

**Relationships between the philosophy of science and didactics of science**

**Relaciones entre la filosofía de la ciencia y la didáctica de las ciencias**

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**Abstract**

Several conceptual relationships between the philosophy of science and didactics of science (i.e. science education as a discipline) have been proposed by a number of different authors from both disciplines. In

this paper, we present a theoretical classification of these relationships, based on the metadiscursive, or second-order, nature which philosophy and didactics share. We describe five different relationships between the two disciplines: material, instrumental, explanatory, rhetorical and metatheoretical. Our system of taxonomic classification may prove of use in further studies of the interaction between these two very productive fields of research.

Key words: philosophy of science, didactics of science, conceptual relationships, metadiscourse, taxonomy.

## Resumen

Diferentes autores han propuesto varias relaciones conceptuales entre la filosofía de la ciencia y la didáctica de las ciencias. En este trabajo presentamos una clasificación de estas relaciones, basada en la naturaleza metadiscursiva, o de segundo orden, que la filosofía y la didáctica comparten. Describimos cinco diferentes relaciones entre las dos disciplinas: material, instrumental, explicativa, retórica y metateórica. Nuestro sistema de clasificación taxonómica puede ser de utilidad en futuros estudios acerca de la interacción entre estos dos campos de investigación muy productivos.

Palabras clave: filosofía de la ciencia, didáctica de las ciencias, relaciones conceptuales, metadiscurso, taxonomía.

## Introduction

The object of this paper is to present a theoretical classification, or *taxonomy*, of the conceptual relationships between two scientific disciplines: the philosophy of science and didactics of science (the latter is here to be understood as to be equivalent to the discipline of *science education*: Ogborn et al., 1996; Lijnse, 2000). The relationships that we try to classify have been extensively examined in the specialised literature throughout the history of these two disciplines,; and a broad compilation of papers related to this issue can be found in Adúriz-Bravo (1999). Our classification could be of theoretical interest for both disciplines, but for different reasons, as we will briefly discuss below. We will proceed to present the classification system together with the theoretical criteria followed in making it, which draw on the concept of *metadiscourse* (Moulines, 1991; Estany, 1993; Adúriz-Bravo, 1999).

The multiple relationships between the philosophy of science and didactics of science constitute a complex and entangled system; it is often difficult to determine to what extent each of these disciplines

involves and is involved by the other (López Rupérez, 1990). As an example of this complexity, we can cite the well-known works by Michael Matthews (1994, 1998, 2000). During our work of meta-analysis on didactical research (Adúriz-Bravo, 1999), we have considered it necessary to somehow characterise and classify the relationships between the philosophy of science and didactics of science, in order to be able to proceed to a more systematic and exhaustive study of them.

The aforementioned relationships mentioned above have been extensively enumerated and described by such well-known scholars within didactics of science, such as Hodson (1988), Artigue (1990), Martinand (1993), Matthews (1994), Izquierdo (1996), and Seroglou and Koumaras (2001). However, the exhaustive lists of relationships provided by these authors have not yet been theoretically structured so far. In this paper, we intend to group the relationships proposed in those previous analyses into five conceptual categories that we believe to be representative of the panorama whole scene.

### **The system of relationships**

An important conceptual characteristic of philosophy and of some social sciences is the possibility of considering, among their objects of study, the discourse generated in different human activities. Such disciplines are then said to be *metadiscursive*. This characteristic is a manifestation of the powerful *recursive* capacity that human conceptualisations possess (Moulines, 1991; Estany, 1993). Science, being in one of its dimensions a discourse, may then be taken as an object to be studied by these different disciplines. Thus we have philosophy of science, history of science, sociology of science, and didactics of science. It is usual to gather these and other analogous disciplines under the name of *metasciences*, i.e. sciences *about* science (Moulines, 1991; Adúriz-Bravo, 1999).

Having said this, as philosophy and didactics, while both are both metadiscursive, they may place themselves at different conceptual levels when referring to one another. In fact, a great variety of combinations between the two of them have been explored in the history of these disciplines. Thus, the recursive system between them constitutes a very complex tree with numerous layers of discourse. In order to coherently inspect this set of relationships, we have found it necessary to consider only two discourses in our analysis. This means that we will concentrate on analysing the position that the philosophical discourse takes regarding didactics of science (Adúriz-Bravo, 1999).

As we have stated, the aforementioned relationships between these two disciplines have sometimes been the object focus of attention and study for researchers from both fields, more frequently from didactics of science, although philosophers are also taking a growing interest in them. (For instance, several articles written by philosophers have appeared in the journal *Science & Education*). The study in-depth study of these relationships within didactics of science is relatively recent: Richard Duschl (1985) spoke of a “mutually exclusive development” of both fields up until the early 1980s. In the last fifteen years, work has expanded on exploring, more or less systematically, the interaction between these two disciplines. We have found it interesting, for meta-analytical purposes, to develop a categorisation of the available explorations (Adúriz-Bravo, 2001).

We will suggest that the range of metadiscursive relationships between these two disciplines can be summarised in five theoretical classes, which we will name from the point of view of the philosophy of science. The next five paragraphs are devoted to sketching these classes.

### **Material relationship**

Didactics of science is concerned with the teaching and learning of scientific knowledge. This includes current available knowledge in the natural sciences and, in no less an important way, the history and nature of such knowledge (Adúriz-Bravo, 1999). The philosophy of science then provides relevant *contents* to be included in the science curriculum (Matthews, 1994, 1998; McComas et al. *et al*, 1998; Millar and Osborne, 1998):

Knowledge and understanding of the epistemology of science is an essential aspect of any education in science, and any approach which neglects a consideration of it is incomplete and epistemologically thin. (Osborne, 1996: 55)

This first relationship stems from the general acknowledgement within didactics of science that there is a need to introduce the contents of the philosophy and history of science at school. Such an introduction has caused a lot of considerable controversy (particularly around concerning the distortion of history that is functional to didactics of science; : Brush, 1974; Lombardi, 1997), and is still being critically examined today (Matthews, 2000).

In this first relationship, the philosophy of science is an object of study for didactics. We call this the *material* relationship, due to the fact that didactics of science involves a study of the philosophy of science *per se*, independently of its being a metadiscipline, and analyses it in order to contribute to its teaching and learning (Adúriz-Bravo, in press).

### **Instrumental relationship**

Didactics of science has a *practical* intervention in science education as its main goal (Lijnse, 2000). To achieve this goal, the discipline formulates proposals and prescriptions (Adúriz-Bravo, 2000). Some of these didactical proposals explicitly use the philosophy of science to improve the quality of teaching and overcome learning difficulties (e.g. Duschl, 1990; Monk and Osborne, 1997; Matthews, 2000). That is, the philosophy of science is used as a theoretical tool because of its intrinsic *auxiliary* values within the process of science curriculum innovation.

In this second relationship, the philosophy of science becomes *instrumental* for didactical purposes. Philosophical contents are used inasmuch as they can facilitate general science education. This is the particular relationship between the philosophy of science and didactics of science that has been most extensively studied (Adúriz-Bravo, 1999).

### **Explanatory relationship**

Many of the theoretical models and perspectives accepted in the philosophy of science have been used by didacticians of science (i.e. science educational researchers) as pertinent explanatory constructions for theoretical problems within didactics of science (Cleminson, 1990). Researchers have adapted these models for different particular purposes; a very powerful example of this mechanism of adaptation is the analogy between ontogenesis and phylogenesis, which is the basis for much recent didactical research in didactics of science. Many scholars have noticed this incursion of didactics of science into the field of the philosophy of science:

A recurrent feature of note in the body of constructivist literature is the attention drawn to the parallelism between the ontogenesis of children's scientific thinking and the phylogenesis of the scientific products of the culture.. (Monk and Osborne, 1997: 412)

Philosophical constructs have also been used to characterise the images of the nature of science among teachers and students (McComas, 1998). It has been often taken for granted that these naive epistemological models have a powerful incidence in the teaching and learning of science, an (this assumption is critically discussed in by Lederman and Zeidler , (1987).

These are only two of the numerous examples which show how didactics of science has adapted philosophical constructs. Such examples have brought many authors to state that the philosophy of science constitutes an important *theoretical basis* for didactics of science (Clemenson, 1990; Izquierdo, 1996; Adúriz-Bravo, in press; Adúriz-Bravo and Izquierdo, 2001).

This relationship between both the two disciplines is based on *analogy*:. fFacing similar theoretical problems to those of the philosophy of science, didactics of science adapts philosophical constructs to its own purposes. We have labelled this mechanism of conceptual adaptation as *explanatory*. It is also interesting to mention the existence of an inverse theoretical movement, from didactics of science to the philosophy of science, which is slowly beginning to be developed (Adúriz-Bravo, 1999).

## **Rhetorical relationship**

Didactics of science has frequently made use of the philosophy of science as a general framework to support its proposals,. Didactics of science has tried to insert such proposals within a wider context, (a form of worldview, or *Weltanschauung*, ) which includes ideas about the nature, application, teaching and learning of science. These ideas have come from different philosophical schools; – one particularly worthy of note is *constructivism*.

Thus, the philosophy of science plays the role of a *narrative* (in the sense exposed by Lyotard, 1979), through which didactics of science validates its own discourse. Invoking coherence between the two

conceptual systems is used as a criterion of authority, based on the assumption of a superior epistemological status for philosophy (López Rupérez, 1990). The discourse constructed by didactics of science is inserted in a wider system of ideas that philosophy provides. We have called this relationship *rhetorical*, inasmuch as didactics of science constructs through it a narrative of *justification*.

### **Metatheoretical relationship**

The philosophy of science is concerned with the study of scientific knowledge in general, but also with the analysis of each academic discipline in particular (Estany, 1993). Didactics of science -Even if we do not decide to state *a priori* that didactics of science is a scientific discipline, -it can be taken as one of the objects of study by philosophers. Indeed it has been considered in this role by some scholars (e.g. Bunge, 1976; Gilbert and Swift, 1985; Estany and Izquierdo, in press).

Apart from this standard philosophical analysis, in moments of rapid growth, of theoretical or methodological crisis, or of search for consolidation, metatheoretical concerns play an important role within scientific disciplines (Piaget, 1970). Such self-reviewing philosophical research is made from *within* the disciplines (Adúriz-Bravo, 1999). Didactics of science has also explored internal metatheoretical issues, though not very extensively (Porlán, 1998; Adúriz-Bravo, 2000; Gil-Pérez et al., 2000; Estany and Izquierdo, in press).

This fifth relationship places emphasis that didactics of science can be an object area of study for philosophers of science (Adúriz-Bravo, 2000), completing in this way the conceptual system that we have proposed. It is only in this relationship that the philosophy of science properly works as a *metadiscipline* regarding didactics of science (Estany, 1993).

### **Conclusions**

The first remarkable feature to arise from our study is the partial symmetry in the relationships that we have proposed between the philosophy of science and didactics of science. Analyse, for instance, the two

*discipline versus object* relationships (material and metatheoretical), and the two *contents of discourse versus frame for discourse* relationships (instrumental and rhetorical). Such symmetry comes from the privileged position of these two disciplines (which they share only with the history of science and, to a certain extent, with the sociology of science) as specific *metadisciplines* of the natural sciences (Adúriz-Bravo, 1999). The philosophy of science and didactics of science can take up this position because of their metadiscursive nature, which allows them to make reference to themselves and to one another.

However, this symmetry is partly broken in the relationship that we have called explanatory. Due to its short academic life, didactics of science, due to its short academic life, frequently draws on external conceptual systems to construct theoretical explanations (Adúriz-Bravo, 1999; Gil-Pérez et al., 2000). Such directionality is at present being reverted in several aspects, especially through the mutual collaboration of these two disciplines in research in the area of *cognitive science* (see examples of this in Giere, 1992).

We have designed our classification system with two main purposes: a *meta-analytical* purpose that recognises the need for clarification in a rapidly growing area of research, and a *didactical* purpose, related to the need of *teaching* didactics of science to prospective and in-service science teachers (Adúriz-Bravo, 2001).

Finally, something should be said about the possible usefulness of our analysis for both disciplines. As for didactics of science, we think that a classification of the relationships with the philosophy of science is essential, due to the youth of the discipline and the rapidly growing variety of connections, that make separate and specialised study rather difficult. As for the philosophy of science (and particularly for its teaching), it can be illustrative and illuminating to analyse its metadiscursive nature, and its current relationships with other metadisciplines, in a specific example like the one that we have presented in this paper.

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