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Vasilis Koulaidis, Kostas Dimopoulos and Spyridoula Sklaveniti

Science and technology in the public domain are characterised by two opposing trends. On the one hand they are with increasing intensity present in the public domain (Gregory and Miller 1998) via a multiplicity of channels like the official pedagogic discourse and the mass media. On the other hand though, the level of the public awareness about science and technology seems to be alarmingly low (i.e. Eurobarometer 1993; Miller 2000). This trend is further reinforced by the growing anti-science movements and skepticism about the social impacts of science and technology as well as by the revitalisation of a large number of pseudo-scientific areas (Holton 1992).

Within such a social climate the role of the techno-scientific texts of the public domain is very important since they have a considerable contribution in the formation of the general public's 'image' about science and technology. The term 'public domain' is used here to name a communicative distinct field in which the techno-scientific knowledge is presented to lay-audiences—for example, students and the lay public. Typical of such texts are school science textbooks and science articles appearing in the popular press. These are part of a communicative continuum consisting of what Cloitre and Shinn (1985) call the fields of intra-specialist, inter-specialist, pedagogical and popular communication.

The archetype of the intra-specialist communication field is the techno-scientific articles that appear in specialised journals and are addressed to a very narrow community of experts. The inter-specialist communication field, on the other hand, consists of texts addressed to the wider techno-scientific community. The objective of these texts is to address people coming from a variety of neighbouring disciplines. Typical examples of such texts are the articles in journals like *Nature* or *Science.*

Pedagogical communication is the field that comprises texts that tend to present well-established theories to those who are being educated in science and technology. The purpose of such texts is to reproduce the current paradigms (Kuhn 1962, Fleck 1979, Hatzinikita, Koulaidis, Sklaveniti, Tsatsaroni 1996, Koulaidis & Tsatsaroni 1996), of each disciplinary area. The archetype of these texts is the school science textbooks.

Popular communication, in contrast, is the field containing all the techno-scientific texts of the mass media (press, television, popular magazines, and so on) as well as in semi-specialised magazines such as *Scientific American*, *National Geographic* or the French magazine *Science et Vie*.

The first two of the above fields, is shown in Figure 1, constitute the broader communication field within which the techno-scientific knowledge is communicated among the experts (techno-scientific domain) whereas the latter two constitute the field in which the corresponding knowledge is presented to non-experts (public domain).

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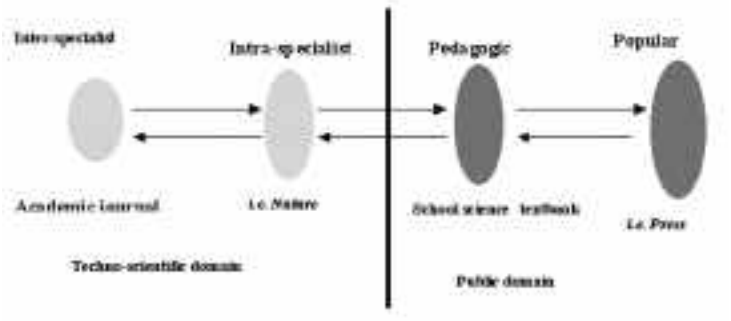


Figure 1: The Communication Continuum of Science and Technology

The techno-scientific texts as they move through the different communication fields are radically transformed. This transformation is described by the term 'recontextualisation'; a term coined by Bernstein (1996) to explain the discursive re-arrangements of a text so as it becomes compatible with the established social order and the dominant ideologies and modes of practice of each context (see page 3). In other words, we mean the process by which any text is transformed into a legitimate text of each context.

In order then to describe the process of re-contextualisation, we use the notions of 'classification', 'framing' (Bernstein 1996) and 'formality' of the employed codes (Halliday 1996). The first two notions correspond to two important functions of each text:

- the positioning of its readers in relation to the specialised body of the techno-scientific knowledge (classification)
- their social positioning as social partners in the communication act established by the text (framing).

The notion of formality corresponds to the degree of specialisation of the respective expressive codes. Classification and formality combine to determine the degree of 'scientificness' of a particular text, since by projecting the internal logic of a techno-scientific discipline (strong classification) and employing its specialised codes (high formality) a text clearly lies into the techno-scientific communicative domain.

More particularly, 'classification' determines the epistemological relationship between knowledge categories (Bernstein 1996). In our case, the categories examined are the specialised 'techno-scientific' and the 'everyday commonsense' knowledge. Strong classification formulates well-defined border-lines between these two types of knowledge while weak classification results in blurred border lines between them.

'Framing' determines the agency of the communicative act's control (Bernstein 1996). Strong framing means that this control belongs clearly to the addresser (that is, the educator or journalist) while weak framing means that there is some space left to the addressee (that is, student or press reader) so as to exert his or her own control over the communicative process. At this point it should be noted that the participants in the act of communication established by a text are regarded here to be the 'model reader' of the text on the one side and 'its implied author' on the other. By 'implied author' we mean a disembodied voice, or even 'a set of implicit norms rather than a speaker or a voice' (Rimmon-Kenan 1983, p.87)—or, better, 'it has no voice, no direct means of communicating, but instructs us silently, through the design of the whole with all the voices, by all the means it has chosen to let us learn' (Chatman 1978, p.148). Additionally, the text selects a 'model reader' through its 'choice of a specific code, a certain literary style' and by presupposing 'a specific competence' of the reader (Eco 1979, p.7).

The notion of framing can be conceptually further elaborated to the dimensions of:

- the power (hierarchical) relationships and
- the 'implied author's' control over the conditions for the 'model reader's' involvement established by the text.

Strong framing concerning the power relationships means that the 'implied author' stands in a higher social position in relation to the 'model reader', whilst weak framing means quite the opposite. Furthermore, strong framing at the level of the 'model reader's' conditions of involvement gives the 'implied author' full control in determining these conditions. Weak framing means that the 'model reader' has the potential for negotiating them.

Finally, formality corresponds to the degree of abstraction and specialisation of the expressive codes employed. Low formality corresponds to codes resembling very much the vernacular ways of expression or representing the realistic appearances of things whereas high formality corresponds to specialised codes that define reality in terms of abstractions and deeper regularities.

The discursive elements of the techno-scientific texts for non-specialists tend to modulate the levels of classification, framing and formality and hence to position their readers both in relation to the interior of the corresponding specialised knowledge and also as social subjects that take part in a specific communicative process. These discursive elements are the syntactic conventions of each representational mode and although the meaning is produced by all the modes involved (Kress and Van Leeuwen 1996; Lemke 1998; Jacobi 1999), our analysis will focus on the linguistic and the visual ones only.

In the following sections we will present two instruments for analysing the linguistic and the visual parts of techno-scientific texts, based on the concepts of classification, formality and framing. After this, these instruments will be applied for the analysis of school science textbooks and press articles about science and technology. The texts we will analyse are:

- six Greek science textbooks used in all Greek primary and secondary schools during the school years 1997–1999 (the secondary textbooks are still in use) and
- 1,867 press' articles published during the period 1996–1998 in four national Greek newspapers of broad readership.

Specifically, the six science textbooks consist of two general science textbooks of the last two grades of primary school (11–12 years old) and two chemistry and physics textbooks of the two last grades of the lower secondary school respectively (14–15 years old). The sample of 1867 articles about science and technology were selected from the newspapers *Vima* ('Forum'), *Eleftherotypia* ('Freedom of Press'), *Eleftheros Typos* ('Free Press') and *Kathimerini* ('Daily') using the sampling procedure of the 'constructed week' (Hansen, Cottle, Negrine and Newbold 1998). By the term 'constructed week' we mean a series of seven week-days (one Monday, one Tuesday, and so on), which correspond to randomly selected non-consecutive dates. For each newspaper four 'constructed weeks' per year of the period 1996–1998 were selected.

In order to implement our analysis, we divided the textbooks and the press material into units of analysis for both the linguistic and the visual mode. Specifically, when the linguistic mode was analysed, we distinguished different genres within them. According to genre analysis (Martin 1996; Cope and Kalantzis 1993) a text differs in structure according to its purpose. The genres appearing in the science textbooks are *reports*, *experiments* and *historical accounts*. The analytical framework is applied after the textbooks' chapters have been divided into units of analysis. In this way a sample of 1153 units was collected for analysing the linguistic mode. Of these units

876 (76%) are reports, 205 (17.8%) are experiments and 72 (6.2%) are historical accounts. Furthermore the unit of analysis of the linguistic mode for the press material is the full text of each article.

As far as the visual mode is concerned, the unit of analysis in both the school science textbooks and the press is any visual representation segregated by a distinct frame, either from the written text or from another visual representation. Following this definition, 2819 and another 1630 visual representations were collected from the six science textbooks and the press material respectively.

All the units were analysed along the three dimensions of classification, formality and framing.

The Instrument for Analysing the Linguistic Mode

Classification

The dimensions of classification, formality and framing consist of variables that become operational applying a specific socio-linguistic approach (Halliday & Martin 1996). More specifically, in order to identify the level of distinction between scientific and everyday knowledge (classification), we use separate criteria for the textbooks and the press material respectively. The need for the adoption of separate criteria is imposed by the differential aims and functions of each type of text.

Science textbooks aim primarily at leading the students from the everyday commonsense knowledge towards the specialised body of techno-scientific knowledge. Therefore a measure of classification in the school science textbooks is the way theoretical techno-scientific generalisations are made. The classification projected by the linguistic mode of the textbooks is strong if the corresponding generalisations are systematically founded and weak if otherwise.

A generalisation is systematically founded if it is based on:

- A large number of observations,
- Reasoned arguments and
- Previously acquired techno-scientific knowledge.

Consequently, if the generalisations recorded in the textbooks are based on the elements above, their content is characterised as specialised (strong classification). It has to be noted at this point that the content specialisation is recorded only for the reports.

On the other hand, the content specialisation of the press articles is defined differently since the primary aim of this kind of texts is not to teach by gradually building the theoretical generalisations but rather to inform. In the press, the measure of classification is taken to be the density of the pieces of techno-scientific factual information (number of pieces of information/total number of the article's words) in each article.

Summarising, the classification promoted by a pedagogic or a media text is evaluated as shown in Table 1.

Classification value	Classification markers	
	Science textbooks	Press articles
Strong	Systematically founded generalisations by: • A large number of observations, • Reasoned arguments and • Previously acquired techno-scientific knowledge.	High density of factual pieces of specialised techno-scientific information
Weak	Non systematic foundation of generalisations (lack of the previously mentioned elements)	Low density of factual pieces of specialised techno-scientific information

Table 1: Classification Markers of the Linguistic Mode

Formality of the Linguistic Code

Science uses a specialised linguistic code. Basic realisations of the specialised character of the techno-scientific linguistic code (formality) according to Halliday and Martin (1996) are:

- the use of specialised terminology and notation;
- the use of nominalisations;
- syntactic complexity; and
- the use of passive voice.

These features are now going to be treated as markers of the level of formality of a text.

The *specialised terminology and notation* encountered in techno-scientific texts may be classified into the categories of terms, symbols or equations. When there are only terms in a text, the marker is assigned the minimum value of 1. When terms, symbols and equations co-exist in the same text the marker takes the maximum value of 3.

In everyday writing, *nominalisations* or, put simply, the use of nouns, usually expresses objects or notions while the use of verbs expresses action or processes. In the everyday linguistic mode, there is a balance between the use of nouns and verbs. In elaborated discourses, however, verbs usually replace the use of nouns. Nominalisation facilitates the taxonomy of scientific terms, enhances the compressive expression of complex information, allows the smooth development of the arguments and allows the formation of new conceptual entities (Halliday 1994, Pueyo and Val 1996). This marker is operationalised by the number of nouns encountered in the nominal groups of a text. The minimum value of the marker reflects the prevalence of single nouns. The maximum value reflects the prevalence of nominal groups with three or more nouns (for example, *rate of change of temperature*).

Syntactic complexity is another important marker. The scientific discourse favours the expression of relational or transactive actions (Halliday & Martin 1996). It also requires the expression of arguments and complex meanings. One part of this complexity is achieved through the use of hypo taxis (subordination) as the dominant syntactical structure instead of clauses being placed side-by-side in a paratactic way (coordination). Simple meanings are expressed through the latter. Complex meanings require the use of hypo taxis. When the paratactic syntax dominates, the marker takes the minimum value of 1 whereas when the hypotactic structure is dominant, the marker takes the maximum value of 3.

Final marker is the *use of the passive voice*. Language used in science describes and interprets the world, projecting the objective character of scientific knowledge. Accordingly, the use of passive verbs in the passive voice becomes frequent, contrary to their use in everyday writing.

When most of the verbs in the unit of analysis are in the active voice, the marker is assigned the minimum value (1). When the passive voice is dominant, the marker has the maximum value (3).

For the evaluation of the linguistic code's formality, the value of each marker is first recorded and then the four values are added.

The sum of these calculations can then be used to characterise the formality of the linguistic code as shown in Table 2 on the next page.

Framing

In order to describe the interpersonal function of the textbooks and the press material (Halliday & Martin 1996) we use the notion of framing. The notion of framing is further elaborated as mentioned in the introductory part by the notion of the power relationships established by each text and the degree that a text allows the readers to

get a sense of active involvement. These functions of framing a text are realised by specific grammatological features.

Formality Value	Formality markers
High (10–12)	Terminology and notation (3=appearance of terms, symbols and equations, 2=appearance of two elements, 1=appearance of only one element) Nominalisations (3=prevalence of nominal groups of three or more nouns, 2=prevalence of nominal groups of two nouns, 1=prevalence of single nouns) Syntactic complexity (3=prevalence of hypo-taxis (subordination), 2=almost equilibrium between hypotaxis and parataxis, 1=prevalence of parataxis (coordination) Use of passive voice (3=prevalence of verbs in passive voice, 2=verbs in passive voice almost equal with verbs in active voice, 1=verbs in passive voice less than the verbs in active voice.
Moderate (7–9)	
Low (4–6)	

Table 2: Formality Markers of the Linguistic Code

In particular, the power (hierarchical) relationships are linguistically realised by the type of the sentences used. A sentence can be:

- imperative,
- interrogative, and
- declarative.

The *imperative* denotes a clear authority of the 'implied author' and hence in this case the framing is strong. The *interrogative* denotes that the 'implied author' still exerts his or her own control over the communicative process by selecting what is going to be asked but this control is now relatively moderated by the fact that the reader can have some options in answering a question that can take multiple appropriate answers. Therefore, the interrogatives signify a moderate level of framing. Finally, in the *declarative* the authority of the 'implied author' might be still present but it is not so obvious any more and so the framing is weak.

The degree of the reader's involvement established by a text, is linguistically realised by the person of the verbs. In specific, with the use of:

- the first person singular (I),
- the second person singular (You),
- the first person plural (We), and
- the second person plural (You).

The *first singular person* (I) represents exclusively the 'implied author'. This person is rarely met in the techno-scientific texts since these texts do not usually express personal views of the author.

The *second singular person* (You) represents the 'model reader'. It can be interpreted both as a sign of familiarity with the reader and as a lack of symmetry between the context of the text production and the context of its reading. This person allows the rules of communication to be explicitly expressed and hence it tends to define clearly the conditions of the readers' participation to the communication process and therefore the framing is strong.

The *first plural person* (We) represents various situations. In particular, it can be interpreted as a symmetric relationship between the context of the text's production and the context of its reading. The 'We' can also be regarded as meaning 'Me and You' but also as meaning 'We others and not you'. Therefore, this person defines the conditions of the reader's participation but yet in a not very clear way, so framing is moderate in this case.

The *second plural person* (You) represents the reader again who in this case is addressed as if he/she belongs to a broader social group which is positioned at some social distance. In this case again, the conditions of the reader's participation are not very clear and so framing is moderate.

The *third singular or plural person* (He/She/It, They) signifies the virtual withdrawing of both the 'implied author' and the 'model reader' from the communicative act. In this case what matters is the content of the text and not the communicating agents. Therefore, framing is weak.

In summary, the hierarchical relationships are linguistically realised by the type of the sentences used in a text while the degree of explicitness of the conditions for the readers' involvement, by the person of the verbs as shown in Table 3.

The combination of the values of the two dimensions of framing, gives an overall value as a measure of the extent to which the communication act's control belongs to the 'implied author' or not.

Framing value	Framing markers	
	Type of sentence (Power relationships)	Person of the verb (Degree of the readers' involvement)
Strong	Imperative	Second singular (You)
Moderate	Interrogative	First and Second plural persons
Weak	Declarative	Third singular or plural person

Table 3: Framing Markers of the Linguistic Mode

The Instrument for Analysing the Visual Mode

This instrument consists of variables that become operational applying a specific socio-semiotic analysis of the 'grammar of the visual design'. This analysis follows the work done by Kress and van Leeuwen (Kress & van Leeuwen 1996).

Classification

The content specialisation (classification) of the visual representations is evaluated using the variables of their:

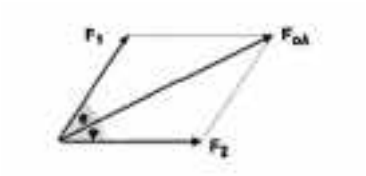
- type, and
- function.

With regard to their *type*, the visual representations can be realistic, conventional and hybrids. Realistic are the visual images that represent reality according to the human optical perception and in this category both photographs and drawings belong (see Figure 2 below).

Source: Chemistry, 2nd Grade of the Lower Secondary School, (1997), Athens: OEDB, p.88.

Figure2

Conventional are the visual representations that represent reality in a coded way (see Figure 3 below). These representations are constructed according to the techno-scientific conventions and are usually graphs, maps, flow-charts, molecular structures and diagrams. Finally hybrids are usually conventional representations with added on realistic features (see Figure 4).



Source: Physics, 2nd Grade of the Lower Secondary School (1999), Athens:OEBD, p.134

Figure 3

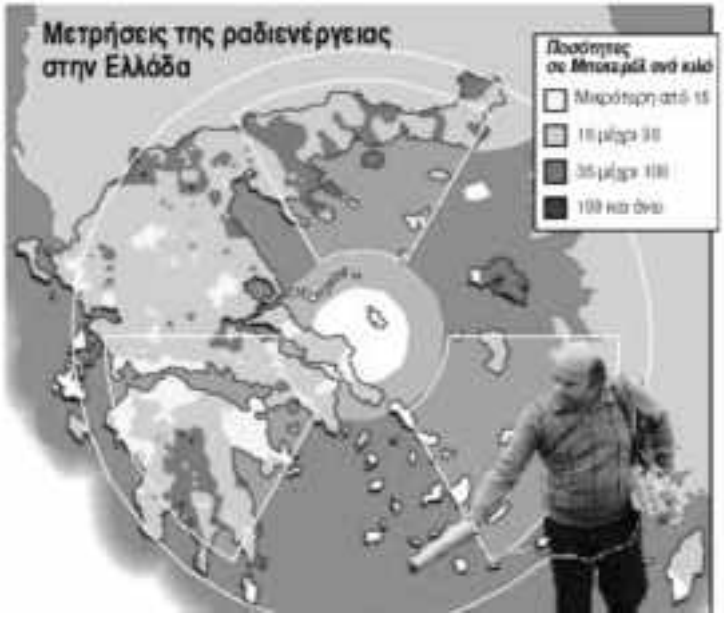


Figure 4: Measurements of Radioactivity in Greece from Vima *15/11/1997)*

With regard to their *function*, visual images are divided into narrative, classificational, analytical and metaphorical. Narrative, are the visual representations that represent 'unfolding actions and events, processes of change and transitory spatial arrangements' (Kress & van Leeuwen 1996, p.56). In such images, the represented action is visualised by a vector, either shown explicitly (see Figure 5 below) or by imagination.

Classificational are the visual representations that exhibit a taxonomy. A group of represented agents plays the role of subordinates with respect to one other represented agent, the super-ordinate. The super-ordinate may either explicitly shown in the illustration, or indicated in the accompanying text or even inferred by the viewer. The proposed equivalence between the subordinates is visually realised by a symmetrical composition (see Figure 5 below).

Analytical are the visual representations that focus on the relations between the 'objects' of representation in terms of a part-whole structure (see Figure 6 below). The parts of the whole may be labelled or it may be left up to the viewer to do so. The meaning of an analytical visual representation corresponds to the linguistic equivalents 'this is' or 'this consists of'.

Finally, metaphorical are the visual representations that 'connote or symbolise meanings and values over and above what they literally represent' (Kress & van Leeuwen 1996, p.45). For example in Figure 8 the posture of Celsius as well as his formal way of dressing (typical dress of a noble man of the eighteenth century), act as metaphors of the high social status of scientists and science in general.

The variables of the type and function of the visual representations, allow the evaluation of the content specialisation (classification) promoted by the visual code. The combination of values of the two variables gives an overall score for the classification promoted by the visual code (see Table 4 below).

Classification value	Type of visual representations	Function of visual representations
Strong (5–6)	Conventional (3)	Classificational (3)
Moderate 4	Hybrid (2)	Analytical, Narratives (2)
Weak (2–3)	Realistic (1)	Metaphorical (1)

Table 4: Classification Markers of the Visual Mode

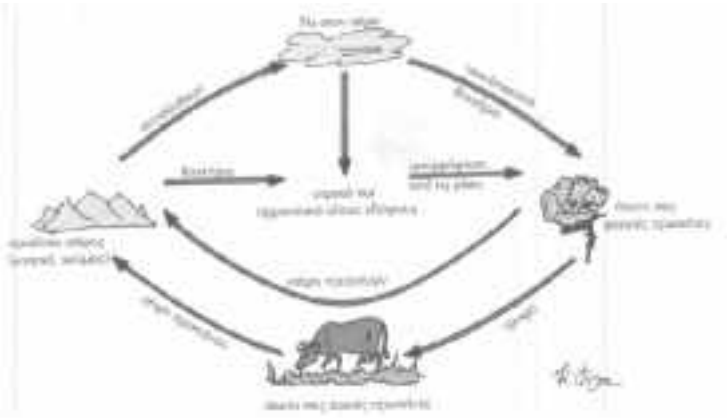


Figure 5: 'The nitrogen cycle in nature' from Chemistry, 2nd Grade of the Lower Secondary School, (1997) Athens: OEDB, p.93

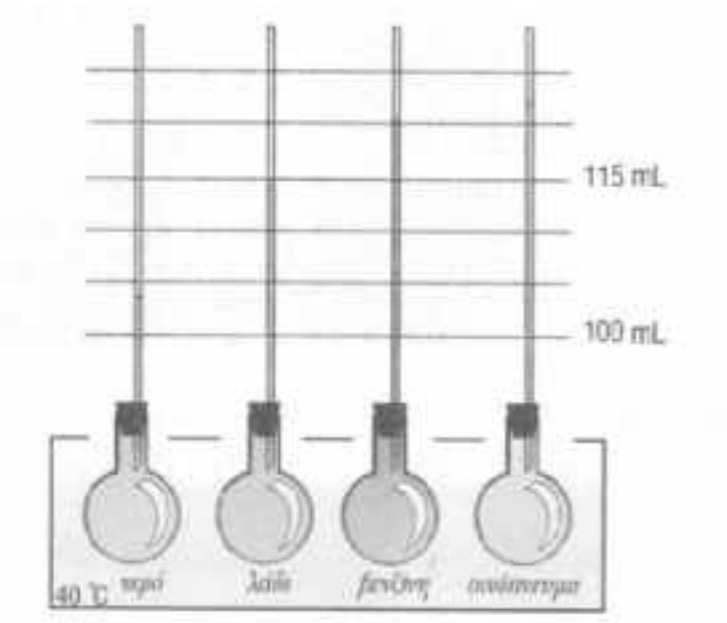


Figure 6: 'Volume expansion of different liquids.' In 'Physics, 2nd Grade of the Lower Secondary School, (1998), Athens: OEDB, p.83.

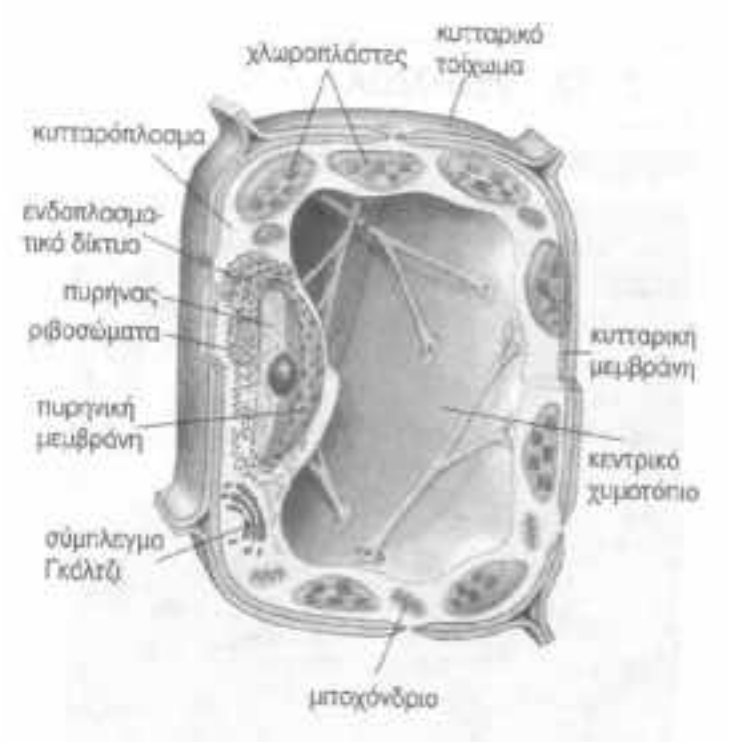


Figure 7: 'The structure of a plant cell'. In Biology, 2nd Grade of the Lower Secondary School, (1999), Athens: OEDB, p.23.

Figure 8: 'Celsius and thermometer.' In Science for primary school, 5th Grade of the Primary School, (1989), Athens: OEDB, p.55.

Formality of the Visual Code

Formality corresponds to the degree of abstraction of the visual representations. There are two levels:

- low formality and
- high formality

Low formality corresponds to representations very close to photographic realism. *High formality*, on the other hand, corresponds to techno-scientific realism focusing mostly on what things are like generically or regularly.

The formality of the visual representations can be estimated using relevant markers. These markers record particular elements of the representations that contribute to their level of abstraction or inversely to their degree of articulation (Kress and van Leeuwen 1996). Each marker may take three values with the maximum value (3) corresponding to high formality and the minimum value (1) corresponding to low formality. The sum of the values of all these markers gives an overall score for formality.

In our analysis, the overall formality scores are transformed into three values: high, moderate and low.

The markers used are:

- Elements of the techno-scientific code;
- Colour differentiation;
- Colour modulation;
- Contextualisation

Elements of the techno-scientific code concerns the existence of geometrical shapes or alphanumeric strings in the visual representations. Such elements rise the formality of the visual code.

Colour differentiation is related to the variety of colours in an illustration. The broader the variety of colours the lower the formality.

Colour modulation corresponds to the degree of modulation of each colour of the representations. Low formality corresponds to many different shades of a colour while high formality corresponds to plain, unmodulated colours.

Contextualisation concerns the background of an image. High formality means the absence of any background while low formality means a fully articulated and detailed background.

The four markers of formality used in this analysis, as well as their evaluation are shown in Table 5 below. According to these the formality in Figure 8 increases from the left to the right circuit.

	Value of formality		
Markers of formality	High	Moderate	Low
Elements of the techno-scientific code	Geometrical shapes and alphanumeric strings	Geometrical shapes or alphanumeric strings	No geometrical shapes or alphanumeric strings
Colour differentiation	Monochrome	2–4 colors (black included)	More than 4 colours
Colour modulation	No shade	1–3 shades	All the shades received by the photographic lens
Contextual-isation	Background of the same colour with the rest of the page	Mono or bi-chromatic background	Background according to the photographic reception

Table 5: Markers of Formality of the Visual Code

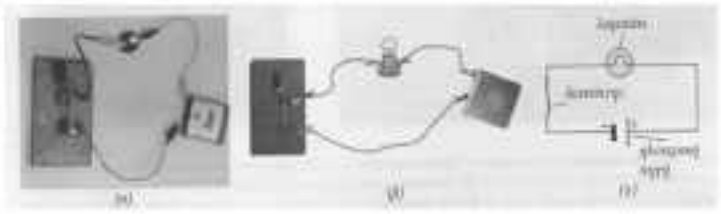


Figure 9: Physics, 2nd Grade of the Lower Secondary School, (1998), Athens: OEDB, p.242.

Framing

In order to make operational the hierarchical relationships that tend to be established between the images and the viewers, we use the variable of the vertical angle of shot. If an image is shown from a low angle, it depicts a relationship in which the content of the image has power over the viewer and hence the framing is strong (see Figure 10a below). If an image is shown at the eye-level of the viewer, it depicts a relationship in which the content of the image has equal power with the viewer and hence the framing is moderate (see Figure 10b below). Finally, if an image is shown from a high angle, it depicts a relationship in which the viewer has power over the content of the image and hence the framing is weak (see Figure 10c below).

Figure 10(a): Strong framing. In Eleftheros Typos *(6/3/200)*

10(b): Moderate framing. In Eleftherotypia *(7/10/200)*

Furthermore, the degree of the viewer's involvement with what is represented in the images, as a measure of his or her potential to participate in the communication process, is visually realised by the variables of the distance and the horizontal angle of shot. The distance of shot regulates the level of intimacy that is possible to be established between what is represented and the viewer and takes the values of close, medium and distant shot that correspond to an intimate/personal, social and interpersonal social inter-relationship respectively (Meyrowitz 1986). Close shot shows objects as if the viewer is engaged with them-as if he/she is using an apparatus, taste a dish, etc. In cases that a person is represented the close shot corresponds to an image that shows head and shoulders of the subject. Medium shot shows objects in full but without much space around them, signifying in this way that these objects are within the viewer's reach, but not as actually used. In cases that a person is

represented the medium shot corresponds to an image that the subject is cut off at the knees. Finally distant shot shows objects as if they are out of the viewers' reach. In cases when a person is represented the distant shot corresponds to an image that the subject occupies about half the height of the frame or anything less than that (Kress & van Leeuwen 1996).

The horizontal angle of shot takes the values of frontal and oblique angle. 'The difference between the frontal and the oblique angle is the difference between familiarity and detachment' (Kress & van Leeuwen 1996, p.143).

The combination of the distance and the horizontal angle of shot determine the degree of the viewers' involvement implied by an image. In particular visual representations characterised by frontal angle and close or medium shot correspond to weak framing (see again Figure 11a) while those characterised by either frontal angle and distant shot or oblique angle and close shot correspond to moderate framing (see again Figure 11b). Finally, representations characterised by oblique and medium or distant shot correspond to strong framing (see again Figure 11c).

10(c): Weak framing. In Kathimerini *(5/11/2000).*

The combination of the three previous variables' values (distance, vertical and horizontal angle of shot) determines the overall value of the framing projected by the visual mode of the texts (see Table 6).

Framing value	Framing markers	
	Vertical angle of shot (Power relationships)	Distance and horizontal angle of shot (Degree of the readers' involvement)
Strong (5–6)	Low angle (3)	Oblique angle and medium or distant shot (3)
Moderate (4)	Eye-level (2)	Either distant shot and frontal angle or close shot and oblique angle (2)
Weak (2–3)	High angle (1)	Close or medium distance and frontal angle (1)

Table 6: Framing Markers of the Visual Mode

Source: 'Vima' (30/08/1998)

Figure 11(a): Weak Framing

Source: 'Vima' (20/12/1998)

Figure 11(b): Moderate Framing

Chemistry, 3rd Grade of the Lower Secondary School, (1998), Athens: OEBD, p.144

Figure 11(c): Strong Framing

Results of the Analysis

Here we present the results from the analysis of the linguistic and the visual modes deployed in the techno-scientific texts appearing in the pedagogic (science textbooks) and the mass-media context (newspaper articles) along the three dimensions of classification, formality and framing.

These results will be presented separately for the primary science textbooks, the lower secondary science textbooks and the press articles so as comparisons to become possible.

Classification

As shown in Table 7 below the content specialisation (classification) promoted by the linguistic mode is high in the school science textbooks while in the press articles it is rather low. It is also worth-noting that there is no significant differentiation in the content specialisation of the science textbooks of the primary and lower secondary level respectively.

Type of text	Strong classification		Weak classification	
	N	(%)	N	(%)
Primary school science textbooks	151	85.3	26	14.7
Lower secondary school science textbooks	620	88.7	79	8.3
School science textbooks (Total)	771	88.0	105	12.0
Press articles	784	42.0	1083	58.0

Table 7: Classification Promoted by the Linguistic Mode

The variation between the textbooks and the press material, as far as their content specialisation is concerned, may stem from their differential communicative objectives. Specifically, the texts of the pedagogic domain have as their primary communicative objective to lead the students towards the internal logic of the techno-scientific knowledge by presenting it as distinct and more specialised in relation to the everyday commonsense knowledge (strong classification). The press articles, on the other hand, aggregate the techno-scientific with other forms of knowledge, hence presenting it as a kind of knowledge with no clear-cut border-lines with the everyday situations (weak classification).

Additionally, as shown in Table 8 below, the finding that the science textbooks tend to present the techno-scientific as more detached from the everyday knowledge (stronger classification) in comparison to the press, is further reinforced by the corresponding findings concerning the visual mode employed in these two kinds of texts (x^2=250.9, df=1, p<0.001).

Unexpectedly, there is a considerable differentiation in the content specialisation promoted by the visual mode in the science textbooks of the primary and the lower secondary level (x^2=312.4, df=1, p<0.001). In specific, as the students proceed from the primary to the lower secondary school, they are more likely to be confronted with texts that employ more content specialised visual representations.

Type of text	Strong classification		Weak classification	
	N	(%)	N	(%)
Primary school science textbooks	311	20.9	1176	79.1
Lower secondary school science textbooks	705	52.9	627	47.1
School science textbooks (Total)	1016	36.0	1803	64.0
Press articles	227	13.9	1403	86.1

Table 8: Classification Promoted by the Visual Mode

Formality

As evidenced by Table 9 below, the formality of the linguistic code employed in the press articles is considerably lower than in the science textbooks (x^2=211.6, df=2, p<0.001).

Type of text	High formality		Moderate formality		Low formality	
	N	(%)	N	(%)	N	(%)
Primary school science textbooks	14	6.0	130	55.8	89	38.2
Lower secondary school science textbooks	265	28.8	468	50.9	187	20.3
School science textbooks (Total)	279	24.2	598	51.8	276	23.9
Press articles	487	26.1	513	27.5	867	46.3

Table 9: Degree of Formality of the Linguistic Code

This result is further reinforced by the trends of formality of the visual code. As shown in Table 10 the formality of the visual code is higher in the science textbooks than in the press material (_^{2}=149.7, df=2, p<0.001) and in the textbooks of the lower secondary level than those of the primary level (x^2=77.2, df=2, p<0.001).

Type of text	High formality		Moderate formality		Low formality	
	N	(%)	N	(%)	N	(%)
Primary school science textbooks	95	6.4	489	32.9	903	60.7
Lower secondary school science textbooks	216	16.2	454	34.1	662	49.7
School science textbooks (Total)	311	11.0	943	33.5	1565	55.5
Press articles	73	4.5	824	50.5	733	45.0

Table 10: Degree of Formality of the Visual Code

The combination of the results concerning the degrees of content specialisation (classification) promoted by the linguistic and the visual modes and the formality of the corresponding codes leads to the conclusion that the school science textbooks tend to prompt more their readers towards the interior of the specialised techno-scientific domain in comparison to the press material. This trend is accomplished by increasing both the degree of their content specialisation and the specialisation of the corresponding expressive codes (formality) employed in them. In this way students are more exposed to the internal logic of the techno-scientific knowledge and become more familiarised with the conventions of the specialised techno-scientific codes. This latter is considered as equally important to the acquisition of the specialised subject matter since 'learning science is the same thing as learning the language of science' (Halliday 1993). The trend towards higher 'scientificness' of the school science textbooks seems to become more evident as one moves from the primary to lower secondary level.

Framing

Framing varies considerably across the different kinds of texts examined here. As shown in Table 11 below,the linguistic mode employed in the press tends to position the readers as social subjects that have a narrower range of control over the communication act established by the text in comparison to the school science textbooks (_^{2}=6.4. df=1, p<0.02). Within this latter category of texts the range of the readers' control over the communication act is expanded dramatically from the primary to the lower secondary level (x^2=188.1, df=1, p<0.001).

Type of text	Strong Framing		Weak Framing	
	N	(%)	N	(%)
Primary school science textbooks	126	54.1	107	45.9
Lower secondary school science textbooks	119	12.9	801	87.1
School science textbooks (Total)	245	21.2	908	78.5
Press articles	472	25.3	1395	74.7

Table 11: Degree of Framing Promoted by the Linguistic Mode

The same trend applies also to the visual mode of the texts (see Table 12 below).

Specifically, the visual mode of the press material tends to pass more of the communication act's control to the side of the 'implied author' in comparison to the school science textbooks (_^{2}=27.0, df=1, p<0.001). Furthermore, the same tendency appears in the science textbooks of the primary school rather than in those of the lower secondary level (_^{2}=25.9, df=1, p<0.001).

Type of text	Strong framing		Weak framing	
	N	(%)	N	(%)
Primary school science textbooks	458	33.0	930	67.0
Lower secondary school science textbooks	265	23.7	852	76.3
School science textbooks (Total)	723	28.9	1782	71.1
Press articles	524	36.9	896	63.1

Table 12: Degree of Framing Promoted by the Visual Mode

Conclusions

The science textbooks project an 'image' of science and technology as highly specialised bodies of knowledge (strong classification). On the other hand, the press presents these two domains as quite aggregated with the everyday knowledge (weak classification). This trend is reinforced by the use of more specialised codes (higher formality) in the school science textbooks in relation to the press material. However, the textbooks of the lower secondary school present science and technology as more specialised bodies of knowledge by the deployment of more specialised codes than are used by the textbooks of the primary level. Finally, the readers' control over the communication act seems to increase from the primary textbooks to the press material, becoming maximised in the lower secondary textbooks.

Both the linguistic and the visual parts of the science textbooks and the press articles function in the same directions (the degree of classification projected by the linguistic and the visual mode of the primary science textbooks is the only exception to that). In this way a quite coherent message is constructed by the interweaving of the two communication modes. This coherency shows that the various kinds of techno-scientific texts have embedded within their construction specific intentions that are being served by all the communication modes employed in them.

If the analysed texts are placed on a two-dimensional space, one dimension corresponds to the level of its 'scientificness' (the level of 'scientificness' is determined by the texts' content and codes' specialisation) and the other to the distribution of the communication act's control between the 'implied author' and the 'model reader' of the text. The picture that emerges is shown in Figures 12a and 12b below. In specific, the press seems to form a 'model reader' that is kept at the periphery of the specialised techno-scientific knowledge domain while at the same time passing to the reader a considerable amount of the communication act's control, respecting probably in this way his or her personality as an adult. The primary textbooks seem to form a 'model reader' that is gradually introduced towards the interior of the specialised techno-scientific knowledge domain while at the same time treat the reader in a communicative paternalistic and didactic way, probably due to his or her very young age.

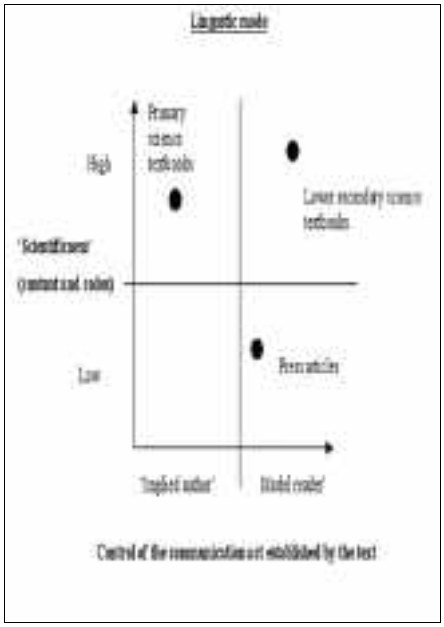


Figure 12a

Finally, the lower secondary science textbooks seem to form a 'model reader' that has already entered into the interior of the specialised techno-scientific knowledge domain and is allocated a great part of the communication act's control. The autonomy of the 'model reader' over the communication action established by this type of text is probably justified by the fact that the latter, having entered the interior of the specialised knowledge domain, becomes more capable of processing the message of the text in a more individualistic and autonomous way. In other words the text of the lower secondary textbooks treats its potential readers as 'proto-experts' deserving a considerable degree of autonomy.

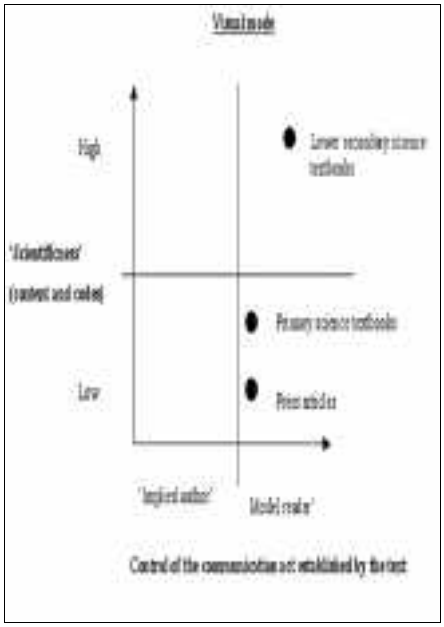


Figure 12b

The particular discursive characteristics of the texts that emerged from our analysis have a profound importance for the effective transfer of texts from one communication field to another. In this particular case, our analysis can find applications for the effective introduction of press material into the pedagogical context. Such an introduction should take into account the degree of compatibility of the discursive characteristics of the press material with the pedagogical texts used in the science classes. In cases of incompatibility our analysis can suggest specific pedagogical interventions that can restore the compatibility between the two types of texts.

References

Bernstein, B. (1996) *Pedagogy, Symbolic Control and Identity: Theory, Research, Critique.* London, Taylor and Francis.

Chatman, S. (1978) *Story and Discourse*. Ithaca, N.Y., Cornell University Press.

Cloitre, M. and Shinn, T. (1985) 'Expository Practice: Social, Cognitive and Epistemological Linkages.' In M. Cloitre and T. Shinn (eds) *Expository Science: Forms and Functions of Popularisation*, Dordrecht, D. Reidel Publishing Company.

Cope, B. and Kalantzis, M. (1993) *The Powers of Literacy: A Genre Approach to Teaching Writing.* London, The Falmer Press.

Eco, U. (1979) *The Role of the Reader*. Bloomington, Indiana University Press.

Eurobarometer (1993) *Europeans, Science and Technology: Public Understanding and Attitudes*. Brussels, Commission of the European Communities.

Fleck, L. (1979) *Genesis and Development of a Scientific Fact*. Chicago, University of Chicago Press.

Halliday, M.A.K. (1994) *An Introduction to Functional Grammar*. London, Edward Arnold.

Halliday, M.A.K. (1996) 'On the Language of Physical Science.' In M.A.K. Halliday and J.R. Martin (eds) *Writing Science: Literacy and Discursive Power.* (pp.54–68) London, The Falmer Press.

Hansen, A. Cottle, S. Negrine, R. Newbold, C. (1998) *Mass Connunication Research Methods*. London, Macmillan Press.

Hatzinikita, V. Koulaidis, V. Sklaveniti, S. and Tsatsaroni, A. (1996) 'Approfondir la Science et 'Lire' les Manuels Scolaires Scientifiques.' In A. Giordan, J.L. Martinanand et D. Raichvarg (eds) *Les Sciences, Les Techniques et Leurs Publics.* Chamonix, Centre, Jean Franco.

Holton, G. (1992) 'How to Think about the Anti-science Phenomenon.' *Public Understanding of Science*, 1(2) 103–128.

Jacobi, D. (1999) *Le Communication Scientifique: Discours, Figures, Modeles*. Grenoble, Presses Universitaires de Grenoble.

Koulaidis, V. and Tsatsaroni, A. (1996) 'A Pedagogical Analysis of Science Textbooks: How Can We Proceed?' *Research in Science Education*, 26(1) 55–71.

Kress, G. and Van Leeuwen, T. (1996) *Reading Images: The Grammar of the Visual Design*, London and New York, Routledge.

Kuhn, T.S. (1962) *The Structure of Scientific Revolutions*. Chicago, Chicago University Press.

Lemke, J.L. (1998) Multiplying Meaning: Visual and Verbal Semiotics in Scientific Text. In J.R. Martin and R. Veel (eds) *Reading Science: Critical and Functional Perspectives on Discourses of Scienc*e (pp.87–113) London and New York, Routledge.

Martin, J.R. (1996) 'Literacy in Science: Learning to Handle Text as Technology.' In M.A.K. Halliday and J.R Martin (eds) *Writing Science: Literacy and Discursive Power*, (pp.166–202) London, The Falmer Press.

Meyrowitz, J. (1986) 'Television and Interpersonal Behaviour: Codes of Perception and Response.' In G. Gumperz and R. Cathcart (eds) *Inter/media: Interpersonal Communication in a Media World.* (pp.253–272) New York, Oxford University Press.

Miller, J.D., (2000) *The Public Understanding of Science and Technology in the United States: A Report to the National Science Foundation, Science and Technology Indicators*, Washington, D.C, National Science Foundation.

Pueyo, I.G and Val, S. (1996) 'The Construction of Technicality in the Field of Plastics: A Functional Approach Towards Teaching Technical Terminology,' *English for Specific Purposes,* 15 (4) 251–278.

Rimmon-Kenan, S. (1983) *Narrative Fiction: Contemporary Poetics*, London, Methuen.

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