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Teachers' Views of Science, Physics and Technology

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Abstract

Recent research in science education shows that teachers have ideas, attitudes, and behaviors related to science teaching based on a lengthy "environmental" training period, in which they themselves were students. The influence of this incidental training is enormous because it corresponds to reiterated experiences acquired in a non-reflexive manner as something natural, thus escaping criticism. We will discuss how the view of science contained in the curriculum affects teaching, although this is clearly of major significance. This is essential to give a correct image of Science / Technology / Society interactions

Key words: *teacher, physics, science, technology*

Introduction

We have to refer here mainly to the constructivist approach, which is considered today as the most outstanding contribution to science education over the last decades integrating many research findings. (As an obvious example, consider the process - product curriculum debate in science education, the stance taken by each side of this debate about the nature of science, and the consequent impact on teachers' attitudes and approaches to classroom practice).

Contribution to Science, Physics and Technology

Many teachers hold the view that: science knowledge is unproblematic; science provides right; truths in science are discovered by observing and experimenting; choices between correct and incorrect interpretations of the world are based on commonsense responses to objective data. Teachers need to understand, very particularly, that:

- Pupils can not be considered as 'tabula rasa', They have preconceptions or 'alternative frameworks' which play an essential role in their learning process (Viennot 1979, Driver.1986), obliging guiding science learning as a 'conceptual change' (Posner et al 1982) or, better, as a conceptual and epistemological change (Gil and Carrascosa 1990, Dusch and Gitones 1991);
- A meaningful learning demands that pupils construct their knowledge (Resnik 1982);
- To construct knowledge pupils need to deal with problematic situations which may interest them; that obliges them to conceive a science curriculum as a program of activities (Driver and Oldman 1986), that is to say problematic situations that pupils can identify as worth thinking about (Gil et all 1991; Astolfi 1993);

- The construction of scientific knowledge is a social product associated with the existence of many scientist teams; this suggests organizing pupils in small groups and facilitating the interactions between these groups (Wheatley 1991) and the scientific community, represented by the teacher, by texts etc.
- The construction of scientific knowledge has axiological commitments: we cannot expect, for instance, that pupils will become involved in a research activity in an atmosphere of 'police control' (Briscoe 1991). This has stimulated research on classroom and school atmosphere (Welch 1985), pupils' (and teachers') attitudes towards science (Schibecci 1984; Yager and Penick 1986) and STS relationships: The construction of knowledge has to be associated with the treatment of problematic situations which appear as relevant and interesting to pupils (Gil- et al 1991), enabling them 'to assume the social responsibilities of attentive citizens or key decision makers' (Aikenhead 1985).

The most important thing is that all these contributions constitute related components of an integrated body of knowledge which is generating the emergence of a constructivist teaching/learning model, capable of displacing the usual transmission/reception one. But, how can teachers acquire, effectively, this theoretical corpus of knowledge to be able to replace the reception learning paradigm by the constructivist one? It is necessary to call attention to the fact that something as apparently simple as "knowing the subject matter to be taught" implies in very diverse professional knowledge (Coll, 1987; Bromme, 1988): knowledge that extends far beyond that traditionally provided in higher education courses. As a matter of fact, knowing the subject matter to be taught should include (Gil and Carvalho 1994):

- knowing the problems that rose the construction of the knowledge to be taught, without which, knowledge seems to have been built up arbitrarily. Knowing the History of Science, not only as a basic aspect of scientific culture, but ultimately, as a means of associating scientific knowledge with the problems that led to the building up of this knowledge (Otero 1985, Matthews, 1990, 1994; Castro and Carvalho, 1995). Above all, knowing what difficulties were faced in the building up of this knowledge; the epistemological obstacles involved; since this knowledge constitutes an essential aid to understanding students' difficulties (Saltiel and Viennot, 1985; Driver, 1994); knowing as well how this knowledge developed and how the various points came to be joined up into one consistent body of knowledge, and , consequently, avoiding static and dogmatic views that distort the very nature of scientific work (Gagliardi and Giordan, 1986);
- knowing the methodological orientations employed in the construction of knowledge. In other words, knowing how researchers approach problems, the most notable features of their activity, and the criteria used to validate theories. This knowledge is essential to the appropriate orientation of laboratory practices, to solving problems, and to the students' construction of knowledge (Gil et alli,, 1991);
- knowing the Science / Technology / Society interactions. This is essential to give a correct image of physics, since scientists' work is not carried out apart from the society in which they live -- it is affected by the problems and circumstances of the historical moment -- and their actions clearly influence the surrounding physical and social environment. It may appear superfluous to insist on this point, but when we analyze our university teaching, we see that it is reduced to the transmission of conceptual content, devoid of the historical, social, and technological features that marked mankind's development;
- acquiring some knowledge of recent scientific developments to transmit a dynamic, non-closed view of physics. It is likewise necessary to acquire knowledge of other related areas to be capable of approaching the "frontier problems", the interactions among the various fields, and unification processes;
- knowing how to choose appropriate content, accessible to students and capable of arousing their interest and given a correct view of physics;
- being prepared to deepen the knowledge acquired during the initial teacher training courses contemplating the scientific advances and curricular changes.

While the assertion that these are the views of "many" teachers may or may not be justified, this quote does illustrate links of views of science with attitudes to classroom practice. A teacher with this set of views will approach classroom teaching with the intended endpoint of students having clear statements of the relevant knowledge, and will approach laboratory work with the intent of students discovering relevant knowledge through observation. Equally important is that these views are quite common among students. Hence students often expect the same approaches, a point well made by Hirschbach, a Nobel Laureate in chemistry: „In our science courses, the students typically have the impression - certainly in the elementary or beginning courses - that it's a question of mastering a body of knowledge that's all been developed by their ancestors. Particularly they get the impression that what matters is being right or wrong - in science above all. I like to stress to my students that they're very much like the research scientists: that we don't know how to get the right answer; we're working in areas where we don't know what we're doing. I think any way we can encourage our students to see that, in science, it's not so important whether you are right or wrong. Because the truth is going to wait for you." (Hirschbach, as quoted in Marton, Fensham & Chaiklin, 1994 (p 472).

Conclusions

As with views of teaching and learning, students' views of the nature of science impose a constraint on what teachers can do in classrooms. It should not be surprising if Carr et al. (1994) are correct in the above quote in their view that "many" teachers hold the described view of science. Almost all physics (and science) teachers acquire views of the nature of science implicitly through their experiences of learning science content. The further they progress through their science learning the more likely it is that the learning expected of them will be consistent with the view described by Carr et al. Serious consideration of the nature of the discipline they are learning, of the origin and status of knowledge claims, is quite rare for university physics students. Explicit study of the nature of science is not an automatic remedy. Gallagher (1991) describes two teachers with strong formal backgrounds in the history and philosophy of science whose general views of the nature of science and its links with the practice of school science were broadly similar with the views of other science teachers in his study, who had not had that study of the history and philosophy of science. It appears that, as with the content of physics per se, knowing the content of history and philosophy of science by itself is not enough. One also needs to understand how and why and for what purpose that knowledge interacts with pedagogy.

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Opinii ale profesorilor față de știință, fizică și tehnologie

Rezumat

În urma studiului realizat am prezentat în mod structurat care sunt atitudinile şi punctele de vedere ale profesorilor de fizică referitoare la modul de abordare a științei și disciplinelor tehnologice. Există mari deosebiri între opiniile profesorilor de fizică, fiecare fiind mai mult influențat de modul de abordare al acestor discipline aşa cum a fost la rândul său învățat. Orientările metodologice actuale pun accent pe modul de interdisciplinaritate şi viziune comună asupra disciplinelor înrudite.