

The language  
of school  
textbooks and  
the ideology  
of science

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próxima  
edición

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FECHA DE RECEPCIÓN: AGOSTO DE 2000

ABSTRACT

*Much research has been devoted to problems related to the comprehension of science textbooks. However, less attention has been paid to their representation of science as such. This paper presents aspects of research aimed at characterising the language of texts used in social and natural science courses, and its influence on learning processes. One central aspect is the worldview implicit in the language. This was investigated through analysis of transitivity and ergativity, grammatical metaphor and modality. Results suggest that science is presented as a series of events, classifications and definitions, in an impersonal context. Science as a human activity is absent. The results of scientific endeavour are presented as unquestionable facts. Thus, the learner is excluded from participation in scientific activity and restricted to the role of passive observer. This, combined with the power hierarchies inevitably involved in classroom interaction, leaves the learner in a position of helplessness in the face of a knowledgeable elite.*

**KEY WORDS:** *Textbooks, transitivity, ergativity, grammatical metaphor, modality.*

## 1 Introduction

In a reflective essay published in 1985, P.J. Fensham observed that "the majority of the school population learns that it is unable to learn science as it has been defined for schools." In their 1990 comment, Gott and Mashiter go even further: "We think the problem is even deeper in that public perception of science almost requires that it be incapable of understanding; it only becomes science when it is not understood." In this paper, I shall attempt to show some of the ways in which the language of school science textbooks, in both social and natural sciences, reinforces this view of science as incomprehensible and therefore inaccessible for the majority of school-children.

A good deal of research has been carried out over the last two decades with regard to the causes of high failure rates and low motivation in school science classes. Most of this work has focused either on the content and, more particularly, the readability of textbooks (for example, Davies and Greene, 1984; Lunzer et al., 1984; Davies, 1990; Britton et al., 1993; Beck et al., 1995; Sánchez, 1996) or on the teaching methodology generally employed in classrooms and the structure of the curriculum (for example, Driver et al., 1985; Rogoff, 1993; Bennett and Dunne, 1989; Edwards and Mercer, 1987; Gott and Mashiter, 1990). In addition Halliday and Martin (1993) have noted some of the characteristics of

written scientific discourse which make it difficult for the uninitiated to read and understand.

Recent research carried out with a group of colleagues at Universidad del Norte in Barranquilla, Colombia<sup>1</sup>, suggests that the representation of science embodied in the language of school textbooks is another important factor in the discouragement of school-children from scientific endeavour. In this paper, following a brief summary of the research, I shall be looking at three aspects of this representation, namely, the view of science as product rather than process, the dehumanisation of science and the illusion of certainty; it is our belief that these three characteristics of the discourse of school science are, in effect, three forms of linguistic exclusion from the world of the scientific elite.

## 2 The research project

The data presented in this paper form a part of a research project carried out at Universidad del Norte in Barranquilla, Colombia with the objective of discovering and describing the various ways in which the lan-

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1 The project, entitled "El lenguaje de los textos escolares en Ciencias Naturales y Ciencias Sociales y su influencia en los procesos de aprendizaje", was carried out from 1995 to 1998 by Diana Ávila, Norma Barletta, Solange Carreño, Diana Chamorro, Jorge Mizuno, Gillian Moss and Carlina Tapia with the support of the Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología "Francisco José de Caldas" (COLCIENCIAS) and the Universidad del Norte Research Centre (CIUN).

guage of school textbooks influences learning processes in natural and social science subjects, concentrating on eighth grade, that is to say, ages 12-14. Initially, we carried out a survey to discover which were the most frequently used texts and chose the two most frequent from each of the two fields specified, for a total of four books<sup>2</sup>. We then undertook the search for schools where we could carry out observations of the use of these books in the classroom and selected the chapters or units to be analysed according to the teachers' plans for the observation period. The following types of analysis were applied to the chapters thus selected:

- topic type and information constituents (Davies and Greene, 1984)
- textual units (Davies 1994 and personal communication, 1992)
- transitivity and ergativity (Halliday, 1994)
- modality (Halliday, 1994)
- grammatical metaphor (Halliday, 1994; Halliday and Martin, 1993)
- lexical density (Halliday, 1985/1989)
- thematic development (Halliday, 1994; Fries, 1981/1983)

Results of this analysis and some initial reflections on possible sources of comprehension difficulties are presented in a recent publication (Moss et al., 1998). Transcriptions of observations and interviews were

2 The books selected were: in Social Sciences, *Sociales 8*, Editorial Santillana and *Civilización 8*, Editorial Norma; in Natural Sciences, *Investiguemos 8*, Editorial Voluntad and *Descubrir 8*, Editorial Norma.

analysed, leading to a categorisation and characterisation of both learner and teacher discourse, indications of levels of comprehension and learning on the part of the students, and approaches to the use of the textbook on the part of the teachers. In the final stages, we studied the interaction between the three elements (text, learner and teacher) and attempted to establish correlations between them. Some of the results of this second stage in the analysis, together with some suggestions for teachers will be published shortly (Colectivo Urdimbre, 2000).

### 3 Science as product not process

One of the salient characteristics of all the four books analysed is the tendency to present science as a body of immovable and unquestionable data, rather than as an ongoing process of discovery, hypothesis and adjustment. In terms of discourse, this view is embodied in the high frequency of grammatical metaphor (Halliday, 1994) in the form of nominalisation and the high percentage of relational processes in the transitivity system (ibid). As has been cogently argued by Gill Francis, nominalisation is a form of linguistic expression which tends to objectify and make static phenomena which in the real world are dynamic and changing:

Nominalisation is a synoptic interpretation of reality: it freezes the

processes and makes them static so that they can be talked about and evaluated. In other words, they are no longer about what is happening, but what is being internalised and 'factualised' by society as to the status of what has already happened: the relationships between events rather than the events themselves.

Nominalisation also implies information loss in that features such as time sequence and completeness versus incompleteness are lost along with the tense and aspect which normally express them in the corresponding congruent verbal forms. The upshot is that learners are faced with a set of data with which it is difficult or impossible to interact. Statements about actions, which might more easily be questioned, are replaced by simple presentations of "things/facts" which must be either memorised for future repetition or simply passed over. Here are some examples from the texts we have studied, the first from a Social Science text, the second from the field of Natural Sciences<sup>3</sup>; relevant nominalisations have been underlined:

(1) [Napoleón] cayó en desgracia con los jacobinos, pero el cese del Terror, la amistad con miembros del Directorio y su matrimonio con Josefina (...) le valieron el ascenso a general de división y el mando de la campaña de Italia.

<sup>3</sup> Details of sources of examples are given in the section entitled EXAMPLES which follows this NOTES section.

'[Napoleon] fell into disfavour with the Jacobins, but the end of the Reign of Terror, his friendship with members of the Directory, and his marriage to Josephine (...) won him promotion to the rank of general and command of the Italian campaign.'

(2) La respiración pulmonar es la que se realiza con pulmones. Los anfibios, los reptiles, las aves y los mamíferos poseen este tipo de respiración.

'Pulmonary respiration is that which is carried out with lungs. Amphibians, reptiles, birds and mammals have this type of respiration.'

In example (1), the topic is a series of events in the early career of Napoleon which would more 'naturally' be expressed as a narrative with a series of material processes: ended, befriended, married, was promoted, commanded. The nominalisation process turns these actions into fixed states and robs them of time and aspect, making it more difficult for the inexpert reader to interpret the time sequence and transitivity relations involved. In example (2), we find that respiration is transformed from a physiological activity into an object which is 'possessed' by certain types of animal. Again, this puts the phenomenon at a distance and makes it more difficult for the learner to identify with his/her personal experience (Imagine asking someone "What type of respiration do you have?"). This distancing and factualising effect is compounded by the fact that the

processes most frequently nominalised tend to be those which are central concepts of the topic under consideration; in the two chapters on respiration, for example, the verb *respirar* 'breathe', appears only four times, while the nominalisation *respiración* 'respiration, breathing' appears more than sixty times. The effects of this are further intensified by the high frequency of relational processes used to link nominalisations as opposed to other types of process which indicate actions of one type or another. This feature will be looked at in more detail in the following section.

#### 4 The dehumanisation of science

Analysis of the four texts revealed several discourse features which tend, individually, to impersonalise the content being presented: absence of mental, verbal and behavioural processes; high frequency of relational processes used to express identification and classification; lack of ergativity; frequency of nominalisation. This section presents our findings as regards these four features, which, taken together, present a highly dehumanised vision of science.

In our analysis of the transitivity system evidenced in the four texts under study, we found the following distribution of process types (see Table 1: Distribution of process types).

The high proportion of material processes found in both areas was in accordance with our expectations; the description of historical events in the case of Social Sciences and of chemical and physical reactions in the case of the Natural Sciences almost inevitably involves the use of a large number of material processes. What we found surprising was the distribution of the other types of process. It seems extraordinary that in the Social Sciences which purport to describe the development of human groups and the relations between them, the essentially human verbal and mental processes should be so extremely scarce, and the behavioural virtually non-existent. Similarly, taking into consideration the fact that the units analysed in Natural Sciences were about Biology, the lack of behavioural processes is most striking. In both cases, the absence of verbal and mental processes is symptomatic of the lack of reference to the processes of scientific research, communication and discovery as human activities. We thus find that both the human aspects

Table 1: Distribution of process types

Field \ Process	Material	Mental	Relational	Behavioural	Verbal	Existential
Social Sciences	43.5%	6.5%	33.5%	0.5%	13%	3%
Natural Sciences	39.5%	6%	42.5%	5.5%	4.5%	2%

of the object of study and the human scientist involved in carrying out that study are systematically excluded from the discourse of these text books.

This 'dehumanisation' effect is highlighted even further by the high proportion of relational processes present in both fields, laying emphasis on identification, naming, classification and listing of parts. For example,

(3) El aparato respiratorio humano está formado por las vías respiratorias y los pulmones.

Las vías respiratorias

Son las encargadas de transportar el aire desde el medio ambiente hasta los pulmones y viceversa.

Las vías respiratorias comprenden las fosas nasales, la faringe, la laringe, la tráquea y los bronquios.

'The human respiratory system is made up of the respiratory ducts and the lungs.

The respiratory ducts

These are responsible for transporting air from the atmosphere to the lungs and vice versa.

The respiratory ducts comprise the nostrils, the pharynx, the larynx, the trachea and the bronchi.

(4) A comienzos del siglo XIX, Canadá tuvo un desarrollo diferente al de los Estados Unidos. Era una colonia de la Corona que se había organizado de acuerdo con el Acta de Quebec (1.774) en dos provincias, Alto y Bajo Canadá. Partiendo de este aspecto, el desarrollo canadiense tuvo los siguientes elementos: ...

'In the early 19th century, Canada's development was different from that of the United States. It was a Crown colony which had been set up according to the Quebec Act (1774) as two provinces, Upper and Lower Canada. As a result of this, Canada's development had the two following features: ...'

A further feature of the transitivity system found in these texts adds to the 'dehumanisation of science' picture: non-ergativity. The proportions of ergative and non-ergative processes found in the texts is shown in Table 2.4 (see Table 2: Proportion of ergative and non-ergative processes<sup>4</sup>)

Thus a large number of phenomena, most particularly in the Natural Sciences, are presented with no reference to a causal agent and, therefore, in some sense, self-generating. Some examples follow.

(5) El proceso de expansión [de Estados Unidos] comenzó con la necesidad de iniciar la conquista del oeste.

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4 Although we occasionally came across verbal or mental processes which could be considered ergative, the concept of ergativity is principally applicable to material processes; Table 2, therefore, refers to proportions of ergative and non-ergative material processes. Processes expressed in passive voice were counted as ergative as an agent is implied even when expressed.

Table 2: Proportion of ergative and non-ergative processes

FIELD \ ERGATIVITY	ERGATIVE (MATERIAL) PROCESSES	NON-ERGATIVE (MATERIAL) PROCESSES
Natural Sciences	48%	52%
Social Sciences	65.5%	34.5%

'The [U.S.] expansion process began with the need to undertake the conquest of the West'

(6) Apareció entonces la idea del sueño americano ....

'Then the idea of the American dream appeared ...'

(7) [A la laringe] se le conoce regularmente con el nombre de nuez o manzana de Adán.

'[The larynx] is generally known as the Adam's apple.'

(8) Los cromosomas reciben diferentes nombres, a saber: ...

'The chromosomes receive different names, such as: ...'

(9) Los análisis químicos de los cromosomas revelaron que los genes se encuentran formados por ADN (...) y proteínas (...).

'Chemical analyses of chromosomes revealed that genes are made up of DNA (...) and proteins (...).'

In the case of example (5), one is tempted to ask 'who?' Who expanded the U.S.? Who felt

the need to conquer the West (and why?)? Who conquered it? Example (6) shows the American dream arising out of nothing, by spontaneous combustion, as it were<sup>5</sup>, with no explanation as to how or why it arose or who was responsible. (7) and (8) exemplify the tendency to present as simple matters of fact the dictates of the scientific community as regards classifications and labelling, with no recognition of the processes involved in the setting up of taxonomies and categorisation of natural phenomena nor of the need to reach consensus. Example (9) is a case of the disappearance of the human scientist. Chemical analyses, apparently, carry themselves out and reach their own conclusions.

The dehumanisation of science in these texts is rounded out by the use of nominalisation. In section 2 above, I made reference to the loss of information regarding time and aspect implied in the use of nominalisation. Here I shall present two examples of the way in which nominalisation also

5 This seems particularly questionable when we consider that this textbook is in use in a Third World country which is especially vulnerable to U.S neo-imperialism.



entails loss of information as regards the agents involved in both natural and social processes.

(10) La incorporación del oxígeno y la eliminación del gas carbónico en los animales se puede llevar a cabo de cinco formas diferentes, las cuales dan origen a cinco tipos de respiración ...

'The incorporation of oxygen and the elimination of carbon dioxide in animals can be carried out in five different ways, giving rise to five types of respiration ...

(11) La impopularidad y las represalias de los Borbones provocaron el regreso de Napoleón de la isla de Elba, donde estaba desterrado ...

'The unpopularity and reprisals of the Bourbons led to the return of Napoleon from the island of Elba, where he was in exile...'

The lack of agency is particularly confusing in the case of the Social Science text, example (11), where the reader is left wondering who was unpopular with whom, by and against whom the reprisals were carried out and whether Napoleon returned on his own initiative or was returned by some other power.

## 5 The illusion of certainty

One of the grammatical systems we examined in the course of our analysis of the four textbooks chosen for the study was that of modality. I

shall refer here to the feature of modalization as defined by Halliday (1994:89) as "scales of probability and usuality" and realised in modal verbs, subjunctives, conditionals and modal adjuncts. The results were unequivocal; modalization simply does not form a part of the discourse of these texts. In the two of texts, one in each of the two fields, we found no examples whatsoever of modalization and, in the other two, one example each. That is to say, the information covered in the texts is presented in terms of absolute certainty and universality, further distancing the learner from both the possibility of critical engagement with the text and the recognition of science as a human activity which inevitably involves uncertainty, hypothesis, reassessment, probability and so on.

## 6 Conclusions

In the preceding lines, I have attempted to show that aspects of the discourse of school textbooks in the Natural and Social Sciences present a vision of science as a set of unassailable facts, isolated from the everyday world and inaccessible to the common run of human beings. The presentation of science as product, as a set of fixed and finished data, the omission of the human being as both subject and object of scientific enquiry, and the disregard for notions of uncertainty, so central to the contemporary understanding of science, all contribute to the placing of science at a distance

from the world of the learner. It might be argued that the discourse features described here are normal features of scientific discourse and that learning to cope with them is an integral part of learning science. While this is true to some extent, there are, I believe, two serious objections to this approach:

- we are dealing here with science education and not science as such; presenting learners with this type of language from the start is like throwing them into the deep end of the swimming pool to sink or swim as best they may;

- as suggested by Halliday and Martin (1993), this type of discourse is rooted in the positivist tradition and appears much less appropriate in the context of probability and uncertainty of contemporary science.

It is our belief that this phenomenon increases the difficulties inherent in the learning of science by alienating the learner from scientific activity and reinforcing the prevailing ideology of science as incomprehensible and inhuman. This, in turn, adds to the difficulty of the task of educational institutions in both the encouragement of students with the talent and inclination to become future scientists and the formation of members of the general public who, while not actively involved in scientific activity, are willing and able to engage in critical discussion with those who are. ■

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### Examples

1. *Civilización*, p. 14
2. *Descubrir*, p. 106
3. *Investiguemos*, p. 93
4. *Ciencias Sociales*, p. 127
5. *Ciencias Sociales*, p. 123
6. *Ciencias Sociales*, p. 123
7. *Investiguemos*, p. 94
8. *Descubrir*, p. 88
9. *Descubrir*, p. 89
10. *Investiguemos*, p. 86
11. *Civilización*, p. 19