ISSA Proceedings 2006 – On The Role Of Pragmatics, Rhetoric And Dialectics In Scientific Controversies

1. *Introduction*

Scientists use natural language with a formal orientation to report the results of their scientific works. This formalism may include logics and mathematics. Even when this is the case, however, extensive use is made of natural language. Other than in communicating their findings, language is used by scientists in the proper building of science. In other words, language is constitutive of science, as it is of all other social human activities. In this preliminary work I study aspects of the use of language in the actual production of science. Specifically, I have in mind that activity by scientists of informal discussions with colleagues, as might start in coffee-breaks, or as happens in more regular meetings. These discussions, sometimes contentious, are often responsible for new ideas, that can solve scientific problems.

As Laudan rightly asserts, the fundamental aim of science is the solution of problems, while scientific theories may be considered as "attempts to solve specific empirical problems about the natural world" [Laudan, 1977]. Epistemology, dealing with questions concerning knowledge, tries to explain how such solutions and theories are created and critically evaluated, thus accounting for the growth of knowledge.

From Aristotle, and up to the first half of last century, scientific endeavor and the resulting science have always been considered as epistemically certain and undisputable. Yet, in practice, the activity of scientists has ever been immersed in controversies. Reflecting this contradiction, epistemology in the last decades has been troubled by a dichotomy, that either considers science from a normative viewpoint or from a descriptivist one.

Recently, I had the opportunity to elaborate a model of the practice of science for epistemic use [Ferreira, 2005], which aims at solving the impasse of this dichotomy in favor of an intermediate acceptable position. In this paper I will deal with some language aspects of that model, wherever it applies to spoken language cases of the practice of science. In what follows I will present an outline of the model, to subsequently briefly discuss the incidence of rhetoric, dialectic and pragmatics in relation to the epistemics of the model. I finish by revisiting a related case of the practice of science, in terms of the use of language.

2. *The model*

The production of scientific theories is described by this model as a unified and interactive process of generation (discovery, invention) and justification. The implicit feedback mechanism between justification and discovery consists in advancing or justifying a hypothesis from the evidence of data or from established results, a process called generative justification [Nickles, 1985]. More explicitly: starting with a problem, a scientist tries to find a solution to it, by searching heuristically the space of data and previous knowledge. The assessment of the hypothesis' plausibility, or some assurance of its correctness, comes from the context of justification, as hypothesis' generative support, reducing its conjectural status. Let us remark that this is quite different from justifying a claim indirectly by testable consequences, as in Popper's model, where discovery is considered only a psychological process, devoid of epistemic interest. It is appropriate to stress that the model here presented is a unified model of scientific problem solving and theory production, and that it recovers an epistemic role for the discovery/generation context.

In the derivation of the above model, use is made of the consideration of the need for efficiency of research activities, which imposes a connection between generation and justification. This allowance for efficiency of means to ends adds to the epistemic *rationality* of the process, contributing to enlarge the amplitude of this concept. The remarkable consequence of this feature, however, is that it connects the epistemic appraisal of science to the work of practical scientists. This translates to saying that rationality becomes agent-dependent [Laudan, 1996, 128]. When deciding on how to use experimental evidence to better support a hypothesis, or, on less than rigorous heuristic procedures, the strategies of different researchers will usually vary. Different individual background assumptions and cognitive aims may bring what should be a "rational discussion" down to (or up to!) a controversy. This points to the controversial character of science in practice, as corroborated by its history, but generally not acknowledged at all.

Regarding our modeling task, this characteristic of science renders the above model incapable of representing the activity of real scientists. However, it suggests that, somehow, to represent science properly the model should incorporate that controversial aspect! And that is what I propose: to embed the concept of controversies in the previous model.

In proceeding to this intent, use is made of the concept of controversies, as formulated by Marcelo Dascal [1995, 2003 p. 280]. Very briefly, *controversies* are a type of dialogical polemical exchange between at least two persons, who confront each other in oral or written debates. In the case of scientists, the unpredictable reactions of the opponents, as characteristic of these polemics, and the protagonist's responses, guarantee the necessary criticism for assuring the rationality of the process of searching for solutions to scientific problems or to developing theories. In [Ferreira, 2005], I have argued for the following two claims:
1. The incorporation of the concept of controversies gives my previous model the ability to account for the activity of scientists closer to reality than the other available models (of Popperian or Kuhnian extraction), and
2. Scientific controversies form a privileged, if not the most appropriate, argumentative environment, that renders possible the invention and justification of new scientific theories. The acceptance of these claims can be verified by anticipating, or rather observing, the process of development of scientific controversies in practice, identifying the moves from discovery/generation to justification, and vice-versa. The model, in brief, recovers an epistemic role for discovery and it allows analyzing science closer to reality than other available models. As all models, however, it may not represent well all epistemic aspects of the activity of scientists.

3. *The use of language in the practice of science*
The practice of science is actually organized to be controversial, considering its procedures of daily discussions with colleagues, scientific conferences, the refereeing of papers, proposals for research funding, public debates, etc. In all these activities, the use of natural language is ubiquitous. The role played by language in our model, however, is very different from the one in the positivists' and neo-positivists' models. In the later, language is used to examine logically, in the form of statements or propositions, the ideas of discovery, and to passively register the accumulation of scientific justified results, as Meyer (1980) asserts.

This author argues properly that scientificalness cannot be disclosed by the language used in science in the form of scientific statements. In the proposed model, on the other hand, language has a very important active role, being constitutive of the whole process of the practice of science as a controversy-based activity carried out by scientists. This scientific endeavor is one of human activities that demands our cognitive capacity at its maximum, where language plays the roles of “environment, resource and tool of cognition” [Dascal, 2004], in intimate interaction with thought.
Accounting for the paramount importance of language in scientific controversies, the toolbox to use for its study should contain several disciplines for language studies, and mostly, pragmatics, rhetoric and dialectics, considering that controversies are instances of language use, moreover spoken language use. The importance of dialectic and rhetoric to describe and promote dialogical understanding and interpretation closely related to science was first recognized and theorized by Aristotle. Only recently, however, have these arts been considered as possible cognitive tools for the formation of modern scientific theories and the appraisal of scientific progress. Pragmatics, introduced by and after Paul Grice for elucidating aspects of the communicative function of language, is the appropriate instrument to study controversies, according to Dascal [1995].
The whole process of epistemic assessment of the practice of science in terms of controversies is not all-transparent, however. If one thinks of the individual researcher as a member of a research team, it is fair to accept that he would build for himself a controversy-oriented attitude, in order to anticipate the polemical confrontations he might face in his daily practice. To take account of that, I have suggested that scientific controversies unfold in a dual space of inter- or external, and intra- or inner controversies [Ferreira, 2005]. In other words, scientific controversies comprise a dual dialogical argumentative space, internal and external to the knowing subject.

4. *An example of scientific of controversy*
To illustrate this brief study of controversies by means of language, I will use an example of a real scientific controversy, described in [Ferreira, 2005], from where I use parts of the same text, as composed from interviews, and which appear here between quotations marks. The protagonists are researchers whom I know**[i]**, and who allowed me to report and comment on their accounts. To facilitate the exposition, I will call them A, B and C. I interviewed them separately, and at

different times, because of logistic conditions. At the time of the interviews they were not informed of the concept of controversies, and as far as I know, they did not know it.

This controversy belongs to systems theory, a subject of applied mathematics and engineering. This is interesting, because it shows that controversies can happen even within the mathematical sciences. However, it will be described here without any formulas or equations. A more complete analysis of the controversy, including some mathematical expressions, is promised to appear.

“The debated problem deals with the notion of decoupling for implicit and generalized systems. The polemic started when analyzing a simple example of a system, from whose state and output equations it was possible to see that a disturbance input is eliminated from the output expression, and so does not influence the output. However, the same expression also shows that the initial condition of the output is influenced by the initial condition of the disturbance – which is incompatible with the standard notion of decoupling. Based on this last fact, two of the researchers, say, A and B, defended the view that the perturbation influences the output, and the third one, C, the originator of the discussion, argued that it does not”.

I start now describing some of the polemical moves of the controversy, as recovered from the recording of the interviews, and concomitantly, analyzing the corresponding language that would have been used. This is, of course, a virtual language. The fact that we do not have a recording of the actual utterances that were exchanged limits drastically the possibilities of analysis.

“In the beginning, C had to convince the others of the mathematical interest of the problem under discussion. In the first two or three days, the confrontation went off as a dispute, where opinion and emotion prevailed over arguments, and where each one complained that he did not understand the point of the others, or to be misunderstood by them”. This starting part of the controversy pertains to the question of acknowledging what is at stake, with very polemic corresponding moves. The nature and relevance of the problem were disputed. The controversy spreads rapidly favoring the focus on new topics relevant to the initial problem. The scope of the problem is enlarged and finally becomes more clearly delineated. The reasons for the lack of mutual understanding at the beginning may be due to unshared undisclosed interpretative assumptions. Our epistemic model, however, allowing controversial generative-justifying criticism, can contribute to render hypothesis less biased by background beliefs, increasing the possibility of justifying a hypothesis within common grounds. The pragmatics of the discourse is of paramount importance at this stage, because communicating ones intentions and understanding others' is most relevant to decreasing the polemic content of the interchanges.

"In the sequel, with arguments more philosophical than mathematical, C, dialectically adopting the point of view of B, and using B's standard definition of decoupling, conceded that the system of the example discussed should be declared as not decoupled from the disturbance. However, the consequences of this result would not be so interesting from a theoretical perspective, since then it would be very difficult to find examples of decoupled systems at all". At this stage, the controversy becomes more argumentative, and the moves are dialectical and rhetorical. (See [Van Eemeren & Houtlosser, 2002] for studies on these perspectives in argumentative discourse analysis). Since at this stage the mutual understanding is better established, the prevailing intention is to persuade the opponents. The use of persuasive arguments by one of the contenders may motivate another participant to initiate an inferential process, which might permit the appreciation of a different viewpoint, or perhaps add some new feature, to achieve a more comprehensive understanding of the problem. Appeals to logos are present, but also to order and pathos. Style of reasoning starts to appear, as the controversy tends to a discussion. However, pragmatics is always important in controversies and we should consider the 'marriage of pragmatics and rhetoric', as attempted in [Dascal 2003, p. 600].

In continuation, after much discussion, A, now willing to accept the decoupling hypothesis (that is, in terms of the model, 'reasoning to the item being justified'), began to agree that it might be interesting to consider a weaker definition of decoupling. From this moment on, in reality, the participants found themselves contending about which concept of decoupling was significant for the problem discussed. It resulted that with a weaker definition of decoupling the exemplified system could be, after all, considered decoupled.

The evolution of this controversy, from the initial dispute to the final resolution, through the criticism of the confrontation process, led to the disclosure of the interpretative background assumption underlying the standard definition of decoupling. The whole process extended along one month, with almost daily meetings. The participants expectations, as regards the possibility of a solution, often changed from optimism to pessimism and vice-versa. On the other hand, in the last stage of the controversy, the time needed to formulate precise mathematical definitions and to elaborate the necessary proofs was much shorter than in the preceding stages.

It should be said that this controversy, as one might imagine, also occurred within the inner reflections of each participant, when anticipating the next day's moves [Ferreira 2005]. In this inner space of the controversy, language is used in mental processes, and is studied as such by *psychopragmatics* [Dascal 2003, p. 422].

NOTE

[i] One is my colleague, Paulo Sérgio Pereira da Silva, from the University of Sao Paulo. The other two are Emmanuel Delaleau, from École Nationale d'Ingénieurs de Brest, and Michel Fliess, from École Polytechnique, in Paris. I am grateful to them for the interviews.

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