

# Towards a new relationship between: innovative ideas and designs adopted by teachers for improving the study environment of life and earth sciences in Morocco.

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**Abstract.** Science teaching requires not only the acquisition of scientific knowledge, but also the appropriation of scientific ways of thinking and the development of a scientific and technological culture. According to the constructivist model, the teacher must consider the classroom as a research laboratory, enabling learners to apply scientific approaches to the construction of knowledge. Adopting this model requires consideration of coherent methodological and epistemological options, as well as an understanding of key aspects of the nature of science, as the latter is an essential component in developing students' scientific culture. This research aims to explore and analyze the idea of science among Moroccan teachers of life and earth sciences. We explored these ideas through semi-structured interviews, followed by a qualitative content analysis. We found a certain heterogeneity of conceptions among the teachers. They share contrasting conceptions of science, sometimes adequate, sometimes erroneous. This study therefore highlights a profound lack of culture in terms of reflection on the nature of science and the ways in which scientific knowledge is developed. Hence, it is important to add epistemology in initial and in-service teacher training. Thus, training in the history of science appears desirable in order to emphasize the evolutionary and revolving character of science, and to ensure a positive impact on teachers, students, society and the environment.

**Index terms:** conceptions; epistemology; life and earth teachers; nature of science; qualitative analysis; study environment.

## 1 Introduction

From recent research in education, we have seen a shift in the goals of science and technology (S&T) education over the past several decades toward developing scientifically literate citizens who are able to make well-informed decisions about science-related topics and to use their scientific training productively in their daily lives [1].

However, around the 2000s, teaching methods were still too lecture-based, the perception of science education was still dogmatic, and it did not consider the social and cultural backgrounds of learners [2-3-4].

To be scientifically literate, one must have the knowledge and understanding of scientific concepts and processes necessary to make good decisions on personal and societal issues. Understanding the nature of science (NOS) is considered a key component of scientific literacy [5]. The latter is the goal of all science education. In addition, teachers' understanding of (NOS) is very important to improve students' understanding of science in order to develop scientific literacy that can assist them in decision-making [6-7].

Yet, research shows that most teachers around the world have a limited understanding of NOS [8], and that even when they understand it, they often struggle to teach it [9-10].

We aim, through this study to answer the following question: Are Moroccan secondary school teachers' conceptions of science in line with contemporary epistemological paradigms of science? We suggest that, in order to ensure a better understanding of science among learners, the Moroccan teacher must have a well-formed conception of science and its aspects.

Since research on (NOS) in Middle East and North African (MENA) countries is largely neglected [11]. This study will effectively contribute to identifying the epistemological conceptions of science among life and earth science teachers in Morocco.

This research could constitute a detailed diagnosis of the solicited teachers relating to science allowing to set up a training in epistemology and history of science, with the aim of acquiring teachers with an authentic image of science and scientific research, in order to improve science teaching in Morocco.

We aim through this research to explore and analyze the conceptions of life and earth science teachers about aspects of NOS, in order to know whether these conceptions are in line with the references of contemporary epistemology or not.

In order to answer the problematic of our study, our objective is to analyze the conceptions of life and earth sciences teachers, related to science by means of a semi-directive interview. At the conclusion of this interview, the conceptions collected were classified into adequate conceptions (conforming to the epistemological paradigms of science) and erroneous/limited conceptions (disagreeing with the epistemological paradigms of science). The purpose of this classification is not to judge teachers, but to identify conceptions that are at variance with the image of NOS, to understand their origins and to propose ways to change them.

Analyzing teachers' conceptions through this exploratory study can highlight teachers' beliefs that influence their conception of science. In addition, it can help to understand how these conceptions may affect how learners understand and interpret science.

## **2 METHODOLOGY**

In our survey, we used a semi-structured interview, which is a qualitative research method that combines prepared questions with the opportunity for participants to express themselves freely. This allows to obtain rich and nuanced information about our topic. According to Lederman [12], a qualitative approach provides a deeper, conceptual understanding of the idea of science than those established through the quantitative approach. The use of interviews as a means of data collection was therefore recommended to examine the conceptions about science among life science teachers. This analysis of the data could help educational leaders make decisions.

The main steps of the data processing strategy are shown in the figure 1.

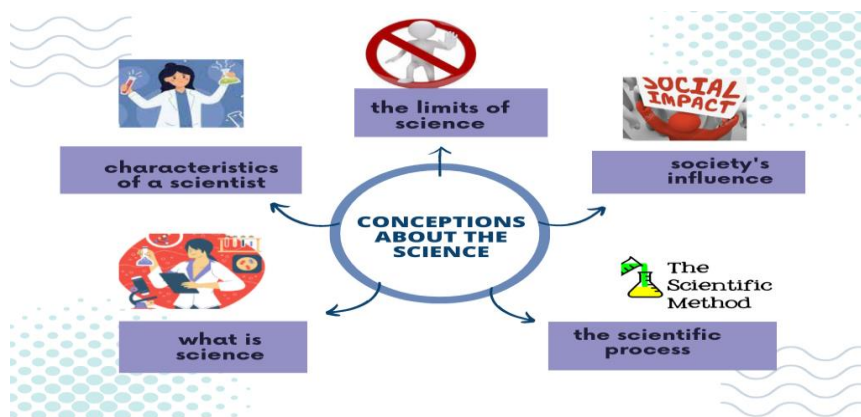


**Fig. 1.** Data processing strategy

## 2.1 Data collection

The first stage of data processing begins with data collection. An interview guide is based on the standardized open-ended questionnaire VNOS-C (Views of nature of science), developed by Lederman, Abd-El-Khalick, Bell and Schwartz in 2002 [12], whose reliability and validity have already been established. The purpose of our interview is to survey teachers' epistemological conceptions of some aspects of NOS. The interview guide was tested several times on female life and earth science teachers prior to launching it on our sample.

We modified the guide after the pre-test to avoid ambiguous, unclear and incomprehensible wording in the questions. The aspects of science covered in the interview are shown in the figure 2.



**Fig. 2.** The aspects of science covered in the interview

Teachers were interviewed individually for 15 minutes each, reminding them of the purpose of the interview at the beginning of each question, and giving them the freedom to express their point of view instead of looking for the right answer.

The interviews were held during May and June of the academic year 2022/2023 in high schools and colleges in Tetouan.

The study population was made up of male and female teachers working in a secondary school in Tetouan, and male and female trainee teachers undergoing a year's training at the Tetouan regional education and training center. The population presented in figure 3 is made up of 80% women and 20% men.

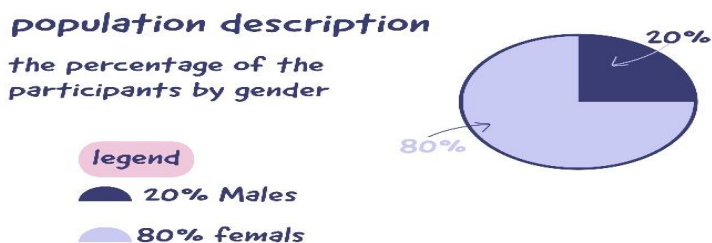


Fig. 3. Percentage of participants by gender

## 2.2 Data analysis

We transcribed the interviews from the verbatim recordings. We analyzed the responses using the content analysis technique, which enables us to move from purely descriptive information to deductions and interpretations. The content analysis of the discourse was based on conceptions underpinned by epistemological benchmarks identified in science didactics.

In this section, we will present the conceptions of the life and earth sciences teachers interviewed and analyze these conceptions using our theoretical framework of reference.

We presented in table 1 the responses to the interviews according to each theme of questions of the interview guide, and we divided the conceptions into erroneous and adequate conceptions.

Table 1. Distribution of life and earth science teachers' conceptions about science into limited/erroneous and adequate conceptions.

Theme of the questions in the interview guide	Teachers' conceptions of science	
	Adequate conceptions	Limited conceptions
<b>Definition of science</b>	Only 10% of teachers think that the definition of science is more complex and evolves with the scientific enterprise.	90% of teachers define science as a body of knowledge, theories, laws... that are already validated by experiments. (Empirical-positivist view of science).
<b>The characteristics of a scientist</b>	The interviewees cite a number of characteristics that reflect an almost magical power of the researcher.	To illustrate the magical power of the scientist, one teacher uses the example of Isaac Newton, who is said to have developed his famous theory of universal gravitation after an apple fell on his head while napping under the tree. For all teachers, the scientist must possess qualities such as rigor, objectivity, curiosity, and a keen sense of observation.
<b>Society's</b>	All teachers are aware of the	None of these teachers give importance

<b>influence</b>	influence of science on society and the influence of society on science. They also have a well-formed conception of the scientific enterprise, i.e. that research requires a collective work.	to the influence of the researcher's own context on his or her research choices, that is to say its objectivity.
<b>The limits of science</b>	20% of teachers think that scientific knowledge is provisional and can be outdated, and that this knowledge never reflects the exact reality.	80% of teachers believe that scientific knowledge is valid, certain, and absolute in all circumstances (Naive realist view).
<b>The Scientific process</b>	5 % of teachers stressed the absence of a univocal method to be followed to establish the so-called scientific knowledge. These are the only teachers who also mention the need for a community and publication of research results.	The majority of the teachers interviewed (95%) consider the scientific method to be a linear implementation of a succession of steps starting with the observation of a fact, to the emission of a hypothesis, then to experimentation, and finally to the production of theories. (Empiricist vision).

## 2.3 Data discussion

Examining the conceptions of life and earth science teachers allowed for the collection of data that showed the inadequacy of teachers' conceptions of NOS, confirming the finding of many research teams. This finding is reported mainly in the results of research conducted with school science teachers [13], and with university science students [14].

### 2. 3.1 Definition of science

Following the analysis of these various conceptions, it seems that a certain heterogeneity of visions exists among the interviewees. Indeed, concerning the definition of science, what challenged us at first is the confusion between science and scientific approach. This science is always defined by its components and not as an intellectual construction in a political, religious, and cultural context

### 2. 3.2 The characteristic of scientist.

Teachers' depictions of the scientist reflect an almost magical power. This obsessive personality is enhanced by creativity, good observation skills, and serendipity.

### *2. 3.3 The influence of society on science*

Teachers had a lot to say when they addressed society's influence on science. They discussed financial constraints, society's influence on the choice of research field; society's values guide scientists' choices....

### *2. 3.4 The limits of science*

Concerning the evolution of science, teachers believed in the existence of a pyramid of knowledge based on previous knowledge, rather than in a scientific revolution based on a continuous reorganization of knowledge by overcoming epistemological obstacles and changing paradigms [15]. This conception is in the same line with a realistic view of science. Only two teachers introduced the provisional aspect of science and that knowledge is admitted temporarily.

### *2. 3.5 The Scientific process*

The majority of the interviewees considered the scientific method to be a linear implementation of a succession of steps starting from an observation of a phenomenon, to the emission of a hypothesis and then to the experimentation, arriving finally at the production of theories (Empiricist vision). Only some teachers emphasized the absence of a univocal method to follow in order to establish a so-called scientific knowledge. They also mentioned the need for a community and the publication of research results.

## **3 Result**

We can summarize the results of this research as follows; for the majority of teachers, science is a body of objective knowledge drawn from observation of the world around us, derived from a logical and rigorous experimental approach, and requiring an almost magical power on the part of the researcher. These results showed that the majority of the teachers we interviewed had heterogeneous conceptions of NOS, sometimes constructivist and in line with aspects of NOS, sometimes imbued with positivism and realism and at odds with aspects of NOS. This is most likely because the majority of these teachers are not trained in epistemology, philosophy, and the history of science; and most likely because they are not adequately trained in aspects of the nature of science during their academic and professional careers.

This work provides support for research on the same theme, and encourages the training of life and earth sciences teachers in history, epistemology, and the reform of the secondary school science curriculum by integrating the NOS. In order to improve the teaching of life and earth sciences in Morocco, by mobilizing the approach and reasoning of two scientific poles: functionalist and historical [16].

## **4 Conclusion**

In conclusion, the purpose of our work is to explore the conceptions of life and earth science teachers about science in secondary schools in Morocco, to see to what extent their conceptions are in line with the main contemporary epistemological paradigms of science.

This work highlights the importance of training in the epistemology and history of science in teacher training (specializing in life and earth sciences for our case study). The 3-year curriculum of the bachelor's degree combines biology and geology and offers the

opportunity to introduce lectures in the history of science that illustrate the evolutionary aspect of the disciplines.

The introduction of epistemology and the history of science in the initial and in-service training of teachers also appears very desirable, in order to make their conceptions of science evolve. Obviously, this training should be accompanied by a follow-up of teachers to help them set up scientific teaching sequences integration, via active methods and scientific approaches of their choice, the history, and epistemology of science. However, this would also require a national evaluation of the science curriculum in the secondary cycle.

In the future, this study can be improved by repeating this work on a larger sample of life and earth science teachers, relating teachers' conceptions of science to their classroom instructional practice. The aim is to ensure a positive impact on teachers, students, society, and the environment.

## 5 Suggestions

We plan to repeat this work on a larger sample of life and earth teachers, relating teachers' conceptions of science to their pedagogical practice in the classroom. Thus, this research could constitute a detailed diagnosis of the teachers solicited regarding science, allowing the implementation of a training in epistemology and history of science, with the aim of making the teachers acquire an authentic image of science and scientific research. All this in a perspective of improving science teaching in Morocco. Our conception for this training is presented in figure 4.

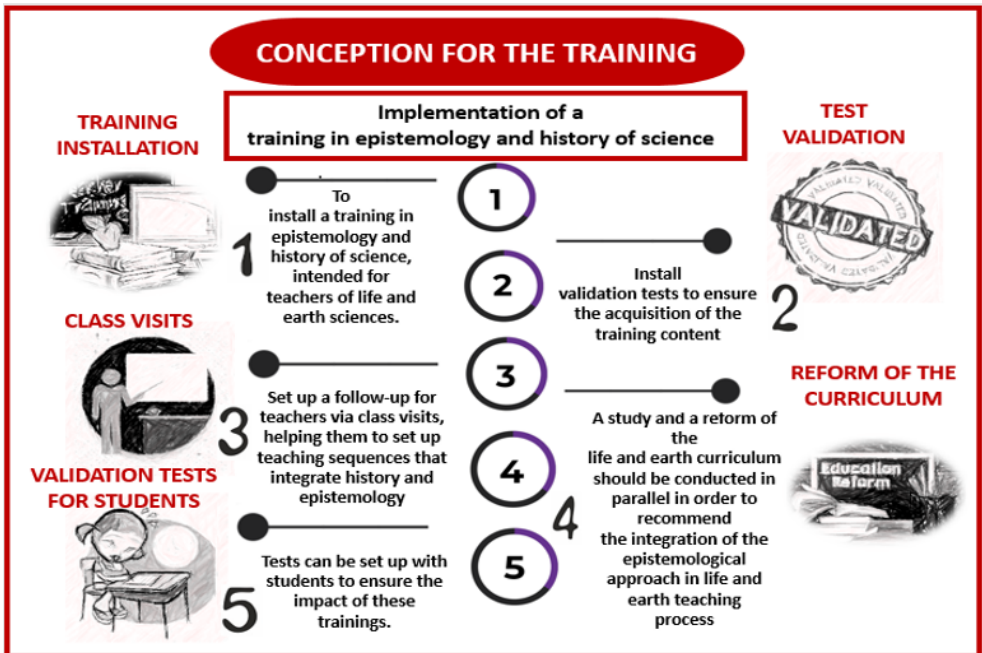


Fig.4. Conception for the training for life and earth sciences teachers

In general, this work requires several research studies and a team of researchers to spread the research steps over several years.

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