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## **The Pedagogic Discourse of the Greek School Science Textbooks of Primary and Lower Secondary Level**

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### **Introduction**

The aim of this paper is the mapping of the pedagogic discourse in the Greek school science textbooks of the primary and lower secondary level. School science textbooks are considered as means of regulating the pedagogic discourse of each of the educational levels. This approach stems from the view that science education (and education in general) is a socialization process into the practices and conventions (i.e. the discourses) of sub-communities, in our case of the scientific community (Lemke, 1990). Within the framework of this view, science textbooks have a central role to play in this socialising process as a resource for shared meaning making (Lemke, 1990; Bazerman, 1998).

### **The issue of textbooks in the science education literature**

The issue of school science textbooks has been a major research topic within the science education research tradition. During the seventies textbooks readability studies were quite popular but interest in them gradually faded. The interest though for science textbooks as a research topic has been sustained since a literature search in the ERIC database for studies on the school science textbooks in the period 1985-2005 revealed 258 relevant studies. These studies can be grouped, according to their particular focus, into the following categories: (a) studies which focus on elements of textbooks, such as the content, vocabulary, illustrations used; and (b) those considering the principles that organize the content and the form of presentation by conceiving textbooks as texts playing a crucial role in the determination of practices and social positions within the pedagogic discourse (Koulaidis and Tsatsaroni, 1996).

This study belongs in the second of the two aforementioned categories, since it aims at addressing both the issue of the relationship between scientific knowledge and school knowledge and the issue of the nature of the pedagogic relationship as well.

### **Theoretical framework**

Our basic hypothesis is that the pedagogic discourse is constructed by the interplay of three basic dimensions, namely classification (Bernstein, 1996), formality (Halliday and Martin, 1996) and framing (Bernstein, 1996).

In particular, classification determines the epistemological relationship between knowledge systems (Bernstein, 1996). In our case, the knowledge systems examined are specialised scientific knowledge and every other form of knowledge lying closer to the everyday

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common-sense realm like mythology, religion, popular culture, practical knowledge, etc. By definition, strong classification formulates well-defined borderlines, while weak classification results in blurred borderlines between these two types of knowledge (Bernstein, 1996).

Formality corresponds to the degree of abstraction, elaboration and specialisation of the expressive codes (i.e. linguistic and visual) employed. Low formality corresponds to codes resembling very much the vernacular or realistic ways of expression that ordinary people use. On the other hand, high formality corresponds to the specialised expressive codes following the conventions that scientific experts use when communicating through them (Halliday and Martin, 1996; Kress and van Leeuwen, 1996).

Classification and formality combined, determine the degree of scientificness of a particular pedagogic discourse. In specific, the combination of the two values that can be ascribed to classification with the two values that can be ascribed to formality (strong and weak) produces four different potential modalities of the science education pedagogic discourse, namely the esoteric, the metaphorical, the public and the mythical one (Dowling, 1994 for Mathematics and Koulaidis & Tsatsaroni for natural sciences) (see Fig.1). The degree of scientificness of the pedagogic discourse increases if one moves from the public (non specialized content and codes, e.g. newspapers science) to the metaphorical (specialized content and non-specialized codes e.g. popular scientific magazines) and from there to the esoteric modality (specialized content and codes e.g. specialized journals). The mythical (specialized codes but non specialized content e.g. science fiction books) is a theoretically potential modality but it very rarely describes real pedagogical practices. For this reason it will be excluded from further consideration within this paper.

	<b>Strong Classification</b>	<b>Weak Classification</b>
<b>High formality</b>	Esoteric (academic textbooks)	Mythical (science fiction)
<b>Low formality</b>	Metaphorical (primary textbooks)	Public (media texts)

**Figure 1.** The pedagogic modalities projected in science textbooks and emerging from the combination of the levels of classification and formality.

Finally, in every pedagogic discourse a social interaction between the addresser of subject-matter (teacher or textbook's voice) and students is established. Framing determines which side, the addresser or the students has the apparent control over the pedagogic interaction (Bernstein, 1996). Strong framing means that the pedagogic control belongs clearly to the addresser while weak framing means that there is some space left to the students so as to exert their own control over the learning process.

Combining further, the dichotomized values of classification, formality and framing one can produce six modalities in order to describe the corresponding pedagogic practice (the mythical domain has been excluded from further analysis). These six modalities can be seen in a diagrammatic form in Figure 2. For instance the liberal esoteric pedagogy corresponds to highly specialized content and codes but weak pedagogic control and it could be projected for example in textbooks used in post-graduate academic studies where the students can be treated as knowledgeable young peers with significant degrees of freedom. On the contrary, while the

authoritarian public pedagogy corresponds to non-specialized content and codes as well as strong pedagogic control and could be projected in text materials used in a health education program for the general public where the main objective would be the provision in the form of strict guidelines and using non technical codes, of scientific knowledge that can be easily applied in the context of every day life.

		Framing	
		Weak	Strong
Scientificity & (classification & formality)	High	Esoteric liberal	Esoteric authoritarian
	Moderate	Metaphorical liberal	Metaphorical authoritarian
	Low	Public liberal	Public authoritarian

**Figure 2.** The pedagogic modalities projected in science textbooks and emerging from the combination of the levels of classification, formality and framing.

In this paper, the two dimensional mapping of the pedagogic modalities shown in Figure 2, will be used so as to describe the discursive transition of science subjects from primary to lower secondary education, at least as this transition is reflected by the use of the linguistic and the visual codes employed in the corresponding textbooks of each level.

**Methodology**

The texts analysed are taken from six science textbooks written in Greek and used in 9.823 Greek primary and secondary schools during 1997-2004. Specifically, these textbooks consist of: a) two general science textbooks for the two upper grades of primary school (11-12 year olds), b) two chemistry and c) two physics for the three grades of the lower secondary school respectively (13-15 year olds).

In order to implement our analytic plan, the textbooks were divided into units of analysis for both the linguistic and the visual mode. Specifically, in order to analyse the pedagogic modality projected by the linguistic mode, different genres within the textbooks were distinguished. These genres constitute the units of analysis. The genres appearing in the Greek science textbooks are reports, experimental accounts and historical accounts. In this way a total of 1153 units of analysis of the textbooksølinguistic mode were identified. Of these units 876 (76%) are reports, 205 (17.8%) are experiments and 72 (6.2%) are historical accounts.

On the other hand all the visual images contained in the six science textbooks were analysed. Any visual image in a distinct frame within the textbooks was considered as a single unit of analysis. Following this procedure, a sample of 2819 visual images was collected.

All the units of analysis for both the linguistic and the visual mode were analysed along the three theoretical dimensions of classification, formality and framing. The analysis was based on the use of two distinct grids of analysis, one for the linguistic and one for the visual mode, that consist of variables that become operational applying specific socio-linguistic and socio-semiotic approaches. Specifically, the basic underlying idea of the two grids is that certain lexico-grammatical and semiotic elements of the linguistic and visual mode respectively, modulate accordingly the levels of classification, formality and framing. For example while

formality in the case of the linguistic mode was evaluated in terms of the density of: a) scientific notation (terms, symbols and equations), b) nominal groups, c) verbs in passive voice and d) sentences in hypotactic syntax, the same notion in the case of the visual mode is evaluated on the basis of the degree an image is characterized by: a) elements like geometrical shapes and alphanumeric strings, b) color differentiation, c) color modulation and d) background differentiation. The two grids have been extensively presented in other publications of the authors (Koulaidis, Dimopoulos and Sklaveniti, 2003; Dimopoulos, Koulaidis and Sklaveniti, 2005).

## Results

Below, the results of the textbooks analysis in terms of the pedagogic modalities promoted by their linguistic and visual expressive modes respectively, are presented.

### The linguistic mode

The analysis of the school science textbooks of both levels showed that the vast majority of their linguistic units belong to the metaphoric modality (strong classification and low formality). Specifically, as shown in Table 1, the discursive transition that seems to occur through the linguistic mode of the textbooks is that of a very gradual introduction of students to the specialized content and codes of scientific knowledge as the latter proceed from primary to lower secondary school. This transition, however, does not seem to be completed at the lower secondary level as the textbooks still employ a linguistic mode that mainly projects a metaphoric modality.

Pedagogic modality	Primary textbooks		Lower secondary level	
	N	%	N	%
Esoteric	14	7.7	173	17.8
Metaphoric	141	77.9	699	71.9
Public	26	14.4	100	10.3
Total	181	100	972	100

**Table 1.** The pedagogic modality (in terms of classification and formality) promoted by the linguistic mode of the school science textbooks of primary and lower secondary level.

As far now as the level of framing projected by the linguistic mode, is concerned, it was found that the primary textbooks are characterized by much stronger framing than the textbooks of the lower secondary level (see Table 2). Thus, the science textbooks of primary level construct a social identity of students according to which, the latter are put in a subordinate social position and are highly directed towards the acquisition of the relevant subject-matter. On the contrary, the science textbooks of lower secondary level construct a social identity of students according to which these are highly autonomous learners who can access the relevant subject matter in their own ways.

Level of framing	Primary textbooks		Lower secondary level	
	N	%	N	%
Strong	87	48.1	26	2.7
Weak	94	51.9	946	97.3
Total	181	100	972	100

**Table 2.** The level of framing promoted by the linguistic mode of the school science textbooks of primary and lower secondary level.

The pedagogical message emerging by the data shown in Tables 1 and 2 is that, as students become gradually more experienced in science (by being introduced to texts characterized by stronger classification and formality) they are increasingly allowed to experience more autonomous ways of negotiating the terms of their participation in the learning process (weaker framing).

### The visual mode

The analysis of the visual images showed that the majority of them in the primary textbooks correspond to the public modality while in the textbooks of the lower secondary school correspond to the metaphoric modality (see Table 3).

Pedagogic modality	Primary textbooks		Lower secondary level	
	N	%	N	%
Esoteric	49	3.3	92	6.9
Metaphoric	516	34.6	742	55.7
Public	922	62.0	498	37.4
Total	1487	100	1332	100

**Table 3.** The pedagogic modality (in terms of classification and formality) promoted by the visual mode of the school science textbooks of primary and lower secondary level.

The results imply that the visual mode tends to play a similar role with the linguistic mode since both seem to function so as to gradually introduce students, as these move from primary to secondary school, into the more specialized discourses of scientific knowledge.

It is characteristic that especially in the primary school the visual mode is not so much employed so as to promote the conceptual understanding of the scientific content as to attribute a pre-eminent value to real world elements, the salience of which seems to be exploited as an (experiential) anchor to the introduction of students to the reified and highly abstract world of science (Dimopoulos, Koulaidis and Sklaveniti, 2003). With regards now to the level of framing promoted by the visual mode, it was found that the school science textbooks of both primary and lower secondary level promote a kind of social-pedagogic relationship characterized by weak framing (Table 4) thus tending to empower their readers so as to maintain their own control in the communication-pedagogic process.

Level of framing	Primary textbooks		Lower secondary level	
	N	%	N	%
Strong	303	21.8	174	15.6
Weak	1085	78.2	943	84.4
<b>Total*</b>	1388	100	1117	100
* These totals correspond to realistic representations only				

**Table 4.** The level of framing promoted by the visual mode of the school science textbooks of primary and lower secondary level.

### Discussion

The results from the analysis of both the linguistic and the visual modes employed in the science textbooks of both levels, show that the discursive transition that emerges is from the metaphoric-authoritarian towards the metaphoric-esoteric or metaphoric-liberal modality. In other words the main pedagogic transitions that occur as the educational level rises are primarily

the weakening of the pedagogic control and, secondarily an increase in the formality of the linguistic code employed (gradual move towards the esoteric modality). The latter is still moderate and remains uncompleted even in the textbooks of the last class of the lower secondary school (age level 15-16 years old).

The pedagogic message projected is that, as science students progress through the specialised knowledge domain, they become more capable of processing the textbooks' message in more individualistic and autonomous ways. In other words, the lower secondary textbooks treat students as independent learners that have control over how they learn and so they do not feel intimidated by the pace and the ways the textbooks deliver the relevant subject matter.

The trend imposed by the science textbooks of a gradual move towards more specialised forms of scientific knowledge (both content and codes specialised) with a parallel increase in the students' autonomy in determining how to access the relevant text material is in distinct opposition to the widely held pedagogic position, very often translated into teaching practice, which favours more guidance and fewer opportunities for initiative on the part of the learners, as the school subjects become more academic and content-specialised (Cazden, 1988; Rodrigues and Bell, 1995). This conflict could potentially explain the effects of disorientation and lack of ability to focus on the important pieces of information, experienced by many students at this level (and especially the less competent), while trying to make meaning out of the relevant textbooks (Yore, Craig and Maguire, 1998).

Furthermore, the comparison between the pedagogic modalities emerged by the linguistic and the visual mode of the science textbooks respectively, reveals that the visual mode tends to lower both the classification and the formality of the relevant texts. In this way though, by not being exposed to the conventions of the techno-scientific images students may be excluded from 'seeing' and 'processing' reality in a similar way with the experts (Lynch, 1985; Trumbo, 1999). On the other hand the visual mode tends to relate more to the public modality and hence it becomes the main vehicle for relating the every-day experiences of students with the scientific knowledge.

Closing this paper, it should be pointed out that the framework presented here allows the development of a common theoretical language so as to describe the pedagogic modalities projected by school science textbooks as well as by many other learning materials employed in science education. This theoretical language could enable both the authors of science textbooks and the teachers that use them to become much more reflexive about their pedagogic implications.

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