

## Representations of the (or) sciences in teaching : epistemological, cultural and societal aspects

*Coordinated by Laurence MAURINES & José-Luis WOLFS*

This issue focuses on the representations of the science(s) conveyed by different educational actors (authors of programs or textbooks, teachers, pupils, etc.). In the introductory text, Stéphanie Ruphy presents how contemporary epistemology addresses the question of delimitation / demarcation between science and not science. The following seven texts aim to characterize the representations of the science(s), to analyze the factors that can influence them, and to examine the stakes in particular in terms of education. They have in common to seek to derive tracks obtained from the results which, not only, can contribute to the research in science didactics, but also to open more widely to a reflection on the role of the school and the teaching of the science(s) in democratic and pluralistic societies facing many challenges, both physical and economic (ecological, climatic) and ideological and social (religious fundamentalisms, identity crispations, etc.). It is also to question of the conditions of an emancipatory scientific culture. At the end of this issue, two great witnesses give their thoughts on this one: Sébastien Charbonnier (philosopher) and Sarah Croché (sociologist).

### Summary of articles

#### ■ STÉPHANIE RUPHY

*Philosophical perspectives on the demarcation issue between science and non science today*

The issues of the demarcation between science and non science are significantly renewed in our contemporary societies, which put science and technological innovation at the center of their development. Which resources are offered today by philosophy of science to think this demarcation and propose operational criteria of demarcation? This article presents some of the main recent relevant philosophical propositions, which acknowledge both the shortcomings of the traditional epistemological criteria proposed last century and the abandonment of unitary view of science that used to go hand in hand with these criteria.

#### ■ FABIENNE PAULIN, SYLVAIN CHARLAT & ERIC TRIQUET

*Historical sciences: an implicit and neglected aspect of epistemology in evolutionary biology teaching*

School curricula tend to leave increasing space to epistemology in life and earth sciences, of which the evolutionary theory is a central element. In this article, we investigate how the specificities of evolutionary sciences, including both « functional » (mechanistic) and historical aspects, are taken into account in official instructions for life and earth sciences in high school. In this analysis, we assign scientific objects and approaches to either mechanistic or historical sciences, based on their distinctive features. Our results indicate that mechanistic sciences predominate in official instructions. The historical approach is virtually absent, although historical themes, that would require such an approach, are present in the curricula. We hypothesize that this paradox, resulting from an insufficiently explicit integration of historical sciences, might explain some of the repeatedly documented difficulties encountered by teachers when it comes to evolution.

#### ■ ELIE RACHED

*Higher secondary students' informal reasoning modes during classroom decision-making on a socio-scientific issue*

Our research describes higher secondary students' informal reasoning during a classroom decision-making on a socio-scientific issue. Specifically, we examine students' choices, their information

preferences and their informal reasoning modes. 30 students (16-17 years' old) responded to a survey presented to them before (pre-test) and after (post-test) an instruction on a socio-scientific issue regarding energy decision, choosing a heating system for a residency, in the context of global warming debates. Results indicate that students use mainly social information and a combined social-scientific informal reasoning mode. While no straight relation was found between heating system choices and informal reasoning modes. However, students with scientific and social informal reasoning modes tended to change their reasoning mode in the posttest more than students with a combined (scientific and social) informal reasoning mode.

■ **LAURENCE MAURINES, MAGALI FUCHS-GALLEZOT & MARIE-JOËLLE RAMAGE**

*Freshmen's representations on scientists and scientific knowledge: exploration of associated characteristics and their specificities*

With the prospect of a scientific acculturation for citizenship of all the pupils and of a renewed interest for scientific studies and careers, the official texts at the secondary level education ask more or less explicitly science teachers to help pupils to understand the specificities of sciences as well as the existence of different regimes of truth. We present some of the results to a questionnaire exploring the images of science of 662 freshmen of the scientific university Paris – Sud. We present the multidimensional grid we elaborated to characterize NoS (Nature of Science) by basing our approach on practices. Considering that scientific knowledge is the result of the work driven by persons who act as scientists within a community inscribed in a society and a history, this grid mobilizes all the science studies, in particular the psychology of science. We examine the following questions: how do students characterize the scientific knowledge and what qualities do they attribute to a scientist? How do students consider the specificity of the scientific knowledge with regard to other knowledge ? How do they envisage for an individual the articulation of scientific and religious practices? To what extent their representations of science evoke a rich vision of NoS ? We put in perspective the results obtained with the images of science conveyed by the science programs.

■ **CORALIE DELHAYE & ELENI KALESI**

*Comparison of the prescribed curriculum and students' views. The case of positioning between scientific knowledge and religious beliefs in Greece*

This study's questions start from the observation of phenomena of rejection of scientific discourse in the name of religious discourse, or inverse phenomena, in education. The aim is to highlight the possible continuities or discontinuities between prescribed curriculum and students' views in the case of a country where the school system is highly prescriptive and centralized. This study consists of a comparison between, on one hand, the positioning between science and religious beliefs officially prescribed in some programs, professor's books and school textbooks, and on the other hand the positioning between science and religious beliefs really adopted by the students. The students position themselves strongly in favor of the autonomy between scientific knowledge and religious beliefs and, mildly, in disfavor of the fideist or classic concordist conceptions. This is only partially in line with the official curriculum. Indeed, although autonomy is part of the prescribed positioning and fideism of the proscribed positioning, complementarity does not seem to be part of the positions widely adopted and rationalist criticism is not rejected. Some explanations are put to the test and discussed in the text.

■ **JOSÉ-LUIS WOLFS**

*Are conceptions of the secularization of science and society going hand in hand or not? (Survey conducted in Belgium and Morocco for sixth form secondary pupils)*

To what extent does the adherence to a secularized conception of science of an individual depend on his conceptions of secularization in other fields (politics, ethic, society)? To what extent are the different dimensions linked or not? This question, already raised by Weber, is examined here on the basis of an exploratory survey carried out in two countries with contrasting conceptions of secularisation (Belgium and Morocco): 196 Muslim Moroccan pupils and 621 Muslims, Catholics and agnostics or atheists pupils from Belgium were asked by a closed-response questionnaire about their views on the secularization of both science and society. This inquiry with questions the concept of secularization on the theoretical and empirical plans leads to an observation and new questions. It appears that students with a secularized conception of science almost all have secularized conception on societal aspects, but the reverse is not true. The role of several variables related to the societal context of these two countries and the religious affiliation of the pupils is analysed.

■ **BENOIT URGELLI, KENZA GUELLADDRESS & ANNE QUENTIN**

*Teaching evolution and the nature of science in responding to student challenges : modelization of teachers postures*

Teaching evolution is a socioscientific issue insofar as it can generate students' challenges in the science class. It questions the place of beliefs about the origin of man, in secular school. During the year 2016, we have conducted an exploratory survey by online questionnaire for 53 science teachers. By multi-category analysis, the aim was to modelize the diversity of teachers' postures when students confused and amalgamed scholarly knowledge and religious beliefs. Most teachers state that this situation is infrequent. Some explains to the students the nature of sciences in relation to the nature of religions and beliefs (posture of understanding), others argue against religion by critical rationalism (posture of rebuttal). Some teachers say that exposing school audiences to scientific knowledge are sufficient to distance automatically their beliefs about the origin of man, without explaining the nature of science and religion (posture of avoidance). We will discuss the complexity of these postures, their hypothetical foundations, and an idea commonly admitted that teaching the nature of science and evolution should decrease the vivacity of this socioscientific issue.

■ **RACHEL SOLOMON TSEHAYE & HENRI VIEILLE-GROSJEAN**

*Coloniality and western-centrism : what is at stake in knowledge production ?*

This article deals with the power relations in the production of scientific knowledge, which highlights the imbrication of science and politics. It focuses on the existence and the influence of an ostracizing phenomenon that questions the universality claim in the science framework and scientific paradigms theorized in the (mainly Western) learned bodies. Adopting a reflexive and critique posture and using an inductive methodological approach and some elements from a literature review, the authors aim to shed light on the new forms of relevance attributed to the notion of coloniality. It provides a concept that may be enforced in the analysis of norms conflicts and social and cultural gaps. It also constitutes an analytical grid of the hierarchy in the spread of knowledge and the subsistence of subaltern groups.

■ **SARAH CROCHÉ**

*From the construction of a « world educational culture » based on the 'western' science to the production of a man responsible to establish his own truth*

This short text wants to be a post face for the issue of the journal Recherches en education which deals with representations of science (or sciences) in teaching. It delivers a sociological statement declined in three parts. It first proposes to return to some aspects highlighted by the authors of some articles published in this issue. It then deals with the UNESCO's project to build a "world culture of education" and the place that has been given to "Western science". Finally, looking back at recent projects and the work of international organizations (United Nations and UNESCO) dealing with education, this text aims to highlight the gradual shift in the project from building a "global culture of education" supported by science to that of producing, by the school, a man responsible for his own trajectory and able to build his own opinion.

■ **SÉBASTIEN CHARBONNIER**

*Is it possible to make unbelieve pupils? Epistemological issues about what to believe means*

The tradition of liberation through knowledge, from Plato to the Encyclopedia (learning rationally makes us free and allows better action in the world), is the very political project of public education. In this context, the scientific disciplines make sense in the pupils' curriculum. However, it is interesting to think these emancipatory possibilities of knowledge without abounding in a somewhat exclusionary (and contemptuous) sharing between "believers" and "knowers" as the imaginary of "barbarism" can produce it (there are them "to enlighten" and us "the enlightened"). In this sense, this paper attempts to present the epistemological foundations of a philosophy of belief that allows us to analyze the determinations that lead us to believe this or that thing, and allows us to characterize the proper scientific way of producing justified beliefs. Thus, it is the aims of scientific learning that will be less confusing, we hope, with regard to our aspirations to live in a democracy.

## Varia

### ■ **BETTINA BERTON**

*The type of discourse we call the socratic dialogue: a reference for philosophical discussions in primary schools?*

Different practices of termed philosophical discussions have been developing in French primary schools for about fifteen years. Several recommendations of these practices refer to the type of discourse we call the socratic dialogue, thus reviving a former reference found in a few entries from the Buisson dictionary (1878-1887); the writers generally condemn this type but they use it as a reference when it comes to discussing the introduction of philosophy as a subject in the upper primary level. The didactic analysis of these two historical moments when the socratic dialogue is designed as a reference points out the theoretical weakness of the construction of this reference, not the least of which is the denial of its didactic transposition.

### ■ **FRÉDÉRIC MAIZIÈRES & BERNARD CALMETTES**

*Understanding the meaning of the didactic action of teachers in two disciplines*

The research which is presented here aims to test a model to study the meaning that the teacher gives to his didactic action in different disciplines. The purpose is to refine the development of a model previously built as part of a grounded theory, that is to say a theory that takes into account both theoretical references that are not frozen and empirical research results that we present in the first part of this article. The data is built from observation and from the video of two sessions conducted in the same CM2 class in two disciplines, namely musical education and physics with the same teacher, and the implementation of two pragmatic interviews that were held before and after the sessions. The results allow us to define the relationship that the teacher has with all disciplines and more specifically with the two disciplines observed here. They also highlight the fact that if his didactic action primarily prevails over his "will", time-related constraints may result in the end in his "not can" prevailing over his "will".

### ■ **MINNA PUUSTINEN, MÉLISSA ARNETON & NATHALIE LEWI-DUMONT**

*Help seeking among secondary school students with a visual impairment: which specificities?*

The purpose of our study was to describe the specificities of academic help seeking in blind and partially sighted students. We developed a 25-item questionnaire tapping mathematics-related help-seeking behaviour at school (during mathematics lessons) and outside school (while revising mathematics lessons and doing mathematics homework) in French upper and lower secondary school students with a visual impairment. The collected data allowed us to describe the declared help-seeking behaviour of four blind and twelve partially sighted students. The results are discussed in the light of findings on normally sighted students' help seeking reported in the literature.

### ■ **GENEVIÈVE THERRIAULT, AGNIESZKA JEZIORSKI, BARBARA BADER & ÉMILIE MORIN**

*Cross case study of the relationship to knowledge regarding the natural sciences and the humanities and social sciences: portraits of secondary school students in Quebec*

This article offers a cross study of the relationship to knowledge regarding the natural sciences and the humanities and social sciences, from the point of view of secondary school students in Quebec. It is an extension of studies in science education and humanities which tends to strengthen civic engagement and the teaching and learning of socio-controversial issues at the secondary level, in order to enhance various facets of the relationship to knowledge and to the act of learning of young people. Several studies have analyzed the relationship to knowledge of students about natural sciences. However, very little research has attempted to characterize the relationship to knowledge toward humanities and social sciences then to draw distinctions with respect to relationship to knowledge in the natural sciences. This study aims to analyze the relationship to knowledge about each of the two areas and then identify possible links between them. To do this, we appeal to a conceptualization incorporating the viewpoints of two contrasting disciplinary fields, within epistemic, identity and social dimensions of the concept of relationship to knowledge. In terms of method, two data collection instruments are mobilized: a questionnaire name "bilan de savoirs" and the semi-structured interview. The sample includes 41 secondary V students of Quebec state, who

responded to the questionnaire. After, 10 students participated to the interviews in order to deepen the answers given previously and address new aspects. The results allow to draw parallels but also distinctions between the relationship to knowledge in respect of the natural sciences and humanities and social sciences. Finally, the results lead us to formulate proposals for teacher education in which the practice of interdisciplinarity in secondary schools is encouraged.