of earth science in Morocco. We'll investigate at one aspect of the problem related to program content. It deals with the evolution of teaching about concepts and geological phenomena that have a relation with plate tectonics "integrative concept", from 1967 until today. It aims to identify approaches with which the programs address the topics of geology in high school.

OBJECTIVES AND RESEARCH QUESTIONS

The objective of this research is to analyze the contents of the programs of earth sciences, to assess development in the concept of plate tectonics, and identify approaches in dealing with concepts and geological phenomena from the program.

Our research questions were formulated as follows:

1. What is the emphasis on geology in the Live and Earth Sciences (L.E.S) programs especially that they respond appropriately to the aspirations and ambitions of the actors of the educational community, and they keep pace with increases experienced by science of the earth, particularly the concept of plate tectonics?
2. What are the pedagogical approaches used in teaching geology concepts, such as "plate tectonics»?
3. In terms of external didactic transposition, what are the obstacles we can identify in the teaching of concepts and geological phenomena associated with plate tectonics?

METHODOLOGY

In this study, we conducted a diachronic analysis of the evolution of official programs for teaching integrative of the concept "tectonic plates" since 1967 to today. To trace the history of the construction and teaching of integrative concept of "the plate tectonics" in high school, we gathered various existing official programs for the teaching of earth sciences that have made our analysis corpus.

Our corpus of analysis consists of official documents (teaching guidelines that have been called official instructions) dating from 1967 to the present. We believe this is a date that corresponds to a sufficient period (30 years) before the introduction of plate tectonics. We will focus our analysis on the geological concepts and notions relating to the internal geology and that has a material relationship with the plate tectonics.

All official texts available to us are operated by a semantic analysis to determine the approaches of education of the plate tectonics "integrative concept" in a given program. The gap between scientific advances and their introduction into the teaching will also be evaluated. We will not limit ourselves only to the analysis of the evolution of scientific knowledge, but we will try to identify the different factors that promote or inhibit and block the introduction of certain themes in school curricula, and for this we measured the Time of the Didactic Transposition (DTD Quessada & Clement, 2005a).

RESULTS AND ANALYSIS

The preliminary analysis of our documents indicates the existence of two periods: before and after introduction of the concept.

Table 1. Board of Teaching About Plate Tectonics in The Programs of Natural Science (Sciences of Life and Earth From 1967 To 2007)

Year of Program publication	Teaching level (Age)	Keywords of the school curriculum	Approaches used in the program
1967	Level 9 (15-16 years)	Igneous and metamorphic rocks Geological history of Morocco Petrographic and tectonic concepts	Descriptive
1971	Level 7 (13-14 years) Level 9 (15-16 years)	Volcanism, volcanic rocks Moroccan rocks: basalt, granite ... Petrographic and tectonic concepts	Descriptive analytic
1974 1976	Level 8 (14- 15 years) Level 10, experimental sciences (16- 17 years)	Volcanism, volcanic rocks Moroccan rocks: basalt, granite ... Petrographic and tectonic concepts Crystalline state, minerals, crystals	Descriptive analytic
1979	Level 8 (14- 15 years) Level 10, experimental sciences (16- 17 years)	Volcanism, granite, Magma Structure of the earth, study of Earthquakes. Notions of endogenous and metamorphic rocks Tectonic Concepts	Descriptive analytic
1984	Level 8 (14- 15 years) Level 10, experimental sciences (16- 17 years)	Crystalline state, minerals, crystals Volcanism, granite, Magma Structure of the earth, study of Earthquakes. Notions of endogenous and metamorphic rocks	Descriptive analytic

1995	Level 9 (15- 16 years) Level 10, experimental sciences (16- 17 years)	Tectonic Concepts Internal geological phenomena Magmatism, volcanic and plutonic rocks Tectonic deformations Metamorphism Intraplate volcanism Plate tectonics.	Explanatory deductive Synthetic
2007	Level 8 (14- 15 years) Level 12, experimental sciences (18- 19 years)	Internal geological phenomena Magmatism, volcanic and plutonic rocks Tectonic deformations Metamorphism Plate tectonics.	Explanatory deductive Synthetic systemic

A- The analysis of the first part program: before the introduction of plate tectonics :(1967 to 1995)

The analysis of the Moroccan program of geological education in high school, before the introduction of integrative concept "tectonic plates" (the first part: from 1967 until 1994), showed that the taught content has remained generally stable, and has not suffered any major changes in broad outline (see Table 1). The approach often used, whose knowledge is divided into parts, is purely analytical and remains without significance for the learner, and it is very difficult to learn, and may not engage properly taught knowledge in given situations. We conclude that while the program and curricula makers neglect the relationships between the different elements of the taught geological phenomena, and this can be justified by the absence of an inclusive concept which can give a global vision and a deeper understanding of the taught concepts.

B- The analysis of the second part program: after the introduction of plate tectonics: (1995 to 2007)

The introduction of tectonic plates has helped programs and curricula makers offer a systemic approach; it helps bring the relationship between the different elements of geological phenomena that have internal identifying reactions. This approach gives importance to the overall vision in the study of phenomena, and allows the study of several variants at the same time, with simple models to use even when they are often inaccurate. The concept of plate tectonics is introduced for the first time in the 1994 program, integrating concept is discussed in detail in the programs of two successive levels of education, the 9th level and the 10 level in the high school.

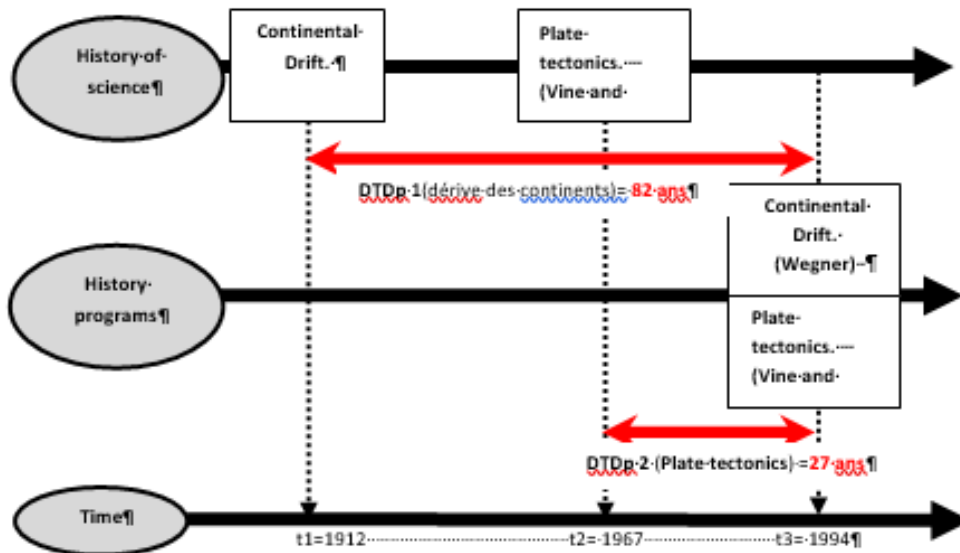


Figure 1. The Period Of Didactic Transposition Of Curricula (Dtdp), The Dtdp1 For The Concept Of Continental Drift, And Dtdp2 For The Inclusive Concept Of Plate Tectonics.

The didactic transposition of scientific concepts in official texts of school curricula is an important step, we studied the use of the concept of DTDs historical curricula, measuring the DTPP (within didactic transposition programs) for two geological concepts that are "the drifting of continents" and "the plate tectonics" (fig 1). We notice when there is a wide variation of DTDP for the two examples studied, it reflects that there are other influences that the development of scientific knowledge on program renewal.

The analysis of the history of science shows that the tectonic theory was developed between 1960 and 1967 to 1968. In 1970, the model of plate tectonics was developed, and the different actors of the scientific community were beginning to consider its significance and implications in all the earth sciences, which is why she is considered in the field of education, as integrator concept. Indeed, in sciences, nothing is constant, everything changes, and there are always confirmations and changes. At this level, we note that the new curricula of 2007 has not taken into consideration these confirmations and changes made during 37 years of its existence, which could enrich the content of curricula and textbooks, especially as these amendments are linked the development of modern techniques used in field studies and resolution of scientific geological problems. Unfortunately, the programs only sustained transfers of the taught content from one level of education to another.

DISCUSSION AND CONCLUSION

The analysis program allowed us to distinguish two periods in the content of programs related to the integrative concept of plate tectonics.

- The first period from 1967 to 1994, where the taught content has remained broadly stable in outline until the introduction of the theory of plate tectonics, currently considered integrating concept. In this period the school institution was awaiting the stability of academic knowledge related to continental drift and plate tectonics, and building consensus among members of the scientific community, before its introduction into the school curriculum. We see then that the scientific community does not introduce knowledge that is still debated among scientists.

- The second period from 1994 until today where the concept of plate tectonics is introduced for the first time in the 1994 program, knowing that this concept has been constructed and accepted by the scientific community in 1968. The programs have undergone, significant changes, but are still insufficient. The model of the tectonic theory has not only provided some explanations for understanding the dynamics, function and history of the earth, but has also indirectly unified the way and built several areas of study of Earth sciences as petrology, volcanology, sedimentology, paleontology, stratigraphy, and tectonics and gave rise to new sciences such as geodesy, geostatistics, geophysics and geochemistry (Gohau 1990). And until now, the educational system has not yet decided to introduce these new especially applied sciences, and could make knowledge to be too meaningful to the learner and the teacher.

The decision to introduce new geological knowledge in education depends on many factors related to the actors of the educational institution and the balance of power between institutions: ministries, inspection, universities and research institutions, associations and group pressures.

We note that the results generated from this research, urges us as a researcher in science education, to ask questions about the inclusion of the results of such research in the revisions and changes in programs, and think about editing textbooks just for this subject like the case of disciplines: history and geography HG and PC physics and chemistry whose each discipline is taught by a single teacher, but has two independent books) to give the opportunity to those who specialize in geology and its teaching to offer programs and edit textbook that adequately meet the aspirations and ambitions of the actors of the educational community.

We note also that until now, there has been no introduction of a historical approach in teaching subjects related to tectonic plates, which will give a coherent view of science and technology and their joint development. An approach has to present scientific knowledge as a progressive human construction and not as a set of revealed truths, and clarify with examples the reciprocal nature of the interactions between science and technology (Savatton 2011).

On the other hand, the analysis programs do not have the applied economic interest and the model of tectonic plates. At this level, programs should provide examples that will show that the model of plate tectonics provides an understanding of the conditions of existence of exploitable resources (oil and gas fields located in a passive margin basin.)

This work has allowed us to demonstrate that the old programs studying the geology of local areas near schools, examples of the geological regions and Moroccan rocks, the economic interest of the rocks, which will motivate learners and their teachers, for the new programs have really neglected this aspect of great interest, especially that Morocco is a rich country in terms of geologic, scientific and economic views. The results of this research would merit serious reflections on the part of the ionosphere: program and curricula makers, scientists, didactic researchers and the main actors of the educational system. The marginalization of this science by the Moroccan curriculum must indeed be questioned!

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