Scientific and Technological Culture in ESO Textbooks

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Contents

1. Introduction

In this report we present the most relevant results of a study on the presence of scientific and technological culture and of entrepreneurial innovation cultural factors in textbooks of the ESO (Ensañanza Secundaria Obligatoria, Compulsory Secondary Education, students between the ages of 12 to 16). This project is part of the work carried out by our group on technological culture[2]. The general objective of the group is to analyze the concept of technological culture and to explore to what extent various factors related to it can help us understand better the needs and possibilities of innovation in the Spanish economy. In this general context, the specific objective of this study was to analyze the importance and the types of elements of scientific and technological culture and of innovation culture present in the textbooks of the ESO . We believe that the majority of the population is exposed to these cultural factors mainly through the ESO textbooks.

We have analyzed eighty one books of all the compulsory subjects and of some elective ones that students used in the first and forth years of the ESO during the academic year 2005-2006. We used the books of the four most important publishing houses in Spain. Our aims were:

1. Detect the **relative weight of scientific and technological culture** in the entire body of knowledge transmitted to the ESO students, distributed across subjects, grades and publishing houses.
2. Analyze the **types of scientific and technological culture** of the textbooks, according to the interpretative categories of our analytical model.
3. Analyze the presence and the relative importance of two kinds of metaphors (of **threats** and of **promises**) associated to the perception of science, technology and innovation in the textbooks of the ESO.

1.1 Conceptual basis for the analysis of scientific and technological culture

The conceptual basis of our analysis is the model of technological culture developed previously (Quintanilla 2000, Aibar and Quintanilla 2002). The model was updated and extended for the purposes of this study. In this model culture is defined as the representational, practical and evaluative information which is transmitted through social learning among the members of the same species (Mosterín 1993).

In our model the terms “culture” and “cultural information” are synonymous. We distinguish three types of cultural information.

[2] Supported by COTEC Foundation. See Quintanilla, M. A. & A. Bravo. 1997. *Cultura tecnológica e innovación. Primera parte: el concepto de cultura tecnológica*. Fundación COTEC.

I. **Representational information**: includes representations, beliefs and knowledge of the natural and social world. It contains a wide range of elements such as opinions and perceptions, individual or common, as well as scientific theories and religious beliefs about the world, life, society, humanity and reality in general.

II. **Operational/practical information**: Includes rules or norms of behavior and action. They can be technical, moral, social or of any other kind. They may be expressed explicitly as norms of adequate or inadequate behavior. In this type of culture we include rules of action in concrete situations inspired by praxis or guided by customs as well as the general moral and legal systems.

III. **Evaluative information**: consists of values and individual or social systems of preference of any kind. Cases of values formed explicitly and integrated in coherent and orderly systems and individual and common values related to specific contexts, are both included in this type of culture.

In our analytical model culture is defined as the representational, practical and evaluative information which is transmitted through social learning among the members of the same species

On the basis of this generic concept it is possible to define various types of culture according to the kind of information to which it refers to (artistic, juridical, religious etc) and the specific social group (Spanish culture, European culture, etc).

When we talk about **scientific or technological culture** of a country we talk about a type or a kind of culture which characterizes a determinate social group that we define in the following terms:

Scientific culture: The scientific culture of a social group is the cultural information related to scientific activities, methods, results and their relations to any other social activities that the individuals of this group share. The expression "scientific culture" is used in this context in order to refer not to the professional culture of scientists but to **that part of culture of any individual or group of individuals related to scientific knowledge and activities**. Questionnaires of "social perception of science", "scientific literacy" or "scientific attitudes" of the general population are relatively common instruments that try to measure some aspects of scientific culture. In our model it is important to distinguish between two kinds or levels of scientific culture that we can define as intrinsic and extrinsic

A. **Intrinsic scientific culture**: refers to cultural components immanent to scientific activities. The scientific knowledge in each of the areas and fields of research, theories debated by scientists, facts discovered by scientific procedures, scientific interpretations and explanations of natural and social phenomena, etc. All these are part of intrinsic scientific culture. The norms of the scientific method, the rules of empiric research, the scientific communication of its results as well as the values which are supposed to guide scientific activity (such as objectivity, coherence, precision etc) are also included in this category.

B. **Extrinsic scientific culture**: Includes all the representational (beliefs), practical (norms), and evaluative (values) components which are related to scientific activities, institutions and people, but are not part of the intrinsic scientific culture. The images of science (how people perceive it), the judicial regulation of scientific institutions, the evaluations of science from a cultural, moral, political, religious and other points of view: all these are part of what we call extrinsic scientific culture.

Technological culture. The technological culture of a social group is the cultural information about **technical systems, their functioning, design and production and any other kind of activity related to technology**, shared by its members. The expression **technological culture** is used in this context to refer not only to the professional culture of technologists and engineers but also to components of culture related to technology, its invention, production, diffusion and use of by any individual or group of individuals. Many of the items used in questionnaires about the perception of science refer, in fact, indiscriminately, to technology. But in other contexts there is empirical research that collects information about technological culture, especially market investigations that study the utilization of specific technological devices (mobile phone, car, etc). As in the case of scientific culture, also in this case it is useful to distinguish two kinds or levels of technological culture: "technological culture incorporated into technical systems" (intrinsic) and "technological culture not incorporated into technical systems" (extrinsic).

A. **Intrinsic technological culture:** All the knowledge, norms of behavior and values that are immanent to the design, functioning or adequate use of a technical system. The best example of incorporated technological culture is the total of data that appears in the user's guide of a technical system. Another criterion could be: all the cultural information needed to design, produce, and use properly a technical device.
B. **Extrinsic technological culture**: all the cultural information (beliefs, norms, attitudes and values) which are related to technical systems, activities or knowledge as well as to the people and institutions that design, produce and diffuse technologies, but that do not form part of the technology or of a technical system. For example the theories or opinions about the influence of information technologies on the reduction of jobs in industry are part of extrinsic technological culture: it affects people's perception of technology, but not the functioning of technology. The myth of Prometheus or the story of Frankenstein, are part of the technological culture of occidental civilization, but they are not part of a concrete technical system.

In the table we see the summary of the general categories with which we wish to dissect scientific technological and innovation culture transmitted to students of the ESO.

The distinction between intrinsic and extrinsic culture is important for the analysis of scientific and technological culture. As we have suggested in other occasion(Quintanilla 2008, Quintanilla 2005), the actual rate of innovation in a country or company depends, apart from on more or less controllable exterior factors, on two inner features: the **capacity** to innovate and the **propensity** to innovate. It is logical to assume that both are sensitive to cultural factors, although different ones. **The capacity to**

innovate is more related to the access to elements of intrinsic scientific technological culture (technological knowledge, know how etc.), **while the tendency to innovate depends more on the way science and technology are perceived, used and evaluated (elements of extrinsic scientific culture).** A typical example from school books would be: Pythagoras' theorem is an element of the intrinsic scientific culture that one expects to find in all basic mathematics books. But it can be presented in various ways: as a useful tool to solve practical problems, as an abstract truth, as an incomprehensible fact or as reasoned evidence. These are different alternatives that illustrate diverse scientific cultures (extrinsic) related to the same content of scientific culture (intrinsic).

Table 1: Analytical categories of the model of scientific and technological culture

		SCIENCE	TECHNOLOGY
Intrinsic culture	**Representations**	Knowledge Scientific information (CINTR)	Knowledge Technological information (TINTR)
	Practices	Rules of the scientific method. Scientific mode of action (CINTOP)	User Guide and rules of usage of technology. (TINTOP)
	Values	Scientific values: objectivity, universality, truth, precision (CINTVA)	Technological values: efficiency, reliability (TINTVA)
Extrinsic culture	**Representations**	Images of science (CEXTR)	Images of technology (TEXTR)
	Practices	Interest in science. Norms of behaviour (moral, legal etc) related to science (CEXTOP)	Interest in technology. Norms of behaviour (moral, legal etc) related to technology (TEXTOP)
	Values[3]	Evaluations and attitudes toward science (positive or negative) CEXTVA CEXTVA+ CEXTVA-	Evaluations and attitudes toward technology (positive or negative) TEXTVA TEXTVA+ TEXTVA-

In the analysis of scientific and technological culture transmitted in textbooks it is especially useful to take into account these distinctions. It is not enough to know how much Mathematics, Natural Science

[3] In this research we decided to emphasize the presence of terms, expressions or metaphors related to science and to technology that have positive connotations (CEXTVA+; TEXTVA+), negative connotations (CEXTVA-; TEXTVA-) or neutral connotations (in case there is not a clear association or in case the positive and negative connotations which appear in the same paragraph are not relevant CEXTVA; TEXTVA) The distinction between positive and negative evaluation was applied only with respect to extrinsic culture.

or Physics are taught to young students, but **how are they induced to perceive, use, and evaluate them**.[4]

The distinction between intrinsic and extrinsic culture is important for the analysis of scientific and technological culture and for the analysis of the role of cultural factors in innovation processes. We assume that the capacity to innovate depends on intrinsic cultural factors (scientific and technological knowledge, know how, etc.) whereas the propensity to innovate is more dependent on extrinsic ones (**the way science and technology are perceived, used and evaluated)**

In addition in our analysis we are also interested in scientific and technological culture as a factor that possibly influences technological innovation of businesses. We define **technological innovation in this context as the processes in which a technical invention (generally based on the application of new scientific knowledge) converts into a product that has an economic value (a new product or service)**. Based on this essential meaning the concept of innovation is currently used to define any novelty introduced by companies, be it innovation of a technical nature or not. In other words, 'innovation' covers newly emerging practices in organization, marketing, commercial design etc. Unlike what happens with scientific and technological culture, the culture of innovation does not have a precise and defined profile. But it is important for our investigation because we seek to know if cultural elements transmitted in textbooks are related to a culture of business innovation and in what way. The culture of business innovation includes, on one hand, elements of scientific and technological culture and, on the other hand, a collection of cultural elements which refer to the business activities, people and institutions. We are interested in:

A. The presence of stereotypes and social images of businessmen and businesses
B. References to the social function of businesses related to the application of science and technology
C. The introduction of elements of scientific and technological culture with a pragmatic orientation (usefulness and economic benefits)
D. References to entities, practices and values linked to innovation such as accepting a calculated risk, the acceptance of novelty, creativity and the satisfaction of a well done work, efficiency and competitiveness

In order to cover these cultural elements, the analytical model was extended to include two new categories:

[4] Naturally the differentiation between intrinsic and extrinsic culture is not always clear. There are for example moral values which are part of the intrinsic contents of scientific culture (intellectual honesty, respect of the truth), and elements of the intrinsic scientific culture which are incorporated into culture in general.

Table 2: Analytical categories of innovation culture

INNOVATION	Representational, practical and evaluative elements related to the usage of science and technology for obtaining wealth and economic benefits.
BUSINESS	Social images of businessmen and businesses. Business values and practices. References to the social function of businesses and companies.

The **culture of business innovation** includes, on the one hand, elements of scientific and technological culture and, on the other hand, a collection of cultural elements which refer to business activities, people and institutions.

1.2 Methodology

In order to carry out our research we created a corpus to which we applied different techniques of content analysis and statistical procedures. It contains 81 textbooks of all the subjects given in the first and fourth year of the ESO, published by the four leading textbook publishers in Spain, distributed as shown in table 4.

The analysis was carried out in various steps:

1. A thesaurus of scientific vocabulary, based on key words that characterize the books of each kind of subject was assembled
2. Automatic analysis of the presence of the scientific vocabulary in each text
3. The selection of a subset of paragraphs in which generic contents of scientific and technological culture as well as business innovation appear
4. Manual analysis of the elements of scientific, technological and business innovation culture that appear in the subset
5. Analysis of the metaphors of promises and threats mentioned in the selected texts.

To create the thesaurus we used the program WordSmith that allows obtaining lists of words from every text and comparing them with a corpus of reference, achieving in this way a subset of key words that characterize the analyzed text. The complete set of documents was taken as the corpus of reference, enriched by other texts from the project DESAL (Diccionario Escolar Salamanca) (Sánchez, Herrero and Lucas 2007). This allowed us to have a series of lists of words (around seventy words for each thematic area) that characterize the texts of each subject. In addition we used a text on technological innovation (Revilla and Jacob 2001), to obtain the list of key words related to business innovation. This list, combined with some generic terms introduced manually in order to detect scientific contents not related to a specific discipline (such as science, technology, research etc), served as a thesaurus of generic contents related to, innovation, business, science and technology.

Once we obtained the characteristic terms of each scientific field, we used the program Atlas.ti to codify, automatically, every paragraph of the set of documents according to the presence or absence of one of the terms characterizing each of the scientific fields. This allowed us to attain our first goal: estimate the weight of the contents of different scientific and technological fields in the total set of documents, its distribution across subjects, grades, publishers etc.

Between automatically encoded paragraphs, we chose the subset belonging to the category of "business innovation, science and technology" (abbreviated code **InEmCyT,** for Innovación Empresa Ciencia y Tecnología). On this subset we applied a manual content analysis in order to codify each paragraph in the different categories of the model. The codifying process was carried out by four people, according to a previously prepared guide (see Anex 1). The coding decisions of the four judges were compared and disagreements were discussed and resolved until the inter-judge reliability reached more than 90 per cent on a random sample of texts.

Finally two new categories of analysis were defined in order to detect the presence of components of scientific and technological extrinsic culture marked by the notions of **promise** or **threat**. Their presence in ESO books was also checked. We divided the most salient terms of "extrinsic culture", into two groups: those which had a positive connotation and those with negative connotation with relation to science and technology. For this purpose a number of relevant terms was chosen for each specific category, ensuring that the inclusion of new ones did not add new information.

Table 3: Codes for promises and Threats

Categories	Codes
Promises	Adelanto Avance Beneficio Bienestar Calidad de vida Desarrollo Felicidad Futuro Mejora Oportunidades Positivo Progreso Útil Ventaja

Threats	Amenaza Contaminación Desecho Deterioro Negativo Pasado Peligro Pérdida Perjudicial Perjuicio Perverso Preocupación Problema Retroceso Riesgo

We codified the textbooks in two stages. First we used an **automatic procedure** which classified every paragraph according to the presence or absence of the key words that characterize every thematic field. During this stage we introduced the special code **InEmCyT** to classify paragraphs related to **Innovation, Business, Science and Technology**. In the second stage we used only the paragraphs defined as InEmCyT and we classified them **manually** according to the **categories of our model of scientific culture**. In addition at this stage we took all the paragraphs containing social assessments of science and technology and classified them as positive (**promises**) or negative (**threats**).

1.3 Scientific contents of Compulsory Secondary Education (ESO)

The following table presents a summary of the corpus of documents we have used. Altogether we analyzed 81 textbooks distributed across different subjects of the first and fourth grades of the ESO. The books are published by the four most important publishing houses in Spain. Foreign Languages books were not used. Although there are differences between the publishers with respect to the subjects and the texts (some have workbooks etc), we treated every text as an independent unit, and the paragraph as the unit of analysis.

Table 4: Textbooks by subject and publisher

				Texts and Publishers						
Grade	**ESO subject**	**Type of subject**	**Hours per week**	**Textbooks**	**ANAYA**	**EDELVIVES**	**SANTILLANA**	**S.M.**	**Total textbooks**	**Subject****
First grade	Natural Science	Universal	3	Ciencias de la Naturaleza	x	x	X	x	4	CN
				Cuaderno de CC de la Naturaleza		x			1	CN
	Social Science, Geography, History	Universal	3	Ciencias Sociales, Geografía e	x	x	X	x	4	CS
	Physical Education	Universal	2	Educación Física			X		1	MI
	Art	Universal	2	Educación	x				1	MI
	Spanish Language and Literature	Universal	5	Lengua Castellana y	x	x	X	x	4	LL
	Foreign Language	Universal	3	Lengua Extranjera					0	
	Mathematics	Universal	4	Matemáticas	x	x	X	x	4	MA
				Cuaderno de Matemáticas		x			1	
	Music	Universal	2	Música				x	1	MI
	Religion	Universal	1	Religión	x	x	X	x	4	ER
	Technology	Universal	2	Tecnología	x	x	X	x	4	TE
				Cuaderno de Tecnología				x	1	TE
Fourth grade	Biology and Geology	Specialty	3	Biología y	x	x	X	x	4	CN
				Cuaderno Biología y		x			1	CN
	Social Science, Geography, History	Universal	4	Ciencias Sociales, Geografía e	x	x	X	x	4	CS
	Classical Culture	Optional	2	Cultura Clásica	x	x	X	x	4	LL
	Physical Education	Universal	2	Educación Física	x				1	MI
	Plastic Arts	Specialty	3	Educación				x	1	MI
	Renewable Energy and the	Optional	2	Energías Renovables y	x				1	MI
	Ethics	Universal	2	Ética	x	x	X	x	4	ER
				Cuaderno de	x				1	ER
	Physics and	Specialty	3	Física y Química	x	x	X	x	4	FQ
	I.T.	Optional	2	Informática	x				1	TE
	Spanish Language and Literature	Universal	4	Lengua Castellana y	x	x	X	x	4	LL
	Foreign Language	Universal	3	Lengua Extranjera					0	
	Mathematics	Universal	4	Matemáticas		x			1	MA
				Matemáticas	x		X	x	3	MA

				Matemáticas	x		X	x	3	MA
	Communication	Optional	2	Medios de Comunicación			X		1	MI
	Music	Universal	3	Música			X		1	MI
	Religion	Optional	2	Religión	x	x	X	x	4	ER
	Society Culture and Religion	Optional	2	Sociedad, Cultura y Religión	x		X	x	3	ER
	Technology	Specialty	3	Tecnología	x	x	X	x	4	TE
				Cuaderno de Tecnología				x	1	TE
	Total of analyzed textbooks				22	18	20	21	81	
	*Speciality: In the fourth year students chose two of the four following options: a) Science and Nature and b) Art, Music and Technology Science and Nature is divided into "Biology and Geology" and "Physics and Chemistry" each one counts as one option. ** CN: Ciencias Naturales; CS: Ciencias sociales; ET: Ética y Religión; FQ: Física y Química; LL: Lengua Literatura y Cultura Clásica; MA: Matemáticas; MI: Miscelánea; TE: Tecnología									

The texts were digitalized by a program of optical character recognition (OCR), and revised manually. From the electronic version of the texts we obtained the lists of words of each text (after a process of partial lemmatization to reduce plural to singular forms) and the elimination of the most frequent no significant words (*stoplist:* articles, pronouns, auxiliary verbs etc…)

The most relevant characteristics of the texts after they had been purged can be appreciated in the tables in Annex 2. The whole set of documents occupies 30,7 MB and contains 5.3 million words, that make 300 thousands phrases organized in approximately 170 thousand paragraphs.

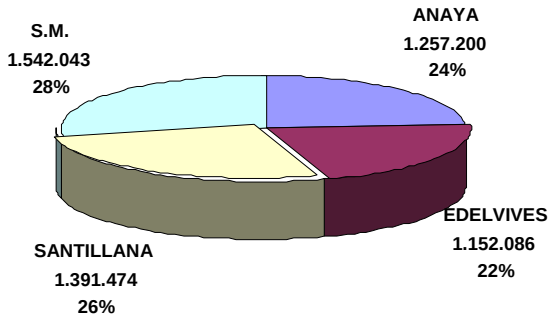

Figure 1: Number of words by publishers

In the adjoined graph the information about the size of the texts of each publisher, estimated on the basis of the total number of words, is summarized. The balanced presence of the four publishers in the total set of documents can be appreciated.

2 The scientific vocabulary of the ESO

In order to appreciate the distribution of texts across the subjects we grouped the books in seven blocks of subjects. Table 5 and the following graph present the distribution of the paragraphs of the subjects in the books of each publisher and the weight of the subject in the total corpus of documents.

The whole set of documents occupies 30,7 MB and contains 5.3 million words, that make 300 thousands phrases organized in approximately 170 thousand paragraphs, distributed evenly and in proportion among the four leading publishers of school texts in Spain.

Table 5: Number of paragraphs by subjects and publishers

	ANAYA	EDELVIVES	S.M.	SANTILLANA	TOTAL GENERAL
CIENCIAS NATURALES (CN)	4122	5502	5823	4937	20384
CIENCIAS SOCIALES (CS)	3650	4120	6139	6729	20638
ÉTICA Y RELIGIÓN (ER)	5952	5279	6303	5590	23124
FÍSICA Y QUÍMICA (FQ)	2195	2612	3444	2332	10583
LENGUA LITERATURA Y CULTURA CLÁSICA (LL)	7034	8147	8650	9019	32850
MATEMÁTICAS (MA)	7115	5825	7563	12982	33485
MISCELÁNEA (MI)	3159		2458	3745	9362
TECNOLOGÍA (TE)	8057	3126	4228	3917	19328
TOTAL GENERAL	41284	34611	44608	49251	169754

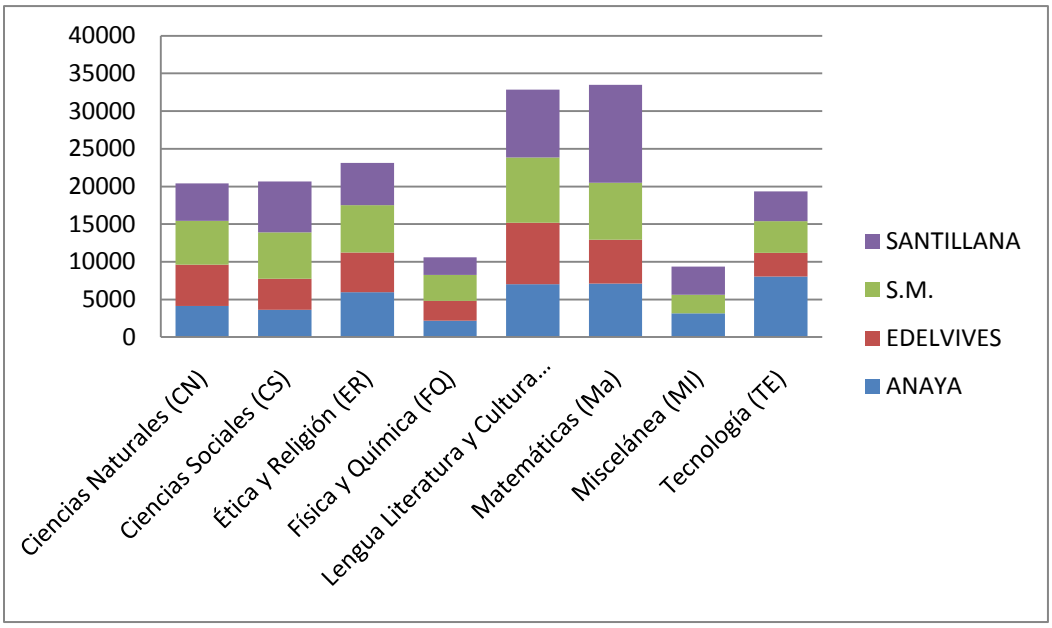

Figure 2: Number of paragraphs by subjects and publisher

It can be observed that the block of **Mathematics** is the one that has most weight (20%) in terms of number of paragraphs, followed by humanistic disciplines (**Language, Literature and Classic Culture**: 19%). Generally speaking our corpus presents a balance between two traditional types of academic disciplines: **exact and natural sciences plus technology consist of 49% of the total**. The other half consists of humanities and social science broadly defined (including in this group Ethics and Religion, as well as the contents of optional subjects belonging to the group of miscellany, mainly Communication, Music, Plastic Arts and Physical Education).

Our corpus presents a balance between two traditional types of academic disciplines: **exact and natural sciences plus technology consist of 49% of the total**. The other half consists of **humanities and social science** broadly defined. The number of paragraphs of 4th grade textbooks doubles that of first grade text books.

The following table presents the same information by grade of the ESO. As seen clearly the quantity in the fourth grade is almost double. In addition the relative homogeneity of the distribution of blocks of subjects in both grades can be appreciated (if we leave out Physics and Chemistry in the first grade).

Table 6: Number of paragraphs by subject and grade

	1st grade	4th grade	Total
MA (MATEMÁTICAS)	12607	20878	33485
LL (LENGUA LITERATURA Y CULTURA CLÁSICA)	11617	21233	32850
ET (ÉTICA Y RELIGIÓN)	5156	17968	23124

CS (CIENCIAS SOCIALES)	9030	11608	20638
CN (CIENCIAS NATURALES)	9998	10386	20384
TE (TECNOLOGÍA)	8449	10879	19328
FQ (FÍSICA Y QUÍMICA)		10583	10583
MI (MISCELÁNEA)	2985	6377	9362
TOTAL GENERAL	59842	109912	169754

2.1 Weight and density of the thematic fields

As we have already indicated grouping the texts according to subjects was used to obtain the key words that characterize every area of study. For this purpose the texts belonging to each subject were used as if they were a single document, from which the set of key words that characterizes it (comparing its vocabulary with that of the entire corpus of documents), was obtained. These lists of key words were obtained automatically using the program WordSmith, but they were purged manually in order to exclude morphological variations of the same words, as well as spurious terms that usually appear. To the eight lists of specialized vocabulary we added a ninth (**InEmCyT:** Innovación Empresa Ciencia y Tecnología) constructed with the key words of the area "innovation and business", enriched manually with a series of generic terms referring to science and technology. The entire list of key words obtained in this way (see Appendix 3) was used in order to codify automatically all of the paragraphs of the set of documents, using the program Atlas.ti. The result of the coding allows us to find out in how many paragraphs of the set of documents appears every key term or code. Grouping the codes in families or **thematic fields** we can estimate the real weight of the contents related to every thematic field in the entire set of documents.

It is important to understand the difference between "subject" and "thematic field" as we use these terms. A subject is defined by the set of textbooks that belong to the same academic course such as science or literature. The texts of all these books were used to select the list of key words that characterize this topic. A thematic field is defined by the set of paragraphs of any book of the set of documents in which appears at least one of the key words that characterize the topic. For example a paragraph from a religion book which talks about biology belongs to the thematic field of biology and to the subject of religion.

In the following tables the distribution of these contents across subjects, publishers, and grades is represented. It must be mentioned that the total number of codified paragraphs according to subjects does not have to match the total number of paragraphs: some paragraphs may not be codified in any thematic field and others may be codified in various different fields.

Table 7: Number of paragraphs in thematic fields by publisher

Thematic fields	Publisher				
	Total	Anaya	Edelvives	Santillana	SM
CC Naturales	30540	7323	6600	7912	8705
CC. Sociales	34576	7503	7159	9704	10210*
Ética y Religión	34408	8273	7335	9251	9549
Física y Química	21861	5252	4793	5554	6262
Inn-Emp-Cien-Tec	18641	4499	3987	4941	5214
Lengua, Lit y C. Clásica	24943	5578	5610	6568	7187
Matemáticas	36364	8016	7480	11053	9815
Miscelánea	14493	3630	2539	4304	4020
Tecnologías	34972	10298	6804	8566	9304

*Significant cells (p≤ 0.05) are highlighted in red.

As can be observed, the distribution of thematic fields across publishers is equivalent to the distribution of the blocks of subjects; that is they have a relatively similar weight and rather a homogeneous presence in the different publishers. However there are three cases (highlighted in color) in which a significant deviation from the expected values can be seen: Social Science in SM, Mathematics in Santillana and Technology in Anaya have a relatively higher weight than expected. This means a certain degree of specialization of these publishers.

> The special field **InEmCyT appears in the four publishers in similar proportions to their weight in the set of documents**, what means that none of the publishers has a specific profile with respect to this thematic field. It is nevertheless relatively more present in 4th grade than it is in 1st grade textbooks

In table 8 we can see the distribution of the thematic fields across the grades. The fields of Natural Science and of Language, Literature and Classical Culture are significantly more present in the first year. However all the other thematic fields (except Miscellany, in which there are no significant differences between the first and the fourth years) are more present in the fourth year. It is interesting that although in the first year Physics and Chemistry are absent, the contents of these thematic fields are still present, as they appear in other subjects. And also that the special field **InEmCyT is significantly more present in the fourth year than in the first year.**

Table 8: Number of paragraphs in thematic fields by grade

		Grades		
		Total	1º	4º
Fields	CC Naturales	30.540	12.527	18.013
	CC. Sociales	34.576	9.465	25.111
	Religión	34.408	9.409	24.999
	Física y Química	21.861	5.434	16.427

Inn-Emp-Cien-Tec	18.641	4.481	14.160
Lengua, Lit y C. Clásica	24.943	9.121	15.822
Matemáticas	36.364	11.940	24.424
Miscelánea	14.493	4.960	9.533
Tecnologías	34.972	11.625	23.347

*Significant cells (p≤ 0.05) are highlighted in red.

2.2 References across curricular boundaries

Naturally, textbooks do not only contain the subject they are dedicated to, but many other themes. It is interesting to check how the contents of different thematic fields are distributed across all the other subjects. The following tables present the most relevant information about the weight of each thematic field in every block of subjects.

The first column of table 9 represents the total of paragraphs codified according to key words of each thematic field, and the rest of each row the distribution of these paragraphs across the different subjects (sets of books grouped into blocks of subjects).

As expected, the most significant weight appears in the cells situated along the diagonal of the table of thematic fields, although there is also **a significant statistical association between Natural Science and Physics and Chemistry** on the one hand and **Social science and Ethics and Religion** on the other hand as highlighted in table 10.

Table 9: Number of paragraphs in thematic fields by subject

Thematic fields	Subjects								
	All the subjects	Ciencias Naturales	Ciencias Sociales	Ética y Religión	Física, Química	Lengua, L. y Cultura Clásica	Matemáticas	Miscelánea	Tecnología
CC Naturales	**30540**	12075	4771	2133	2999	2876	1831	896	2959
CC. Sociales	**34576**	2905	12682	6568	1031	6417	1413	1168	2392
Etica Religión	**34408**	2133	6179	15117	408	6896	1258	1079	1338
Física y Química	**21861**	4012	1649	1088	7787	1550	1626	1119	3030
Lengua, Lit y C. Clásica	**24943**	493	1446	3252	184	16811	595	746	1416
Matemáticas	**36364**	2266	1949	1586	2649	2610	20922	1032	3350
Miscelánea	**14493**	1004	1550	1590	465	2724	1181	3504	2475
Tecnologías	**34972**	2787	3109	2194	2501	4430	3963	2041	13947
Inn-Emp-Cien-Tec (InEmCyT)	**18641**	2515	3849	2896	877	2668	1753	997	3086
Total codes	**250798**	**30190**	**37184**	**36424**	**18901**	**46982**	**34542**	**12582**	**33993**
Total codified paragraphs	**169754**	**20384**	**20638**	**23124**	**10583**	**32850**	**33485**	**9362**	**19328**

*Significant cells (p≤ 0.05) are highlighted in red.

Table 10: The weight of thematic fields by subject (vertical percentages)

Thematic fields	Todas las materias	Ciencias Naturales	Ciencias Sociales	Ética y Religión	Física, Q.	Lengua, L. y Cultura .	Matemáticas	Miscelánea	Tecnología
CC Naturales	12%	40%	13%	6%	16%	6%	5%	7%	9%
CC. Sociales	14%	10%	34%	18%	5%	14%	4%	9%	7%
Ética Religión	14%	7%	17%	42%	2%	15%	4%	9%	4%

Física y Química	9%	13%	4%	3%	41%	3%	5%	9%	9%
Lengua, Lit y C. Clásica	10%	2%	4%	9%	1%	36%	2%	6%	4%
Matemáticas	14%	8%	5%	4%	14%	6%	61%	8%	10%
Miscelánea	6%	3%	4%	4%	2%	6%	3%	28%	7%
Tecnologías	14%	9%	8%	6%	13%	9%	11%	16%	41%
Inn-Emp-Cien-Tec (IECT)	7%	8%	10%	8%	5%	6%	5%	8%	9%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

*Significant cells (p≤ 0.05) are highlighted in red.

The percentages of the diagonals of this table represent the weight of every thematic field in the corresponding subject or block of subjects. A higher percentage means a more specialized character of the corresponding subject (more isolated of the rest of the curricular contents). The most salient case is of **Mathematics.**

The specific field of **InEmCyT,** which appears at the end of the table**,** counts for 7% of the total of codified contents and **is distributed homogenously across all the subjects,** with a slight higher weight in Social Science (10%) and slightly lower (5%) in Physics Chemistry and Mathematics.

The following table represents what we can call the **density of thematic codifications according to subjects**, that is, the average number of different thematic codes in a paragraph of each subject. The average density is 1.48 for all the subjects, that is, in every hundred paragraphs of the corpus there is an average of 148 references to different thematic fields. The lowest level is again in Mathematics and the highest in Social Science (1.80), Physics and Chemistry (1.79) and Technology (1.76). The first column summarizes the distribution of the thematic codifications of paragraphs: In every 100 paragraphs of the set of documents 18 have Natural Science contents, 20 Social Science, 20 Ethics and Religion etc. This table represents the same for every subject.

Table 11: The density of the thematic fields by subject

Campos temáticos (thematic fields)	Materias (subjects)								
	Todas las materias	**Ciencias Naturale**	**Ciencias Sociales**	**Ética y Religión**	**Física, Q.**	**Lengua, L. y**	**Matemáticas**	**Miscelánea**	**Tecnología**
CC Naturales	**0,18**	0,59	0,23	0,09	0,28	0,09	0,05	0,10	0,15
CC. Sociales	**0,20**	0,14	0,61	0,28	0,10	0,20	0,04	0,12	0,12
Ética Religión	**0,20**	0,10	0,30	0,65	0,04	0,21	0,04	0,12	0,07

Física y Química	**0,13**	0,20	0,08	0,05	0,74	0,05	0,05	0,12	0,16
Lengua, Lit y C. Clásica	**0,15**	0,02	0,07	0,14	0,02	0,51	0,02	0,08	0,07
Matemáticas	**0,21**	0,11	0,09	0,07	0,25	0,08	0,62	0,11	0,17
Miscelánea	**0,09**	0,05	0,08	0,07	0,04	0,08	0,04	0,37	0,13
Tecnologías	**0,21**	0,14	0,15	0,09	0,24	0,13	0,12	0,22	0,72
Inn-Emp-Cien-Tec (InEmCyT)	**0,11**	0,12	0,19	0,13	0,08	0,08	0,05	0,11	0,16
Densidad por material	**1,48**	**1,48**	**1,80**	**1,58**	**1,79**	**1,43**	**1,03**	**1,34**	**1,76**

The contents of **InEmCyT,** represent 11% of the total of codified thematic contents and it has the highest density in the textbooks of Social Science (19%) and the lowest in Mathematics (3%).

The average density is 1.48 for all the subjects, that is, in every hundred paragraphs of the corpus there is an average of 148 references to different thematic fields. The lowest level is again in Mathematics and the highest in Social Science (1.80), Physics and Chemistry (1.79) and Technology (1.76).

2.3 The semantic structure of the thematic fields

The contents of scientific culture that are transmitted in the textbooks not only have more or less a transversal character across the different subjects but in addition they present a structure of meanings which is not always obvious. Part of this meaning can be shown by analyzing the relations between different thematic fields or on a more desegregated level, between different scientific concepts represented by key words or groups of key words.

Table 11 presents a 9 x 9 matrix of thematic fields. Every cell represents the number of paragraphs which contain codes of the thematic field of the corresponding row and column. The diagonal cells (and the totals of the rows and columns that coincide with them) represent the total number of different paragraphs in which codes of every thematic field appear. The general sum of the table (13.4397) represents the number of different paragraphs that were codified in at least one thematic field.

Table 12: Shared contents by thematic field

	CC Naturales	CC. Sociales	Religión	Física y Química	Inn-Emp-Cien-Tec	Lengua, Lit y C. Clásica	Matemáticas	Miscelánea	Tecnologías	Total
CC Naturales	30540	8749	6393	7892	4888	2670	5223	2560	6930	30540
CC. Sociales	8749	34576	13345	4402	7184	6209	4631	3696	7510	34576
Religión	6393	13345	34408	3221	6146	7174	4074	3511	5868	34408
Física y Química	7892	4402	3221	21861	3176	1636	5021	2068	6303	21861
Inn-Emp-Cien-Tec	4888	7184	6146	3176	18641	2988	3838	3016	6682	18641
Lengua, Lit y C. Clásica	2670	6209	7174	1636	2988	24943	2977	2918	5101	24943
Matemáticas	5223	4631	4074	5021	3838	2977	36364	2568	9117	36364
Miscelánea	2560	3696	3511	2068	3016	2918	2568	14493	5150	14493
Tecnologías	6930	7510	5868	6303	6682	5101	9117	5150	34972	34972
Total	30540	34576	34408	21861	18641	24943	36364	14493	34972	134397
%	*22.7%*	*25.7%*	*25.6%*	*16.3%*	*13.9%*	*18.6%*	*27.1%*	*10.8%*	*26.0%*	

*Significant cells (p≤ 0.05) are highlighted in green.

The "central" character of the field InEmCyT is salient. It has significant associations with all the rest, except Language and Mathematics. The isolation of Mathematics that does not have significant associations with any other thematic field should also be mentioned.

We can present this data in a form of a net in which nodes represent the thematic fields and the lines the relations of co-appearance or semantic association. See graph 4 (Escobar 2009).

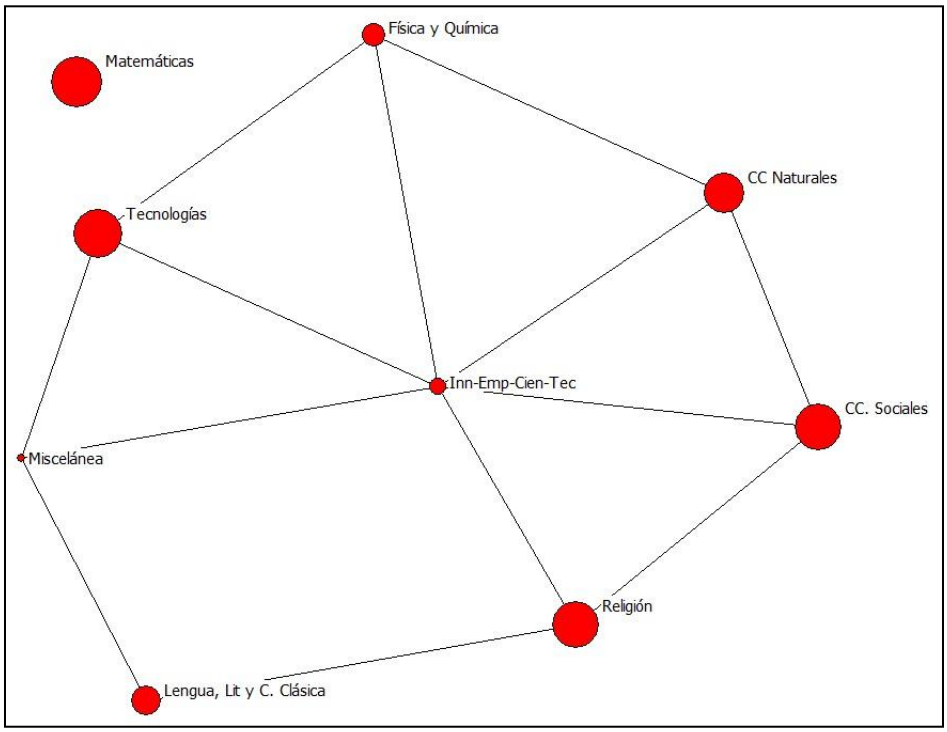

Figure 3: Semantic structure of thematic fields

The field **InEmCyT**, that has a reduced weight, assumes however a central role to the extent that its contents (including words referring to science and technology in a general way, like "science", "technology", "research", etc.) are associated with all the rest (except Mathematics and Language).

Category **InEmCyT** has significant links to every thematic field, in a direct or indirect way (as it is the case of the field "Language, Literature and Classic Culture"), except Mathematics which seems to be an isolated planet in the constellation of scholar topics.

In order to understand better how these relations are produced we have to sharpen the "focus" of our instrument of observation and analyze the internal structure of the thematic fields and the semantic relations between more basic concepts.

2.4 Semantic nets and scientific concepts

The key words that correspond to the scientific and technological subjects (Natural science, Physics, Chemistry, Mathematics, Technology) in addition to the field **InEmCyT** were individually codified, although until now we only presented the grouped results in families of codes or words. But in order to analyze the internal structure of the thematic fields created in this way, we can now use the results of the codification on a desegregated level, indentifying the key words and their semantic relations of co-

appearance. In this way we obtain a much more detailed representation of the scientific contents that are transmitted in the textbooks, their semantic structure and their relations with other components of scientific culture.

To do this we applied to the individual codes or key words the same analysis of semantic relations technique we have just seen with respect to the scientific fields. In order to simplify the analysis, we only took into account those codes or key words that have more than 200 appearances (227 key words in total) and we built with them the residual matrix from which several techniques can be used in order to discover underlying semantic structures.

The first option consists of lifting the threshold for the relation until the visualization of a net that can be

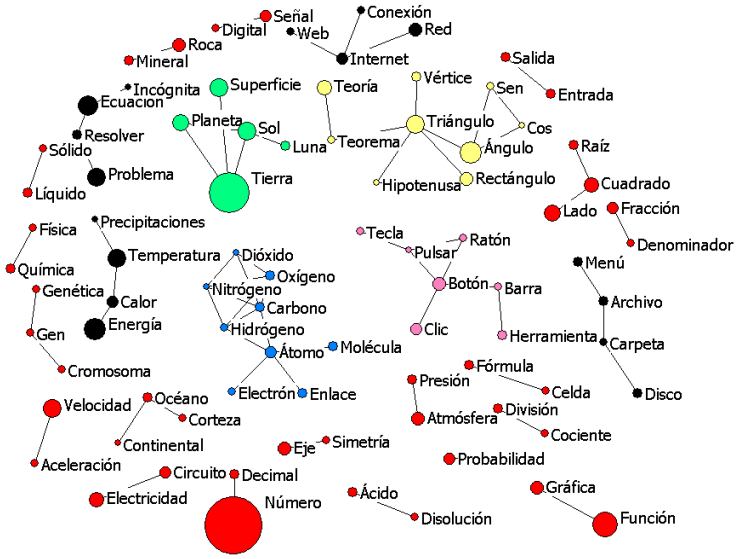

Figure 4: Global conceptual net

interpreted[5]. Continuing with this procedure, choosing a threshold of 60 for adjusted residuals, graph 5 is obtained from which the following results are worth mentioning:

Only eight sets of concepts with more than three relations are generated. The most extended one is around the word **atom** and it also includes eight other concepts: **carbon**, **oxygen**, **nitrogen**, **hydrogen**, **dioxide**, **molecule**, **link** and **electron** what allows us to identify him as the nucleus of the thematic field

The following important set of relationships is related to **Mathematics** and is articulated around the concept **triangle** that connects eight other concepts in two sets. On the one hand, **angle**, **sine** and **cosine** and on the other hand **theorem** and **theory**. Finally it is worth while mentioning the appearance of other concepts connected only to the triangle, which are **hypotenuse**, **rectangle** and **vertex**.

[5] The main decision that has to be taken is to establish the mentioned threshold. The most recommended technical solution is to apply the correction of Bonferroni. In the example we are dealing with we should have multiplied the meaning of the residual by the number of tests done (221x220/2=24310). In this way the critical value of the normal distribution (only one tail) would be of 4,61 and 4,93 for significant levels of 0.05 and 0.01. Nevertheless, in this context the threshold has been overdimensioned to obtain only the most salient co-appearances.

The third set of concepts belongs to the field of **technology** and is constituted of a group of words related to the **practical application of information technology.** The central concept is button and around it appear **press, mouse, toolbar and click.** Finally, as can be deduced from the meaning of the concepts the word **key board** is connected to **press,** and **tool** is connected to toolbar.

The fourth set belongs to Natural Science and is formed by five concepts articulated around **earth**. The concepts linked to it are **surface**, **planet**, and **sun** and this last one is connected to **moon**.

The rest of sets with more than three components are a) the resolution of equations and problems with an unknown (Mathematics) b) connection, net, web, and internet (Technology) c) energy is linked to heat and heat to temperature together with rain (Physics and Natural Science) and d) disc is linked to file, document and menu, (again Technology)

The main conclusion of this first semantic analysis is the almost **identification of technology with information technology, especially with the usage of information technology (button as a key concept).** The second one is **the central and basic role of concepts such as atom, triangle and earth** in the structures of the scientific concepts of the ESO.

From these results the focus can be widened and each one of these basic concepts can be analyzed creating **auto-nets**. That is representations that only include the concepts connected with every elected concept, in addition to the connections between themselves. In this way the density of the most intensive connexions obtained by the previous procedure is augmented.

The auto-net of **atom** shows a clear association, on the one hand, with related concepts such as **molecule**, **link, electron**, **hydrogen, carbon, nitrogen** and **chemistry** and, on the other hand, with concepts which are especially present in textbooks such as **number, energy, electricity** and **theory**. It is a complex net (with twenty terms) which reflects the conceptual relevance (low number of appearances but a high number of significant connections) of the term. Another salient piece of information is that the most common term in this auto-net is number, which must be interpreted as a generic concept, present in many fields of science, more than as a mathematical concept.

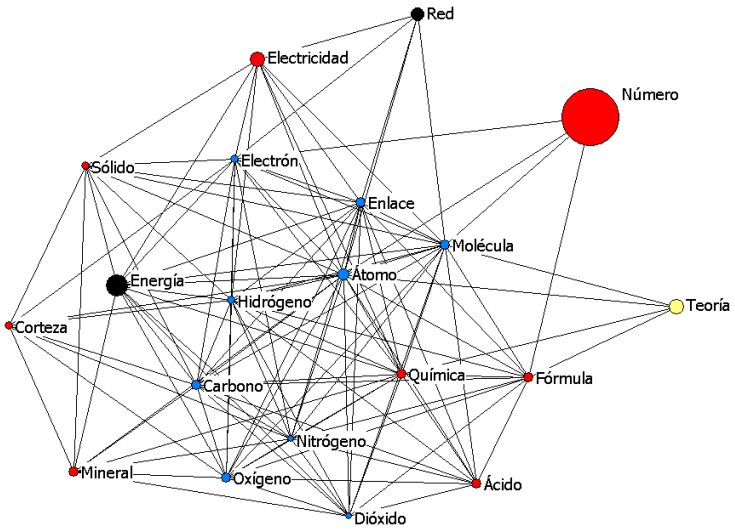

Figure 6: Autonet of the concept atom

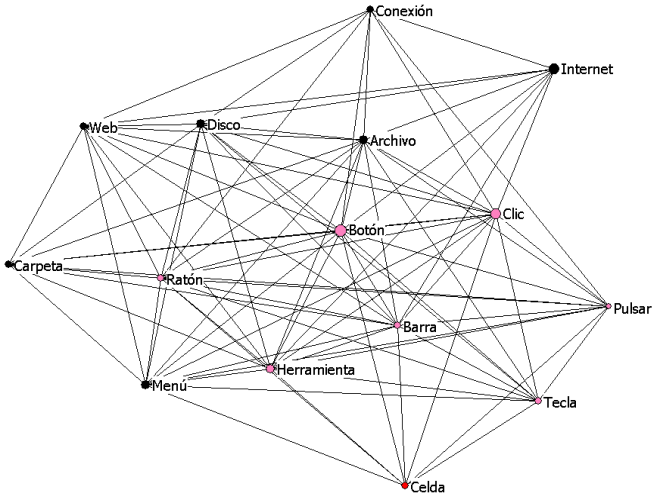

Figure 5: Autonet of the concepto buton

The map of **atom** can be contrasted with that of **button**. In this case the closest concepts are **click**, **toolbar, mouse, disc** and **archive** (all of them have a meaning in the usage of Information Technology). On the other hand, the rest of the concepts of the auto-net are also words related to computers such as **menu, folder, internet** and **connection**.

One of the other four concepts taken from the global conceptual net is **triangle**. In this case, its auto-net is composed by **geometrical concepts**, except the more general words, **theory, theorem, formula** and **solve**. In this case in comparison to the previous ones, the same concept of triangle is the most frequent, together with **angle, side** and **rectangle**.

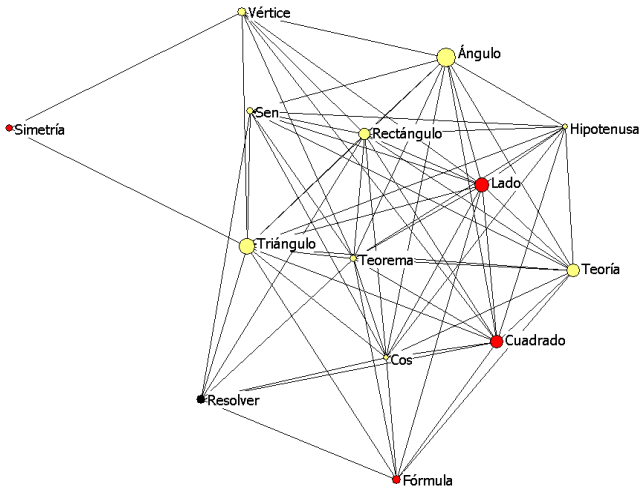

Figure 8: Autonet of the concept triangle

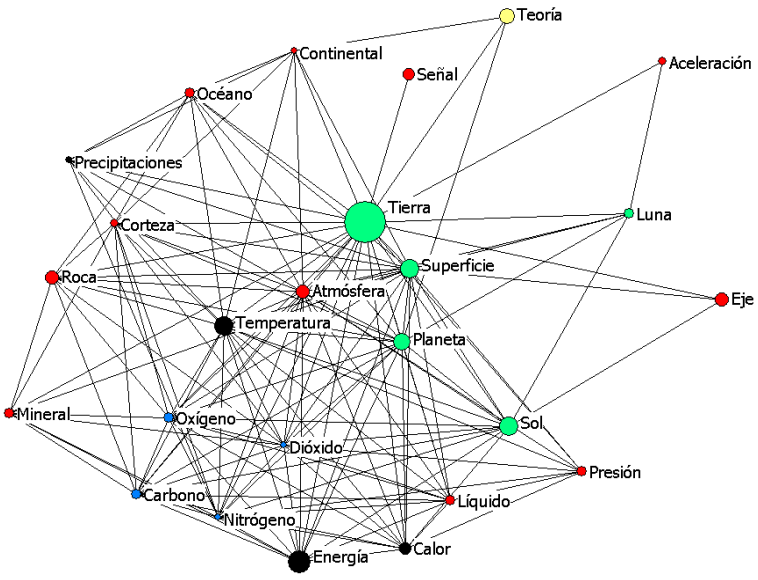

Figure 7: Autonet of the concept Earth

Finally, we present the auto-net of the concept **earth**; the densest of the four (it includes 25 concepts). Nevertheless in comparison with the auto-net of atom, the concept **earth** itself is the most common in the analyzed texts (probably because of its polysemic nature). Very close to earth we find **surface, planet, atmosphere, temperature** and **signal**, while frequent and diverse concepts such as **theory, energy, heat, axis** and **rock** also form part of the set of conceptual connections represented.

Although none of the key words of the thematic field InEmCyT appears among the basic scientific concepts, it is worthwhile to find the auto-nets of concepts such as **science** and **technology**, which are central for our study.

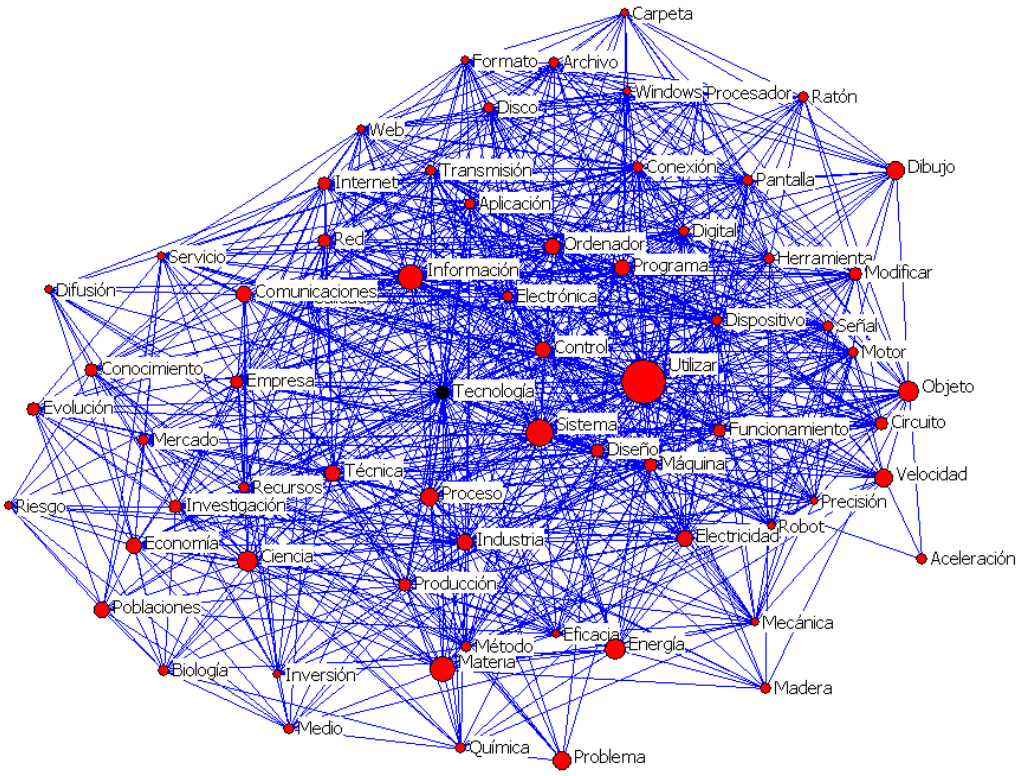

Figure 9: Autonet of the concept Technology

The auto-net of Technology is one of the densest auto-nets in this investigation. Among the closest words to its centre we can find **system, control, use, electronics, technique and process.** Other related common concepts, but less central, are **science, communications, information, computer, program, matter, energy, object, drawing.** There are also interesting relations with **company, market, economics, production** etc.

Contrary the auto-net of the concept Science is less dense. However it shares ties with many concepts of the auto-net of technology, although it is interesting that **concepts related to information technology appear in the auto-net of technology but not in that of science.**

The generic concepts of science and technology (included in the category **InEmCyT**) reveal a more complex network of interrelations where new dimensions of technology play an important role. Nevertheless, information technologies are still the most important content of technology and the less related to science.

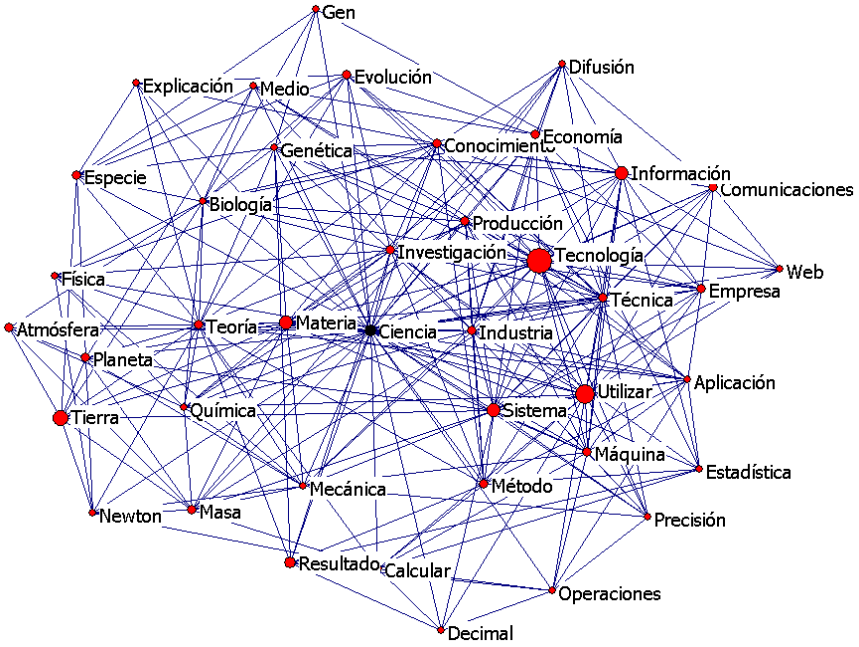

Figure 10: Autonet of the concept Science

The analysis of nets allows us to discover another type of semantic relations which are not based on the statistical significance of the coincidence of words, but on the location of these words in the whole of the semantic net, specifically on its capacity of inbetweenness, i.e to serve as a bridge between other concepts. **It is a measurement that indicates the capacity of each element (in this case, a word) to connect a group of elements (words)**. It is easier to appreciate this concept, suggested by Freeman (Freeman, Borgatti and White 1991), graphically. In graph 9 the concepts C and E are the most central (they are the most connected with the others). However the mediation power of D is just as big as the

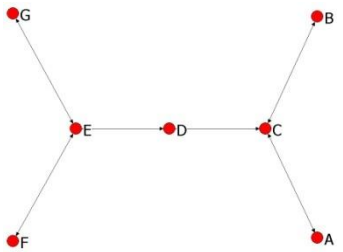

Figure 11: Representation of the relation of intermediation

previous concepts, because it is necessary to link A,B and C with E,F and G. Centering Resonance Analysis considers this measure as an indicator of the structural value of the words (Corman et al. 2002).

As a result we can create a graph in which only the nodes (concepts) with the highest structural value are represented. We suggest the nodes that have a normalized value above 1. According to this criterion, representing the nodes with a size proportional to their frequency, the following representation of the 81 analyzed textbooks is shown in graph 12.

The main result of applying this new criterion is that only those concepts with the highest mediatory capacity are represented. Of the four most connected (atom, button, triangle and earth) that were previously analyzed three disappear and only **earth** is left. Nevertheless other central concepts appear, as can be deduced from a scrupulous observation of the represented nodes. A thematic grouping can even be done in the graph, confirming how applied methodology reveals links between conceptual structures.

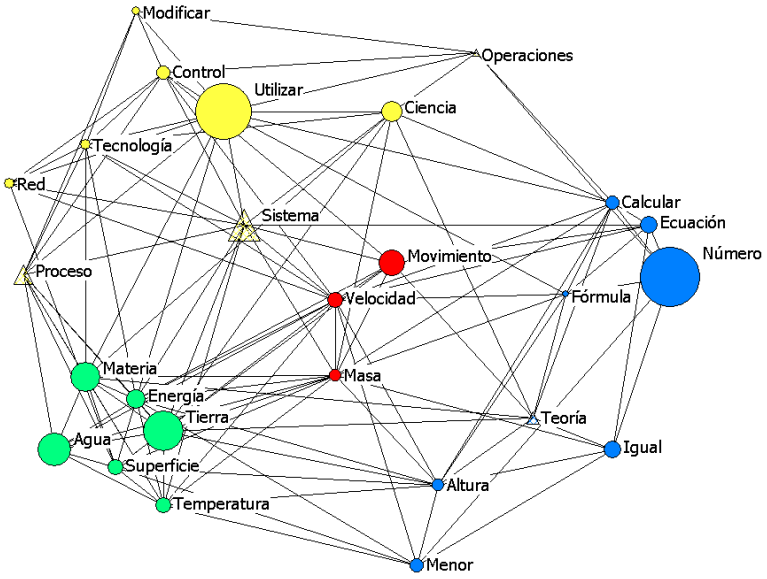

Figure 12: Net of intermediar concepts

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There is a block of Mathematics (blue) that includes number, equation, calculate, formula, less (menor), equal, height and theory. Another block is of Physics (red), which includes speed, movement, mass...The third block is Geography and Nartural Sciences (green) represented by earth, material, water, temperature, energy, surface. Finally the fourth group is operational or technological (yellow) that

Besides the thematic structure of the scientific terms, there are other structural contents which play an intermediary role due to their capacity to connect different fields of science and technology. Some of them have an abstract character like **process, operation, theory, system** and the concept of **science** itself.

consists of system, process, control, usage, modify, net, operations, science and technology. Among all these concepts those who have a more abstract and general character as well as a capacity to connect the others is set a part. These are **process, operations, theory, system** and more generally, that of **science**.

2.5 Innovation, business, science and technology

We can use the same technique to analyze the relations between the components of the thematic block **InEmCyT** and the rest of the scientific contents.

Figure 13 represents the auto-net of the concept **business (Empresa).** It can be observed that it is related to two types of concepts: a group consisted of technological terms grouped around **technology, control, information** and another group of technological terms around **industry, economy, market, competitiveness, production** etc. The absence of relationships with terms of the scientific area except the weak link with the generic concept **research** (**investigación)** is interesting as well as the exclusive position of information technology as the only technological references with regard to business.

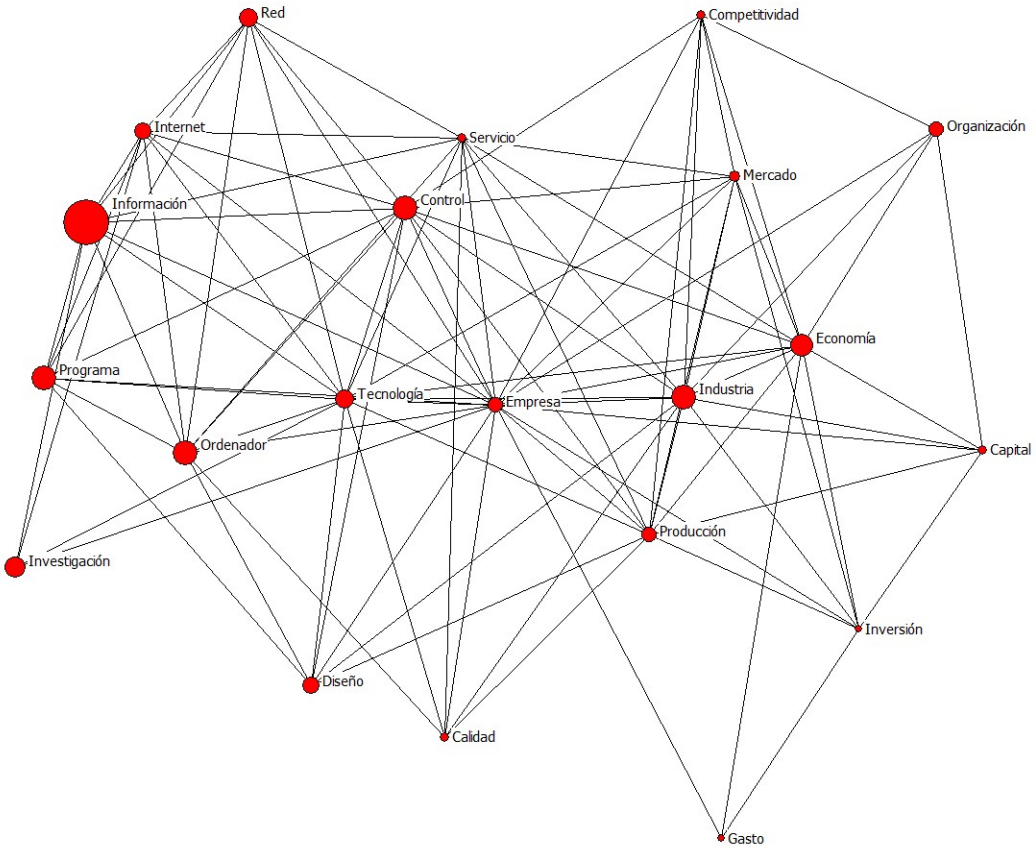

Figure 1: Auto-net of Business (Empresa)

We can expand the zoom on the term **economy** in order to discover its auto-net and thus we obtain the net which appears in figure 14. In the graph we can find important concepts in this context such as **industry, production** and **competitiveness**. Also there is a far reference to **science** and a closer one to **technology**.

We continue with the auto-net of **industry** (figure 15). It demonstrates how the areas of economy and of business are related with science through the concepts of industry and production, more than through the concept of technology. Although there are other terms with a generic character like **research** (figure 16) which also serves as a bridge between business , technology and science.

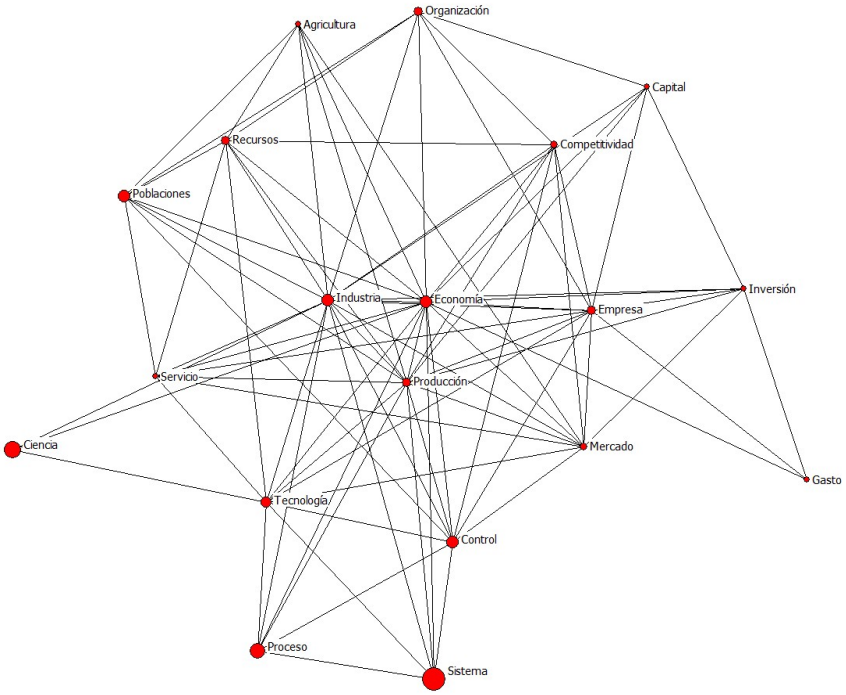

Figure 2: Autonet of Econonomy

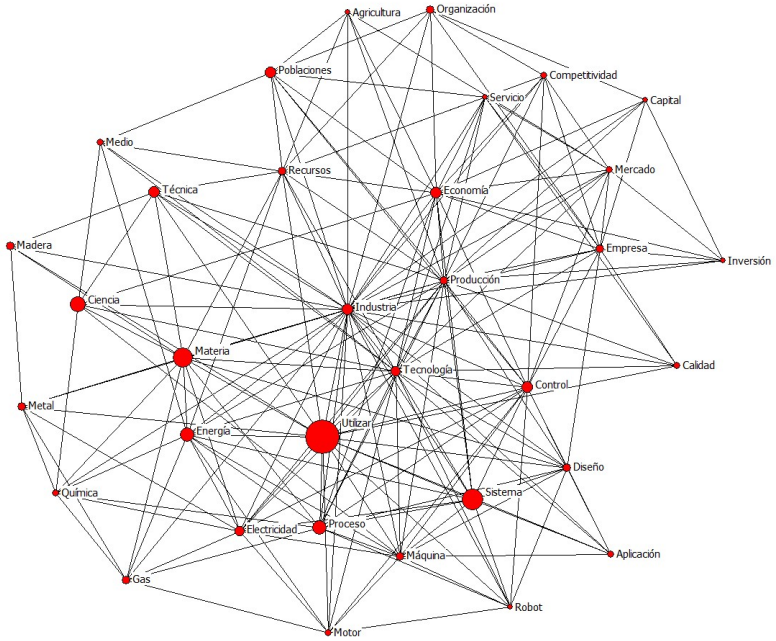

Figure 3: Autonet of industry

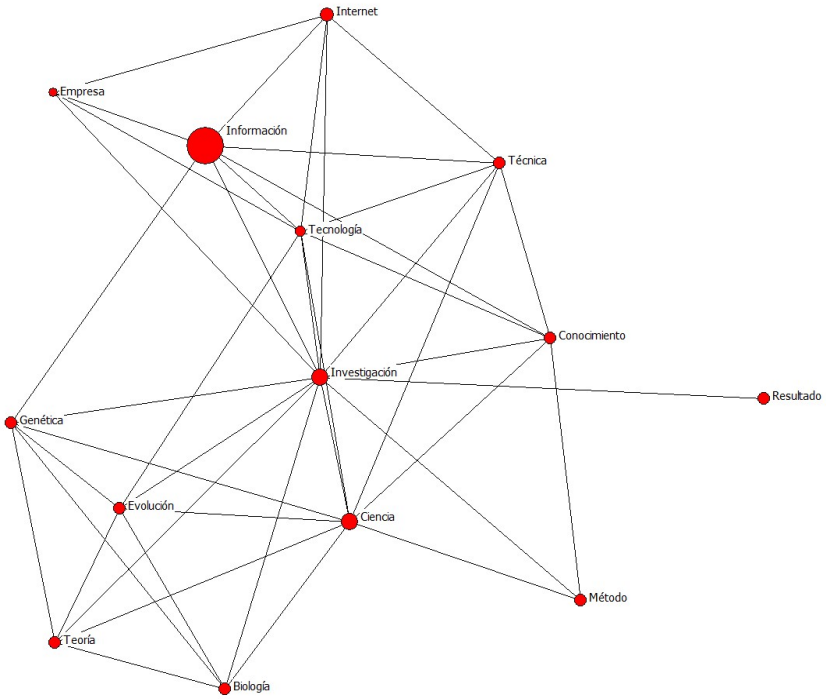

Figure 4: Autonet of research

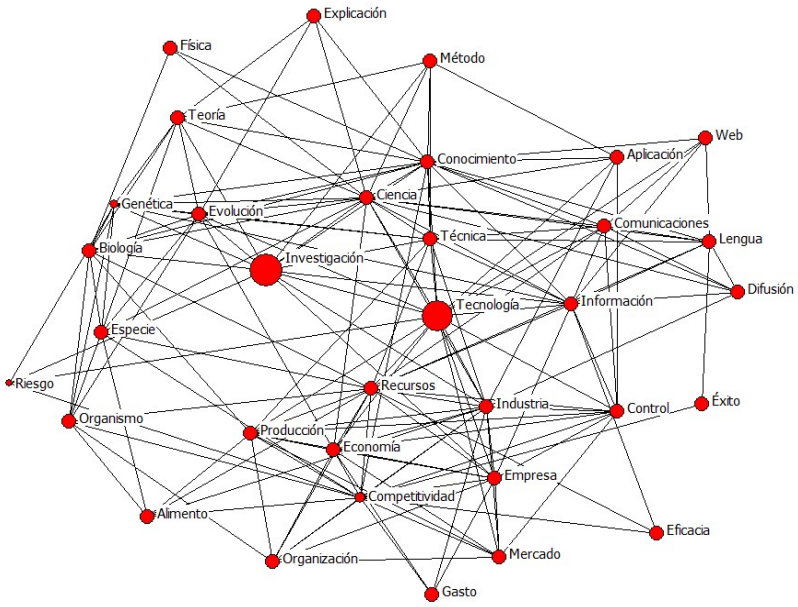

Figure 5: Auto-net of knowledge and competitiveness

There are two concepts whose auto-nets seem totally independent: **competitiveness** on the one hand and **knowledge** on the other hand. The first one refers to the world of business and the second one to science and research. But if we widen the focus to discover the net of relations between them, they appear and allow us to highlight the intermediary of **industry** and **technology**

3 From scientific concepts to scientific culture

In this chapter we present the results of the manual analysis applied to the subset of paragraphs belonging to the thematic field **InEmCyT** (Innovation, Business, Science and Technology). We analyzed manually all the paragraphs which contain at least one of the terms characterizing this thematic field. These paragraphs were codified according to the eighteen categories of our model (see table 0). This was done in order to disclose the elements of scientific, technological and business innovation culture characterizing ESO books

9,797 paragraphs have been codified by the categories of our model of scientific and technological culture enriched with categories of Innovation and Business .The sum of the partial number of paragraphs does not equal the total number, since many appear in more than one category.

Table 13: Summary of manually codified categories

Tabla resumen de categorías codificadas manualmente

TOTAL PÁRRAFC CON AL MENOS UNA CODIFICA MANUAL	9797	CIENCIA	5899	INTRINSECA (CINT)	5095	REPRESENTACIONAL CINTR	3290		
						OPERACIONAL CINTOP	2511		
						VALORATIVA CINTVA	91		
				EXTRINSECA (CEXT)	1011	REPRESENTACIONAL CEXTR	603		
						OPERACIONAL CEXTOP	374		
						VALORATIVA		CEXTVA+	63
							182	CEXTVA-	62
								CEXTVA	48
		TECNOLOGIA	3878	INTRINSECA (TINT)	2572	REPRESENTACIONAL TINTR	2121		
						OPERACIONAL TINTOP	525		
						VALORATIVA TINTVA	151		
				EXTRÍNSECA (TEXT)	1689	REPRESENTACIONAL TEXTR	556		
						OPERACIONAL TEXTOP	925		
								TEXTVA+	155
						VALORATIVA	393	TEXTVA-	164
								TEXTVA	100
		Total códigos de Cultura CT	9777		10367		11722		
		INNOVACIÓN	124						
		EMPRESA	501						

3.1 Scientific, technological and business innovation culture by subject

Applying our model to the ESO books of different subjects reveals the cultural components typical to each one of them. Tables 14 and 15 present the codification of the eighteen categories of our model by subjects. Table 1 gives the number of paragraphs table 2 supplies the vertical percentages of these codifications.

Table 14: Manual codes by subject (number of paragraphs)

N		9,797.00	2,308.00	1,139.00	839.00	1,298.00	831.00	636.00	2,438.00	308.00
						Subject				
		Total	Ciencias Naturales	Ciencias Sociales	Ética y Religión	Matemáticas	Física y Química	Lengua, L. y Cultura C.	Tecnología	Miscelánea
Manual codes	CINTR	3290	1560	308	99	539	498	137	98	51
	CINTOP	2511	752	188	103	887	353	149	59	20
	CINTVA	91	19	7	15	14	15	16	3	2

	CEXTR	603	115	86	200	20	14	148	11	9
	CEXTOP	374	54	78	145	14	21	54	3	5
	CEXTVA+	63	17	13	17	2	5	7	0	2
	CEXTVA-	62	13	3	37	1	1	7	0	0
	CEXTVA	48	20	1	20	0	4	3	0	0
	TINTR	2121	67	177	30	40	61	74	1586	86
	TINTOP	525	59	81	6	33	33	24	263	26
	TINTVA	151	10	16	5	0	5	6	108	1
	TEXTR	556	17	82	127	3	10	62	198	57
	TEXTOP	925	35	162	100	6	25	43	492	62
	TEXTVA+	155	13	22	33	1	4	10	59	13
	TEXTVA-	164	31	17	58	1	5	5	39	8
	TEXTVA	100	5	8	39	1	7	7	30	3
	INNO	124	8	52	11	4	4	9	30	6
	EMP	501	3	140	111	71	3	32	118	23

Table 15: Manual codes by subject (vertical persentages)

%v.

		Subject								
		Total	Ciencias Naturales	Ciencias Sociales	Ética y Religión	Matemáticas	Física y Química	Lengua, L. y Cultura C.	Tecnología	Miscelánea
Manual codes	CINTR	33.6%	67.6%	27.0%	11.8%	41.5%	59.9%	21.5%	4.0%	16.6%
	CINTOP	25.6%	32.6%	16.5%	12.3%	68.3%	42.5%	23.4%	2.4%	6.5%
	CINTVA	.9%	0.8%	0.6%	1.8%	1.1%	1.8%	2.5%	0.1%	0.6%
	CEXTR	6.2%	5.0%	7.6%	23.8%	1.5%	1.7%	23.3%	0.5%	2.9%
	CEXTOP	3.8%	2.3%	6.8%	17.3%	1.1%	2.5%	8.5%	0.1%	1.6%
	CEXTVA+	.6%	0.7%	1.1%	2.0%	0.2%	0.6%	1.1%	0.0%	0.6%
	CEXTVA-	.6%	0.6%	0.3%	4.4%	0.1%	0.1%	1.1%	0.0%	0.0%
	CEXTVA	.5%	0.9%	0.1%	2.4%	0.0%	0.5%	0.5%	0.0%	0.0%
	TINTR	21.6%	2.9%	15.5%	3.6%	3.1%	7.3%	11.6%	65.1%	27.9%
	TINTOP	5.4%	2.6%	7.1%	0.7%	2.5%	4.0%	3.8%	10.8%	8.4%
	TINTVA	1.5%	0.4%	1.4%	0.6%	0.0%	0.6%	0.9%	4.4%	0.3%
	TEXTR	5.7%	0.7%	7.2%	15.1%	0.2%	1.2%	9.7%	8.1%	18.5%
	TEXTOP	9.4%	1.5%	14.2%	11.9%	0.5%	3.0%	6.8%	20.2%	20.1%
	TEXTVA+	1.6%	0.6%	1.9%	3.9%	0.1%	0.5%	1.6%	2.4%	4.2%
	TEXTVA-	1.7%	1.3%	1.5%	6.9%	0.1%	0.6%	0.8%	1.6%	2.6%
	TEXTVA	1.0%	0.2%	0.7%	4.6%	0.1%	0.8%	1.1%	1.2%	1.0%
	INNO	1.3%	0.3%	4.6%	1.3%	0.3%	0.5%	1.4%	1.2%	1.9%
	EMP	5.1%	0.1%	12.3%	13.2%	5.5%	0.4%	5.0%	4.8%	7.5%

*The statistically significant (p< 0.5) cells are highlighted. Higher than expected in red and lower in blue.

Both tables show a salient presence of CINTR, Intrinsic Representational Scientific Culture in Natural Science, Mathematics and Physics and Chemistry books. As can be expected the ESO books of these subjects transmit scientific knowledge to their students. The following paragraph was codified as CINTR and is an example of this category.

> La mitosis es un proceso de división del núcleo por el cual se forman dos núcleos hijos con el mismo número de cromosomas que tenía la célula materna. (BIOLOGÍA_GEOLOGÍA_4º_ANAYA /082)

It is interesting to note that we do not see a similar phenomenon with regard to the books of Social Science. The frequency of paragraphs codified as CINTR in this subject is relatively low. This phenomenon is naturally related to the ambivalent status of this field as scientific.

Another salient characteristic of the ESO books of Natural Science, Mathematics and Physics and Chemistry, is the relatively high number of references belonging to the second category of our model, CINTOP, Intrinsic Operational Scientific Culture. The ESO books of these subjects thus also transmit to their students, elements related to the scientific method. This category can be appreciated in the following quotation:

> Esta es la forma en que trabajan los científicos. Cuando una teoría no puede explicar un hecho nuevo, la cambian, la amplían, la mejoran, hasta que pueda hacerlo. (CCNATURALES_1_ANAYA /0445)

However it is interesting to see that the presence of the third category of our model CINVA , Intrinsic Evaluative Scientific Culture is not significant in most of these subjects with the exception of Physics and Chemistry books . The values characterizing scientific work such as objectivity and universality are hence not of great importance in these books. These kinds of values do appear in humanistic subjects such as Ethics and Religion and Language and Culture.

> This paragraph constitutes of an example of CINVA:
>
> LA CIENCIA Y EL HUMANISMO EN OTROS TIEMPOS La ciencia y la filosofía nacieron en Grecia con un mismo fin: la búsqueda de la verdad. (CULTURA_CLÁSICA_4_ANAYA / 0326)

A related phenomenon that comes up clearly from the above mentioned tables is that in the ESO science books (Natural Science, Mathematics and Physics and Chemistry) **the intrinsic components are not accompanied by a significant amount of extrinsic components**. The five next categories of our model refer to these extrinsic components. As can be seen clearly in tables 14 and 15 the categories of extrinsic scientific culture are especially frequent in Ethics and Religion, and some of them also in Social Science and Language and Literature. **That is, Science is an important issue socially speaking, but most of the attention dedicated to it is limited to the nonscientific subjects**.

First we will give examples of these extrinsic categories of our model and then we will discuss their absence from the ESO science books, relating this phenomenon to other issues. CEXTR, Representational

Extrinsic Scientific Culture refers to the images of science as perceived by society, as can be appreciated in the following example.

> -Otras [disciplinas], en cambio, nos exponen aquellos conocimientos a los que el hombre llega, y de los cuales se puede servir para mejorar sus condiciones de vida. Éste es el caso, por ejemplo, de la Física y la Química. [Ética 4º Edelvives]

CEXTOP, Operational Extrinsic Scientific culture refers to norms of behavior with regard to science in different social spaces, such as legal, moral etc and manifests the importance of science as a social issue.

> Hasta hace relativamente poco tiempo, la mujer ha estado en una situación subordinada con respecto al hombre, al reducirse, casi básicamente, su actividad al ámbito doméstico. Por ello, no ha podido participar plenamente en las esferas de la política, de la ciencia y de la cultura. ¿Te parece justa esta situación? ¿Por qué? (ÉTICA_4_ANAYA / 1709)

> -3 NOS PLANTEAMOS ALGUNAS PREGUNTAS • Cuando la ciencia nos permita conocer el «destino biológico» de una persona (esto es, su propensión a desarrollar determinadas enfermedades), ¿qué límites habrá que imponer a la difusión y el uso de esa información? [Ética Cuaderno 4º Anaya]

CEXTVA+, CEXTVA-, CEXTVA, Evaluative Extrinsic Scientific Culture refers to attitudes towards science that can be positive, negative or neutral. The following quotations represent these categories:

> CEXTVA+ El progreso científico y médico mejora la calidad de vida. A la vez que se producen todos estos adelantos técnicos, la física, la química y la medicina se convierten en los auténticos motores del bienestar en Europa. La publicación del Tratado elemental de química, de Lavoisier (I 805), sentó las bases de la química moderna. Galvani descubrió la corriente eléctrica y Volta inventó la pila. Por su parte, Ampére y Faraday estudiaron la acción de los imanes en la producción de corriente eléctrica (electromagnetismo) y posibilitaron el desarrollo de la electricidad a nivel industrial. (HISTORIA_4_SM / 0740)

> CEXTVA- En conclusión, los descubrimientos científicos y tecnológicos terminan por convertirse en instrumentos de la explotación de una mayoría empobrecida. (ÉTICA_4_SANTILLANA / 1239)

> CEXTVA La sociedad científico-técnica Nuestra sociedad está fuertemente marcada por la influencia de la ciencia y de la técnica. Los avances científicos y técnicos de los últimos años han traído consecuencias positivas y negativas para la sociedad. (RELIGIÓN_4_SM / 1440)

The clear division between subjects that deal with extrinsic components and subjects that deal with intrinsic components can be clearly seen in table 16 and 17 that present the same data but clustered in 6 categories.

Table 16: Clustered manual categories by subject (number of paragraphs)

N		9,797	2,308	1,139	839	1,298	831	636	2,438	308
			Subject							
		Total	Ciencias Naturales	Ciencias Sociales	Ética y Religión	Matemáticas	Física y Química	Lengua, L. y Cultura C.	Tecnología	Miscelánea
Categories of clustered manual Codes	CIENCIA	5899	2165	596	505	1199	747	445	159	83
	TECNOLOGIA	3878	203	476	317	80	129	193	2270	210
	EXTRÍNSECA	2560	266	408	563	48	81	306	754	134
	INTRÍNSECA	7476	2145	687	222	1228	781	343	1905	165
	OPERACIONAL	4222	887	479	327	932	422	257	806	112
	REPRESENTACIONAL	6222	1697	589	399	595	555	391	1802	194
	VALORATIVA	750	119	80	179	20	41	57	230	24
	EMPRESA	501	3	140	111	71	3	32	118	23
	INNOVACIÓN	124	8	52	11	4	4	9	30	6

Table 17: Clustered manual categories by subject (vertical percentages)

%v.

			Subject							
		Total	Ciencias Naturales	Ciencias Sociales	Ética y Religión	Matemáticas	Física y Química	Lengua, L. y Cultura C.	Tecnología	Miscelánea
Categories of clustered manual codes	CIENCIA	60.2%	93.8%	52.3%	60.2%	92.4%	89.9%	70.0%	6.5%	26.9%
	TECNOLOGIA	39.6%	8.8%	41.8%	37.8%	6.2%	15.5%	30.3%	93.1%	68.2%
	EXTRÍNSECA	26.1%	11.5%	35.8%	67.1%	3.7%	9.7%	48.1%	30.9%	43.5%
	INTRÍNSECA	76.3%	92.9%	60.3%	26.5%	94.6%	94.0%	53.9%	78.1%	53.6%
	OPERACIONAL	43.1%	38.4%	42.1%	39.0%	71.8%	50.8%	40.4%	33.1%	36.4%
	REPRESENTACIONAL	63.5%	73.5%	51.7%	47.6%	45.8%	66.8%	61.5%	73.9%	63.0%
	VALORATIVA	7.7%	5.2%	7.0%	21.3%	1.5%	4.9%	9.0%	9.4%	7.8%
	EMPRESA	5.1%	0.1%	12.3%	13.2%	5.5%	0.4%	5.0%	4.8%	7.5%
	INNOVACIÓN	1.3%	0.3%	4.6%	1.3%	0.3%	0.5%	1.4%	1.2%	1.9%

*The statistically significant ($p \leq 0,5$) cells are highlighted. Higher than expected in red and lower in blue.

We can thus see that in the ESO books the scientific knowledge is disconnected from any discussion of its social, moral or legal implications. In addition looking at the components of Technological culture we can assert that scientific knowledge is also disconnected from any practical applications. As can be appreciated from these tables, the frequency of components of technological culture, both intrinsic and extrinsic is notably low in the scientific subjects: Natural Science, Mathematics and Physics and Chemistry. Technology is after all the usage of scientific knowledge in order to produce technical systems. Its absence from these subjects points to a clear inclination toward a pure perception of science.

In ESO textbooks predominates an **academic view of science**: scientific knowledge is disconnected from extrinsic scientific culture as well as from technological applications. And the other way around: representations, attitudes and values related to science are more present in humanistic textbooks than in the scientific ones.

Looking at tables 16 and 17 one can appreciate that generally speaking components of technological culture are concentrated in the subject dedicated exclusively to it (Technology) and to Miscellany. The category TINTR, Intrinsic Technological Representational Culture appears with highest frequency in these two. This category of our model refers to Technological knowledge and the next quotation can serve as a good example of a paragraph codified as such.

> Robots zoomórficos caminadores. CLASES DE ROBOTS Los robots, atendiendo a su aspecto físico y a su funcionalidad, pueden clasificarse de la siguiente manera: ^ Poliarticulados. Son robots que presentan diversas formas y configuraciones. Son esencialmente sedentarios (no se desplazan) y están diseñados para mover sus brazos y herramientas en un determinado espacio de trabajo. En este grupo se encuentran los manipuladores y algunos robots industriales. (TECNOLOGÍA_INF_4_ANAYA / 1110)

TINTOP, Intrinsic Operational Technological Culture, also appears with more frequency in these subjects although it has some presence in Social Science. This category of our model refers to the rules of using technology:

> Hacer clic sobre el botón Done. EL Asistente completará el proceso y la definición de la animación aparecerá en la ventana del programa. (INFORMÁTICA_4_ANAYA / 1906)

TINTVA, Intrinsic Evaluative Technological Culture which includes technological values such as reliability and efficiency is again salient only in the subject of Technology. An example to a paragraph codified in this category is:

> Sin duda alguna, el sistema operativo más utilizado en el mundo de la informática personal es Windows, y la última versión que ha aparecido de él es el denominado Windows XP. Son muchas las novedades de esta nueva versión; algunas de ellas a nivel interno, que le hacen mucho más potente y fiable; otras a nivel de interfaz gráfica, que le hacen mucho más agradable a la vista. Aún con todas estas novedades, la filosofía de

> trabajo es la misma que en versiones anteriores, por lo que los antiguos usuarios de Windows no se encontrarán con grandes dificultades a la hora de manejarlo (TECNOLOGÍA_INF_1_ANAYA / 3004)

As we have mentioned before, Intrinsic Technological Culture is quite isolated from any other subject and is present mainly in the books dealing exclusively with it. Extrinsic Technological Culture, similar to Extrinsic Scientific Culture, does not appear frequently in the books of scientific subjects. It is, however, salient in the social and humanistic subjects, a phenomenon reflecting its importance as a social issue. TEXTR, Extrinsic Representational Technological Culture, referring to the images of technology, appears in Language and Literature, Ethics and Religion and Social Science, in addition to its importance in Technology. TEXTOP, Extrinsic Operational Technological Culture refers to norms of behaviour related to technology and appears (in addition to its high presence in Technology) in Ethics and Religion as well as in Social science. The following quotations represent these two categories of our model

> LOS EFECTOS DE LA TECNOLOGÍA Desde que nacemos, estamos tan rodeados de productos tecnológicos que muchos de ellos nos parecen totalmente naturales. Sin embargo, desde sus orígenes, la tecnología se ha dedicado a controlar y transformar lo natural y a crear objetos y procesos artificiales. (TECNOLOGÍA_INF_4_ANAYA / 0020)

> PROMETEO DÉDALDO/ÍCARO FRANKENSTEIN INTERNÉTICA Si definimos la ética como una reflexión sobre la acción humana, es necesario, incluso imprescindible, elaborar una ética de internet, lo que hemos llamado una intern-ética. No nos podemos dejar llevar por los agoreros que ven en internet el mayor de los males ni por los que depositan en la red todas sus esperanzas. Ni ilusos, ni catastrofistas. Hemos de ser críticos, y pararnos a pensar las posibilidades de creatividad y libertad que internet nos ofrece así como las nuevas formas de esclavitud que arrastra. (ÉTICA_4_SM / 0372)

The next three components of Extrinsic Evaluative Technological Culture are TXTVA+, TXTVA- and TXTVA and they refer to attitudes toward Technology that may be positive negative or neutral. As can be seen in tables 1 and 2 these categories are clearly most frequent in Ethics and Religion with the exception of TXTVA+ which also appears in Technology and Miscellany. From tables 1 and 2 it is clear that .

> TXTVA+ LAS VENTAJAS DE LA TECNOLOGÍA La ciencia y la tecnología contemporáneas han proporcionado al ser humano niveles de bienestar muy superiores a los que disfrutó en cualquier otra época. Desde este punto de vista, ciencia y tecnología son realidades sin duda beneficiosas. (ÉTICA_4_ANAYA / 1426)

> TXTVA- En la unidad 14 vimos cómo cierta clase de desarrollo tecnológico e industrial estaba resultando gravemente nociva para los ecosistemas naturales, hasta el punto de amenazar el equilibrio ecológico del planeta. Nadie puede permanecer indiferente ante una amenaza que pone en peligro no solo los recursos de los que nos beneficiamos, sino nuestro propio futuro como especie. (ÉTICA_4_ANAYA / 1662)

TXTVA Los avances científico-técnicos ¿benefician a toda la humanidad? (ÉTICA_4_SANTILLANA / 0959)

The same pattern of academic bias detected in scientific culture is observed also in technological culture. Information about technologies, their rules of operation and their values are confined to textbooks of technology, whereas social representations, uses and evaluations of technology are mainly included in textbooks of social science without significant relations with intrinsic technological contents.

We can see the same tendency with regard to the last two categories of our model, INNO referring to the utilization of science and technology for obtaining wealth and economic benefits and EMP referring to business culture. The first one is significantly dealt with only in Social Science textbooks and the second in Social Science and Ethics and Religion. The following paragraphs are examples of these two categories.

Estas innovaciones tecnológicas provocaron la bajada de los precios de los tejidos de algodón y, en consecuencia, el aumento de la demanda, lo que obligó a aumentar la productividad. (HISTORIA_4_ANAYA / 1200)

-La situación obligó a muchas industrias a adaptarse, y estas introdujeron nuevos métodos de producción. En las grandes multinacionales, el "fordismo" dio paso al llamado "toyotismo" (limitación de los stocks y de la calidad de los productos, ajuste de la producción a la demanda real), basado en una creciente robotización. Se buscaba abaratar los costos de producción por todos los medios: aumentar el trabajo a tiempo parcial, contener las subidas salariales, trasvasar la producción hacia países donde la mano de obra fuera más barata, etc. Todo ello se completó con un aumento de la investigación en nuevos productos y con la introducción de la informática, la electrónica y las telecomunicaciones. [Historia. 4º Anaya]

The two categories Innovation and Businesess are significantly absent from science books. Innovation is

As a conclusion it can be said that there is a clear separation between intrinsic and extrinsic elements of both scientific and technological culture. There is also a clear separation between scientific and technological intrinsic contents. And last, content related with the culture of innovation and business is confined to social sciences and moral subjects, having a poor relation with scientific culture.

significantly present in Social Sciences and in Ethics and Religion, whereas Business is so just in Social Sciences

3.2 Scientific, technological and business innovation culture by publisher

In the framework of our research we also wanted to see the distribution of the categories of our model of scientific and technological culture in different publishers. Tables 18 and 19 give the number of

codified paragraphs in each of the categories and the vertical percentages of these figures. They thus show the tendencies of each publisher when it comes to Scientific and Technological culture. With respect to scientific culture both intrinsic and extrinsic, Edelvives comes up clearly as the most specialized publishing house. It is also the only one which has significant references to elements of business culture. SM on the other hand is the relatively least interested in scientific contents of any kind. Anaya dedicates significant attention to two of the categories of scientific culture, both intrinsic, CINTR and CINTVA. Santillana dedicates attention to one category, again intrinsic, CINTOP, and interesting enough it dedicates less attention than statistically expected to CINTR.

Table 18: Manuel codes by publisher (number of paragraphs)

n		9,826	2,189	2,233	2,567	2,837
		Publisher				
		Total	Anaya	Edelvives	Santillana	SM
Manual Codes	CINTR	3,299	847	960	616	876
	CINTOP	2,521	495	666	745	615
	CINTVA	91	30	43	15	3
	CEXTR	603	59	275	144	125
	CEXTOP	375	58	110	110	97
	CEXTVA+	63	14	30	12	7
	CEXTVA-	62	4	22	16	20
	CEXTVA	48	7	15	19	7
	TINTR	2,122	598	336	489	699
	TINTOP	527	101	132	135	159
	TINTVA	151	30	45	39	37
	TEXTR	556	88	147	173	148
	TEXTOP	932	232	103	279	318
	TEXTVA+	155	53	32	29	41
	TEXTVA-	164	45	18	46	55
	TEXTVA	101	29	16	31	25
	INNO	127	24	22	39	42
	EMP	502	117	159	77	149

Table 19: Manuel codes by publisher (vertical percentages)

%v.

		Publisher				
		Total	Anaya	Edelvives	Santillana	SM
Manual Codes	CINTR	33.6%	38.7%	43.0%	24.0%	30.9%
	CINTOP	25.7%	22.6%	29.8%	29.0%	21.7%
	CINTVA	0.9%	1.4%	1.9%	0.6%	0.1%

	CEXTR	6.1%	2.7%	12.3%	5.6%	4.4%
	CEXTOP	3.8%	2.6%	4.9%	4.3%	3.4%
	CEXTVA+	0.6%	0.6%	1.3%	0.5%	0.2%
	CEXTVA-	0.6%	0.2%	1.0%	0.6%	0.7%
	CEXTVA	0.5%	0.3%	0.7%	0.7%	0.2%
	TINTR	21.6%	27.3%	15.0%	19.0%	24.6%
	TINTOP	5.4%	4.6%	5.9%	5.3%	5.6%
	TINTVA	1.5%	1.4%	2.0%	1.5%	1.3%
	TEXTR	5.7%	4.0%	6.6%	6.7%	5.2%
	TEXTOP	9.5%	10.6%	4.6%	10.9%	11.2%
	TEXTVA+	1.6%	2.4%	1.4%	1.1%	1.4%
	TEXTVA-	1.7%	2.1%	0.8%	1.8%	1.9%
	TEXTVA	1.0%	1.3%	0.7%	1.2%	0.9%
	INNO	1.3%	1.1%	1.0%	1.5%	1.5%
	EMP	5.1%	5.3%	7.1%	3.0%	5.3%

*The statistically significant (p <= 0,5)cells are highlighted. Higher than expected in red and lower in blue.

The situation is more complex with regard to technological culture. Contrary to its position with regard to scientific culture, Edelvives is the least interested in components of technological culture, intrinsic or extrinsic. The other three publishers dedicate relatively more attention to two categories of technological culture. Anaya to TINTR and TEXTVA+, Santillana to TXTR and TEXTOP and SM to TINTR and TEXTOP. Two categories have relatively higher frequencies in two publishers: TINTR, referring to technological knowledge and TEXTOP, referring to social norms concerning technology. Technological knowledge and managing the relationship between new technologies and their implication to society are the two issues which are dealt with more than expected.

Tables 20 and 21 give clustered categories of the same data. They confirm the salient position of Edelvives with respect to science. They also show that generally speaking with regard to technology both Anaya and SM dedicate to it more attention than the expected one. Anaya is also salient as the only publisher with a clear inclination towards intrinsic components. That is, its books have more references to scientific knowledge, scientific norms and scientific values and to technological knowledge, rules of usage and values concerning its functioning than the others. On the other hand, Santillana is the most interested in extrinsic scientific and technological cultures.

Table 20: Clustered manual categories by publisher (number of paragraphs)

n		**9,826**	**2,189**	**2,233**	**2,567**	**2,837**
		Editorial				
		Total	Anaya	Edelvives	Santillana	SM
Categories of clustered manual codes	CIENCIA	5,916	1,212	1,593	1,500	1,611
	TECNOLOGIA	3,888	978	612	1,048	1,250
	EXTRÍNSECA	2,569	478	604	753	734
	INTRÍNSECA	7,495	1,720	1,731	1,858	2,186

	OPERACIONAL	4,242	868	970	1,243	1,161
	REPRESENTACIONAL	6,232	1,515	1,571	1,385	1,761
	VALORATIVA	751	198	202	174	177
	EMPRESA	502	117	159	77	149
	INNOVACIÓN	127	24	22	39	42

Table 20: Clustered manual categories by publisher (number of paragraphs)

%v.

		Editorial				
		Total	Anaya	Edelvives	Santillana	SM
Categories of clustered manual codes	CIENCIA	60.2%	55.4%	71.3%	58.4%	56.8%
	TECNOLOGIA	39.6%	44.7%	27.4%	40.8%	44.1%
	EXTRÍNSECA	26.1%	21.8%	27.0%	29.3%	25.9%
	INTRÍNSECA	76.3%	78.6%	77.5%	72.4%	77.1%
	OPERACIONAL	43.2%	39.7%	43.4%	48.4%	40.9%
	REPRESENTACIONAL	63.4%	69.2%	70.4%	54.0%	62.1%
	VALORATIVA	7.6%	9.0%	9.0%	6.8%	6.2%
	EMPRESA	5.1%	5.3%	7.1%	3.0%	5.3%
	INNOVACIÓN	1.3%	1.1%	1.0%	1.5%	1.5%

*The statistically significant cells are highlighted. Higher than expected in red and lower in blue.

Edelvives and Santillana stand out again. Edelvives is the only publisher which dedicates significantly more attention to business culture components, while Santillana dedicates significantly less attention to these components. Innovation is not treated more than the expected by any of the publishers.

There are two clear different profiles of publishers: that of Edelvives paying more attention to intrinsic scientific culture, and Santillana with focus on extrinsic components of scientific culture. It is also remarkable that **Innovation** is uniformly distributed across the four publishers.

3.3 Scientific, technological and business innovation culture by grade

Examining the categories of our model of technological and scientific culture by grade reveals several tendencies. As can be seen in tables 22 and 23, in the first grade of the ESO, CINTR, scientific knowledge, occupies a central place. Its relative importance however reduces in the fourth grade. The other intrinsic categories of scientific culture, CINTOP and CINTVA are not salient in either grade. We find a similar situation with respect to the extrinsic categories. Most of them do not appear in higher frequencies than the expected one. The only one which does, CEXTOP, is more salient in the fourth grade. We can thus say that generally speaking intrinsic scientific culture reduces and extrinsic scientific culture increases when we compare the first grade with the fourth grade.

Table 21: Manual codes by grade (number of paragraphs)

n		9,826	2,564	7,262
		Grade		
		Total	1º	4º
Manual Codes	CINTR	3,299	950	2,349
	CINTOP	2,521	679	1,842
	CINTVA	91	23	68
	CEXTR	603	153	450
	CEXTOP	375	59	316
	CEXTVA+	63	14	49
	CEXTVA-	62	8	54
	CEXTVA	48	9	39
	TINTR	2,122	556	1,566
	TINTOP	527	158	369
	TINTVA	151	26	125
	TEXTR	556	111	445
	TEXTOP	932	161	771
	TEXTVA+	155	25	130
	TEXTVA-	164	31	133
	TEXTVA	101	22	79
	INNO	127	30	97
	EMP	502	65	437

%v.

Table 22: Manual codes by grade (vertical percentages)

		Curso		
		Total	1º	4º
Manual Codes	CINTR	33.6%	37.1%	32.3%
	CINTOP	25.7%	26.5%	25.4%
	CINTVA	0.9%	0.9%	0.9%
	CEXTR	6.1%	6.0%	6.2%
	CEXTOP	3.8%	2.3%	4.4%
	CEXTVA+	0.6%	0.5%	0.7%
	CEXTVA-	0.6%	0.3%	0.7%
	CEXTVA	0.5%	0.4%	0.5%
	TINTR	21.6%	21.7%	21.6%
	TINTOP	5.4%	6.2%	5.1%
	TINTVA	1.5%	1.0%	1.7%
	TEXTR	5.7%	4.3%	6.1%
	TEXTOP	9.5%	6.3%	10.6%
	TEXTVA+	1.6%	1.0%	1.8%
	TEXTVA-	1.7%	1.2%	1.8%

	TEXTVA	1.0%	0.9%	1.1%
	INNO	1.3%	1.2%	1.3%
	EMP	5.1%	2.5%	6.0%

*The statistically significant cells are highlighted. Higher than expected in red and lower in blue.

With respect to technological culture we see that TEXTOP, referring to the social management of technologies is the only category of our model which receives significant attention, and that in the fourth grade. None of the categories of our model is especially salient in the first grade, and half of them have even lower frequencies than the expected ones (TINTVA, TEXTP, TEXTVA+, TEXTVA-).

Tables 24 and 25 which gives the data in a clustered form confirms what we have already mentioned. .

Table 23: Clustered manual categories by grade (number of paragraphs)

N		9,826	2,564	7,262
		Grade		
		Total	1º	4º
Categories of clustered manual codes	CIENCIA	5,916	1,637	4,279
	TECNOLOGIA	3,888	936	2,952
	EXTRÍNSECA	2,569	529	2,040
	INTRÍNSECA	7,495	2,133	5,362
	OPERACIONAL	4,242	1,040	3,202
	REPRESENTACIONAL	6,232	1,701	4,531
	VALORATIVA	751	152	599
	EMPRESA	502	65	437
	INNOVACIÓN	127	30	97

Table 24: Clustered manual categories by grade (vertical percentages)

%v.

		Curso		
		Total	1º	4º
Categories of clustered manual codes S	CIENCIA	60.2%	63.8%	58.9%
	TECNOLOGIA	39.6%	36.5%	40.6%
	EXTRÍNSECA	26.1%	20.6%	28.1%
	INTRÍNSECA	76.3%	83.2%	73.8%
	OPERACIONAL	43.2%	40.6%	44.1%
	REPRESENTACIONAL	63.4%	66.3%	62.4%
	VALORATIVA	7.6%	5.9%	8.2%
	EMPRESA	5.1%	2.5%	6.0%
	INNOVACIÓN	1.3%	1.2%	1.3%

*The statistically significant cells are highlighted. Higher than expected in red and lower in blue.

One can say that these results reflect a natural curricular advancement from dealing with scientific contents to observing their applications (Science and then Technology); and from basic scientific and technological knowledge, (Intrinsic) to its social implications (extrinsic).

The most salient characteristic of the results is that the presence of components of intrinsic scientific and technological culture decreases, while the presence of components of extrinsic scientific and technological culture increases. Another clear phenomenon is that the importance of scientific culture reduces and technological culture augments. Business culture components are significantly more present in the fourth grade

3.4 Interrelations between components of Scientific, technological and business innovation culture

In our analysis we also examined the association between the different categories of our model. We wanted to see which components of the model are often accompanied by other components. Table 26 presents the number of times a paragraph classified in each category of the model, was also classified in other categories. Table 27 presents the vertical percentages of these results. In some respects these tables summarize the analysis carried out up to now. The most salient observation is that the **categories of intrinsic scientific culture are hardly associated with other categories**. CINTR is not linked to any other category, CINTOP, to only one, CINTVA, and CINTVA is obviously, associated with CINTOP and also to CEXTR

.

Table 25: Manual codes by manual codes (number of paragraphs)

n

		Manual Coddes																		
		Total	CINTR	CINTOP	CINTVA	CEXTR	CEXTOP	CEXTVA+	CEXTVA-	CEXTVA	TINTR	TINTOP	TINTVA	TEXTR	TEXTOP	TEXTVA+	TEXTVA-	TEXTVA	INNO	EMP
Manual codes	Total	9,826	3,299	2,521	91	603	375	63	62	48	2,122	527	151	556	932	155	164	101	127	502
	CINTR	3,299	3,299	729	36	80	46	20	13	10	111	25	8	3	23	9	8	6	5	20
	CINTOP	2,521	729	2,521	60	43	36	10	6	4	46	16	8	9	12	6	2	1	4	18
	CINTVA	91	36	60	91	13	7	1	0	0	4	1	1	0	1	2	0	0	0	0
	CEXTR	603	80	43	13	603	57	21	22	13	10	1	2	73	12	6	4	6	2	0
	CEXTOP	375	46	36	7	57	375	10	14	7	2	2	1	5	30	2	3	2	0	4
	CEXTVA+	63	20	10	1	21	10	63	11	0	1	0	2	5	2	17	4	0	0	0
	CEXTVA-	62	13	6	0	22	14	11	62	0	0	0	0	2	0	4	14	0	0	1
	CEXTVA	48	10	4	0	13	7	0	0	48	0	0	0	1	1	1	1	10	0	0
	TINTR	2,122	111	46	4	10	2	1	0	0	2,122	120	97	81	233	33	11	10	40	47
	TINTOP	527	25	16	1	1	2	0	0	0	120	527	11	9	19	5	1	1	12	8
	TINTVA	151	8	8	1	2	1	2	0	0	97	11	151	4	23	1	0	2	4	1
	TEXTR	556	3	9	0	73	5	5	2	1	81	9	4	556	51	31	24	23	12	17
	TEXTOP	932	23	12	1	12	30	2	0	1	233	19	23	51	932	29	21	22	25	57
	TEXTVA+	155	9	6	2	6	2	17	4	1	33	5	1	31	29	155	26	0	4	6
	TEXTVA-	164	8	2	0	4	3	4	14	1	11	1	0	24	21	26	164	0	0	3
	TEXTVA	101	6	1	0	6	2	0	0	10	10	1	2	23	22	0	0	101	3	2
	INNO	127	5	4	0	2	0	0	0	0	40	12	4	12	25	4	0	3	127	7
	EMP	502	20	18	0	0	4	0	1	0	47	8	1	17	57	6	3	2	7	502

Table 26: Manual codes by manual codes (number of paragraphs)

%v.

		Códigos Manuales																	
		Total	CINTR	CINTOP	CINTVA	CEXTR	CEXTOP	CEXTVA+	CEXTVA-	CEXTVA	TINTR	TINTOP	TINTVA	TEXTR	TEXTOP	TEXTVA+	TEXTVA-	TEXTVA	INNO	EMP
Maniual codes	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	CINTR	33.6%	100.0%	28.9%	39.6%	13.3%	12.3%	31.7%	21.0%	20.8%	5.2%	4.7%	5.3%	0.5%	2.5%	5.8%	4.9%	5.9%	3.9%	4.0%
	CINTOP	25.7%	22.1%	100.0%	65.9%	7.1%	9.6%	15.9%	9.7%	8.3%	2.2%	3.0%	5.3%	1.6%	1.3%	3.9%	1.2%	1.0%	3.1%	3.6%
	CINTVA	0.9%	1.1%	2.4%	100.0%	2.2%	1.9%	1.6%	0.0%	0.0%	0.2%	0.2%	0.7%	0.0%	0.1%	1.3%	0.0%	0.0%	0.0%	0.0%
	CEXTR	6.1%	2.4%	1.7%	14.3%	100.0%	15.2%	33.3%	35.5%	27.1%	0.5%	0.2%	1.3%	13.1%	1.3%	3.9%	2.4%	5.9%	1.6%	0.0%
	CEXTOP	3.8%	1.4%	1.4%	7.7%	9.5%	100.0%	15.9%	22.6%	14.6%	0.1%	0.4%	0.7%	0.9%	3.2%	1.3%	1.8%	2.0%	0.0%	0.8%
	CEXTVA+	0.6%	0.6%	0.4%	1.1%	3.5%	2.7%	100.0%	17.7%	0.0%	0.0%	0.0%	1.3%	0.9%	0.2%	11.0%	2.4%	0.0%	0.0%	0.0%
	CEXTVA-	0.6%	0.4%	0.2%	0.0%	3.6%	3.7%	17.5%	100.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	2.6%	8.5%	0.0%	0.0%	0.2%
	CEXTVA	0.5%	0.3%	0.2%	0.0%	2.2%	1.9%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.2%	0.1%	0.6%	0.6%	9.9%	0.0%	0.0%
	TINTR	21.6%	3.4%	1.8%	4.4%	1.7%	0.5%	1.6%	0.0%	0.0%	100.0%	22.8%	64.2%	14.6%	25.0%	21.3%	6.7%	9.9%	31.5%	9.4%
	TINTOP	5.4%	0.8%	0.6%	1.1%	0.2%	0.5%	0.0%	0.0%	0.0%	5.7%	100.0%	7.3%	1.6%	2.0%	3.2%	0.6%	1.0%	9.4%	1.6%
	TINTVA	1.5%	0.2%	0.3%	1.1%	0.3%	0.3%	3.2%	0.0%	0.0%	4.6%	2.1%	100.0%	0.7%	2.5%	0.6%	0.0%	2.0%	3.1%	0.2%
	TEXTR	5.7%	0.1%	0.4%	0.0%	12.1%	1.3%	7.9%	3.2%	2.1%	3.8%	1.7%	2.6%	100.0%	5.5%	20.0%	14.6%	22.8%	9.4%	3.4%
	TEXTOP	9.5%	0.7%	0.5%	1.1%	2.0%	8.0%	3.2%	0.0%	2.1%	11.0%	3.6%	15.2%	9.2%	100.0%	18.7%	12.8%	21.8%	19.7%	11.4%
	TEXTVA+	1.6%	0.3%	0.2%	2.2%	1.0%	0.5%	27.0%	6.5%	2.1%	1.6%	0.9%	0.7%	5.6%	3.1%	100.0%	15.9%	0.0%	3.1%	1.2%
	TEXTVA-	1.7%	0.2%	0.1%	0.0%	0.7%	0.8%	6.3%	22.6%	2.1%	0.5%	0.2%	0.0%	4.3%	2.3%	16.8%	100.0%	0.0%	0.0%	0.6%
	TEXTVA	1.0%	0.2%	0.0%	0.0%	1.0%	0.5%	0.0%	0.0%	20.8%	0.5%	0.2%	1.3%	4.1%	2.4%	0.0%	0.0%	100.0%	2.4%	0.4%
	INNO	1.3%	0.2%	0.2%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	1.9%	2.3%	2.6%	2.2%	2.7%	2.6%	0.0%	3.0%	100.0%	1.4%
	EMP	5.1%	0.6%	0.7%	0.0%	0.0%	1.1%	0.0%	1.6%	0.0%	2.2%	1.5%	0.7%	3.1%	6.1%	3.9%	1.8%	2.0%	5.5%	100.0%

*The statistically significant cells are highlighted. Higher than expected in red and lower in blue.

The relative isolation of CINTR came up in earlier stages of our analysis and reinforces the interpretation that **science is taught without connecting it neither to its practical application (technology, innovation) nor to its social implications (extrinsic components**). The absence of significant association between CINTR and the other intrinsic categories of science, CINTOP and CINTVA is maybe less expected. A possible explanation is related to the fact that **textbooks still deal mainly with transmitting information and less with conveying methodologies or values**. The association between CINTVA and CINTOP is quite expected. The discussion of scientific methodology tends to be accompanied by discussion of scientific values. The relationship between CINTVA and CEXTR is also not surprising. The values embodied in scientific activity are classified by our model as intrinsic components, but values are also an important part of the exterior perception of science and of attitudes towards science, thus they can also be classified as CEXTR.

The extrinsic categories of scientific culture are mainly associated between themselves and also, although in a lower rate, with the extrinsic components of technological culture. They are not associated with any intrinsic categories, neither of scientific culture nor of technological culture.

The situation is slightly different with respect to technology. The components of intrinsic technological culture are significantly associated with innovation, INNO (TINTR and TINTOP), with TEXTOP (TINTR and TINTVA) and among themselves (TINTR with TINTVA). So there is more interrelation between the intrinsic components and the extrinsic components of technological culture. TEXTOP, referring to the social management of technology and TEXTVA+, referring to positive evaluation of technology, are the categories associated with the highest number of other groups.

The extrinsic components of technological culture, in spite of having associations with two intrinsic categories, demonstrate mainly (similar to the extrinsic components of scientific culture) associations with other extrinsic components, technological and scientific.

We can thus see again the division characterizing the scientific and technological culture in the ESO books. This is confirmed by the clustered tables (table 28 and table 29).

Table 27: Clustered manual categories by clustered manual categories (number of paragraphs)

n

		Categories of clustered manual codes S									
		Total	CIENCIA	TECNOLOGIA	EXTRÍNSECA	INTRÍNSECA	OPERACIONAL	REPRESENTACIONAL	VALORATIVA	EMPRESA	INNOVACIÓN
Categories of clustered manual codes S	Total	9,826	5,916	3,888	2,569	7,495	4,242	6,232	751	502	127
	CIENCIA	5,916	5,916	372	1,062	5,122	2,905	3,865	294	40	9
	TECNOLOGIA	3,888	372	3,888	1,708	2,620	1,507	2,663	548	111	80
	EXTRÍNSECA	2,569	1,062	1,708	2,569	632	1,351	1,444	559	80	39
	INTRÍNSECA	7,495	5,122	2,620	632	7,495	3,321	5,354	357	87	58
	OPERACIONAL	4,242	2,905	1,507	1,351	3,321	4,242	1,312	221	85	40
	REPRESENTACIONAL	6,232	3,865	2,663	1,444	5,354	1,312	6,232	355	79	51
	VALORATIVA	751	294	548	559	357	221	355	751	13	11
	EMPRESA	502	40	111	80	87	85	79	13	502	7
	INNOVACIÓN	127	9	80	39	58	40	51	11	7	127

Table 28: Clustered manual categories by clustered manual categories (vertical percentages)

%v.

		Categories of clustered manual codes S									
		Total	CIENCIA	TECNOLOGIA	EXTRÍNSECA	INTRÍNSECA	OPERACIONAL	REPRESENTACIONAL	VALORATIVA	EMPRESA	INNOVACIÓN
Categories of clustered manual codes S	Total										
	CIENCIA	60.2%	100.0%	9.6%	41.3%	68.3%	68.5%	62.0%	39.1%	8.0%	7.1%
	TECNOLOGIA	39.6%	6.3%	100.0%	66.5%	35.0%	35.5%	42.7%	73.0%	22.1%	63.0%
	EXTRÍNSECA	26.1%	18.0%	43.9%	100.0%	8.4%	31.8%	23.2%	74.4%	15.9%	30.7%
	INTRÍNSECA	76.3%	86.6%	67.4%	24.6%	100.0%	78.3%	85.9%	47.5%	17.3%	45.7%
	OPERACIONAL	43.2%	49.1%	38.8%	52.6%	44.3%	100.0%	21.1%	29.4%	16.9%	31.5%
	REPRESENTACIONAL	63.4%	65.3%	68.5%	56.2%	71.4%	30.9%	100.0%	47.3%	15.7%	40.2%
	VALORATIVA	7.6%	5.0%	14.1%	21.8%	4.8%	5.2%	5.7%	100.0%	2.6%	8.7%
	EMPRESA	5.1%	0.7%	2.9%	3.1%	1.2%	2.0%	1.3%	1.7%	100.0%	5.5%
	INNOVACIÓN	1.3%	0.2%	2.1%	1.5%	0.8%	0.9%	0.8%	1.5%	1.4%	100.0%

*The statistically significant (p <= 0,5) cells are highlighted. Higher than expected in red and lower in blue.

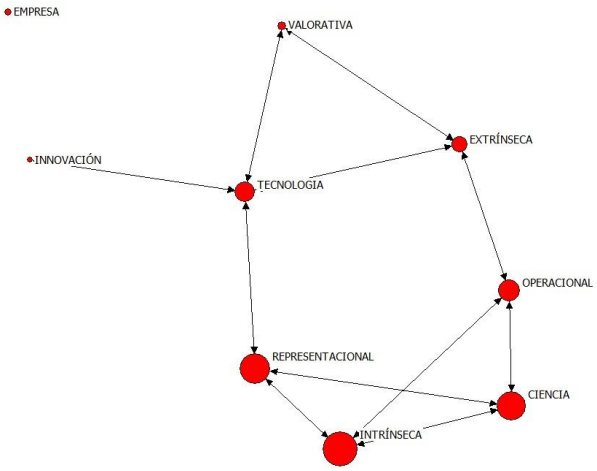

Figure 13: Clustered cagtegories of scientific culture

Science is mainly associated with intrinsic components; technology is mainly associated with extrinsic components. Business culture components are not associated with any other category, while innovation is associated with technology.

4 Images of science and technology: promises and threats

The last part of this report is dedicated to the notions of promise and threat that characterize the ESO books. The subset of paragraphs belonging to **InEmCyT** category have been also classified according to the presence or absence of two groups of terms. One group included terms expressing a positive attitude to science and technology, such as well being, opportunities and advantages. The other included terms expressing a negative attitude to science and technology, such as danger, risk and deterioration. We obtained thus four categories according to the presence or absence of those terms: threats and promises, threats without promises, promises without threats and neither threats nor promises. The following paragraphs represent these categories.

> En contrapartida, el mal uso de la tecnología ha creado problemas que antes no existían. El poder que tiene la tecnología de transformar el mundo es una de sus principales virtudes y uno de sus mayores peligros. (TECNOLOGÍA 1º ANAYA)

> Según este informe, ni el paro, ni la contaminación, ni el armamentismo se podían resolver «técnicamente», porque eran el resultado de una mentalidad tecnológica, y la tecnología no gobierna la naturaleza, sino que la tiraniza y la destruye. (ÉTICA 4º EDELVIVES)

> Los avances científicos son sumamente beneficiosos para la humanidad. En primer lugar, porque permiten combatir numerosas enfermedades. Y, en segundo lugar, porque hacen más cómoda nuestra existencia. (LENGUA 4º SANTILLANA)

Table 30 presents the number of paragraphs codified according to these categories by subject. Table 31 shows the vertical percentages of these appearances.

Table30: Promises and threats by subject (number of paragraphs)

Recuento

		Subject								
		Ciencias Naturales	Ciencias Sociales	Ética y Religión	Matemáticas	Física y Química	Lengua, L. y Cultura C.	Tecnología	Miscelánea	Total
Promises and threats codes	Amenazas y promesas	16	31	59	3	9	20	25	3	166
	Amenazas sin promesas	185	230	163	28	49	127	127	37	946
	Promesas sin amenazas	96	298	340	42	25	140	290	73	1304
	Sin amenazas ni promesas	2218	3290	2334	1680	794	2381	2644	884	16225
Total		2515	3849	2896	1753	877	2668	3086	997	18641

Table 31: Promises and threats by subject (vertical percentages)

% dentro de Materia

		Subject								
		Ciencias Naturales	Ciencias Sociales	Ética y Religión	Matemáticas	Física y Química	Lengua, L. y Cultura C.	Tecnología	Miscelánea	Total
Promises and threats codes	Amenazas y promesas	0.6%	0.8%	2.0%	0.2%	1.0%	0.7%	0.8%	0.3%	0.9%
	Amenazas sin promesas	7.4%	6.0%	5.6%	1.6%	5.6%	4.8%	4.1%	3.7%	5.1%
	Promesas sin amenazas	3.8%	7.7%	11.7%	2.4%	2.9%	5.2%	9.4%	7.3%	7.0%
	Sin amenazas ni promesas	88.2%	85.5%	80.6%	95.8%	90.5%	89.2%	85.7%	88.7%	87.0%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

*The statistically significant (p <=0,5) cells are highlighted. Higher than expected in red and lower in blue.

It can be easily inferred from these tables that the first category, of paragraphs containing both threats and promises, was significantly present only in Ethics and Religion. This result is not surprising as these subjects are designed, up to a certain degree, to deal with and evaluate social phenomena. A more interesting result is that the category of paragraphs with promises but without threats is also higher than expected in Ethics and Religion. The opposite category containing threats but no promises does not however differ from the expected figure. We can thus observe a **relatively positive posture towards science and technology in this block of subjects**.

It is also interesting that in Natural Science the only category which has a relatively high frequency is the one containing threats without promises. Actually, Natural Science is the only subject which is exclusively characterized by this category. This means that we find in Natural Science a relatively pessimistic vision of science and technology. This phenomenon might be related to the old antagonism between natural and human and to the not so old **concern about ecological and environmental problems**.

Another piece of information which comes up from the tables is that in the case of Social Science we see higher frequencies of two contradictory categories: threats without promises and promises without threats. We can assume then that when science and technology are discussed in the framework of this block of subjects it is done either in a positive way or in a negative way, a phenomenon of **polarization** which has been found also in surveys on public understanding of science (Montañés 2010, Durant et al. 2000). It is not surprising that in technology we find more paragraphs than expected codified as promises without threats as it is part of the justification of this subject.

The most purely scientific subjects, Mathematics and Physics and Chemistry score especially high in the number of paragraphs codified as having neither promises nor threats. We already saw that these subjects are disconnected from any extrinsic components of scientific and technological culture. More surprising is to see the same result in Language and Literature. In this case a possible explanation might be the tendency to include old canonical texts that do not refer extensively to science and especially not to technology.

Tables 32 and 33 present the five categories related to threats and promises by publishers. One can observe clearly that only the frequencies of Edelvives and SM differ significantly from the expected figures. However they do so in opposite directions. Edelvives is especially low in paragraphs containing both threats and promises and in paragraphs containing promises without threats, and especially high in paragraphs containing threats without promises. That is the general image of science and technology that emanates from this publisher is a negative one. SM on the other hand is especially high in threats and promises and in promises without threats and especially low in threats without promises. So the image of science and technology in the books of this publisher is slightly more positive.

Table32: Promises and threats by publisher (number of paragraphs)

Recuento

		Publisher				
		Anaya	Edelvives	Santillana	SM	Total
Promises and threats codes	Amenazas y promesas	23	14	24	41	102
	Amenazas sin promesas	116	142	129	128	515
	Promesas sin amenazas	162	158	233	260	813
	Sin amenazas ni promesas	1888	1919	2152	2408	8367
Total		2189	2233	2538	2837	9797

Table 29: Promises and threats by publisher (vertical percentages)

% dentro de Editorial

		Editorial				
		Anaya	Edelvives	Santillana	SM	Total
Promises and threats codes	Amenazas y promesas	1.1%	0.6%	0.9%	1.4%	1.0%
	Amenazas sin promesas	5.3%	6.4%	5.1%	4.5%	5.3%
	Promesas sin amenazas	7.4%	7.1%	9.2%	9.2%	8.3%
	Sin amenazas ni promesas	86.2%	85.9%	84.8%	84.9%	85.4%
Total		100.0%	100.0%	100.0%	100.0%	100.0%

*The statistically significant cells are highlighted. Higher than expected in red and lower in blue.

This information acquires further meaning if we bear in mind our previous analysis of the presence of the categories of our model in the different publishers. We saw that Edelvives was the most specialized publisher when it came to science and the least when it came to technology. SM was the least interested in scientific contents, but relatively specialized in technological contents.

> The publisher which is most interested in science but least in technology conveys a relatively negative image of science and technology. The publisher least interested in scientific contents but with a marked interest in technology conveys a relatively positive image of science.

Looking at the codifying of the promises and threats categories according to grades we can see that paragraphs codified as having both promises and threats were more frequent in the fourth grade as well as paragraphs codified as having promises without threats. Paragraphs containing threats with no promises however were more present in the first grade. So we can see a movement towards a more complex, and the same time, more positive vision of science and technology.

Table 30: Promises and threats by grade (number of paragraphs

Recuento

		Grade		
		1º	4º	Total
Promises and threats codes	Amenazas y promesas	16	86	102
	Amenazas sin promesas	172	343	515
	Promesas sin amenazas	155	658	813
	Sin amenazas ni promesas	2211	6156	8367
Total		2554	7243	9797

Table 31: Promises and threats by grade (vertical percentages)

% dentro de Curso

		Grade		
		1º	4º	Total
Promises and threats codes	Amenazas y promesas	0.6%	1.2%	1.0%
	Amenazas sin promesas	6.7%	4.7%	5.3%

	Promesas sin amenazas	6.1%	9.1%	8.3%
	Sin amenazas ni promesas	86.6%	85.0%	85.4%
Total		100.0%	100.0%	100.0%

*The statistically significant (p <= 0,5) cells are highlighted. Higher than expected in red and lower in blue.

5 Conclusions

The main object of this study was to analyze scientific and technological culture transmitted by ESO textbooks in Spain, including both their quantitative and qualitative aspects. We wanted to examine the relations between science, technology and the culture of business innovation. We based our qualitative analysis on a model of scientific and technological culture which distinguishes between intrinsic and extrinsic elements. The hypothesis that guides the model is that scientific and technological culture of a social group does not depend only on the quantity of scientific and technological knowledge (intrinsic) but also on the social representations, rules of behaviour and attitudes toward science and technology (extrinsic). We believe that this distinction is important for the understanding of the influence of cultural factors on processes of business innovation. Elements of intrinsic scientific and technological culture are related to the capacity of societies to confront processes of business innovation, while elements of extrinsic scientific and technological culture are related to the propensity to innovate that characterize societies. In addition we believe that a high level of integration of the different cultural elements (scientific, technological, social, etc) could also be a crucial factor that influences innovation.

Our main conclusions are:

1. Based on the weight of the different subjects in the textbooks that we examined it could be said that in secondary compulsory education there is a **clear balance between scientific and technological contents, on the one hand, and humanistic and social contents, on the other hand. Mathematics** is the most important individual matter.
2. The analysis of the semantic networks between different scientific contents discloses a dense net of relations between them that crosses the traditional limits of academic disciplines. This means that all the disciplines are connected with **generic contents that can be relevant to business innovation culture.** There is only one apparent exception: **Mathematics has no significant relations to the rest of the subjects.**
3. Another significant characteristic that the automatic content analysis disclosed is the **clear predominance of Information Technologies, from the perspective of the user,** in the area of Technological Education.
4. However there are enough elements in the ESO books that allow connecting scientific and technological contents with relevant concepts of **business innovation culture**, such as the generic concepts of **Knowledge, Competitiveness, Industry, Production, Economy** etc.

5. The Manual analysis of the paragraphs codified as **Business Innovation, Science and Technology** strengths the conclusion that **the ESO books are characterized by an academic biased vision of scientific culture.** On the one hand there **is very little relation between scientific and technological content**s; on the other hand **there is very little relation between intrinsic and extrinsic elements of scientific culture**. Scientific contents are not significantly related to their practical applications through technology. And technology is perceived more as an instrument that you have to learn to use than as a set of practical solutions based on scientific knowledge. In addition there seems to be a division in regard to the transmission of scientific culture: science books provide scientific knowledge, while humanistic and social science books transmit representations of science and attitudes towards it.
6. In spite of all this, **the perception of science transmitted to the students is neither pessimist nor negative; it is actually optimist or polarized** (both pessimistic and optimistic visions of science)**.**

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Tables

Figures

Annex