

ANALYSING THE PRESENCE OF ATMOSPHERIC SCIENCES IN SPANISH PRIMARY AND SECONDARY EDUCATION TEXT BOOKS

Adelaida Portela-Lozano*, Rosa M Rodríguez-Jiménez, Águeda Benito-Capa.
Universidad Europea de Madrid

1. INTRODUCTION

Spanish Law of Education (LOCE, 10/2002, del 23 de diciembre) sets the legal framework for the development of Compulsory Education, remarking the need of improving the knowledge of students in general sciences as an essential element to nowadays society. The recent definition of the European Higher Education has also introduced new demands for Compulsory Education, in the sense of guiding students to acquire such skills as team work, problem solving capacities, the use of technology or the ability to communicate effectively. Spanish Law of Education also establishes a set of learning outcomes such as the observation, appreciation and knowledge of the natural environment or the understanding of scientific methods, on which teachers must work.

For the achievement of these goals, some authors (Benito et al., 2003; Borrut et al., 1992) have suggested the convenience of fostering the introduction of Atmospheric Science contents in the syllabus of the various education levels. Some of the reasons are:

- Meteorology is close enough to the students' reality.
- The natural phenomena described in Meteorology are found motivating by the students.
- The topic is wide enough to develop a consistent amount of physical concepts through it.
- Experimental skills can be easily promoted.
- Environmental values can be developed.
- A scientific attitude to life can also be reinforced.

In the particular case of Spain, as shown by Benito et al (2003), formal education include enough contents which are implicitly and explicitly related to atmospheric sciences.

If well developed, they should be enough to educate society in this respect. Contents appear at all levels of formal education, but their presence increases as levels get higher. At Bachillerato, the last educational level, there is even an optional course on Environmental Sciences. However, the way atmospheric science contents are included presents some deficiencies: some contents are redundant, others are missing; the order in which they are introduced does not go along with the level of complexity involved, etc. All these facts make it difficult at times for teachers themselves to address atmospheric sciences in their classes, at least without the help of a textbook.

Textbooks are a generalised tool for Spanish teachers. It is their main resource, which means that any improvement of a text book will easily generate improvements of education. Unfortunately, authors like Yagüe et al (2003) point out the existence of numerous conceptual errors and other type of mistakes that do not help our students much.

In this sense, the present paper checks the atmospheric science contents of the most recent Science books of the main ten Spanish publishing companies. The analysis approaches not only the contents presented in the books, but also the activities and methodology employed.

2. METHODOLOGY

First of all, the ten main Spanish school publishing companies were selected: Akal, Anaya, Bruño, Edebé, Edelvives, Editex, Everest, McGraw Hill, Santillana and SM. Various books corresponding to different subjects were chosen from each Publisher, all that could easily include atmospheric science contents. Table 1 shows the books that were analysed from each Publisher.

* *Corresponding Author's address:* Adelaida Portela-Lozano, Universidad Europea de Madrid. Villaviciosa de Odón. Spain. E-mail: adelaida.portela@uem.es

CICLE	YEAR	SUBJECT
PRIMARY	1	General Science
	2	
	3	
	4	
	5	
	6	
SECONDARY	1	Natural Sciences Social Sciences
	2	Natural Sciences
	3	Physics & Chemistry Geography Social Sciences
	4	Physics and Chemistry

Table 1. Subjects analysed.

Once selected, the following aspects were checked for each book:

a) The extent of the atmospheric contents, in terms of the weight the latter had within the complete book.

b) The presence of charts and graphics:

- Explaining diagrams
- Pictures and photographs
- Tables

The absolute number of such illustrating charts was estimated for each complete book.

c) The number of activities included, classified into problems, experiments, widening activities, and revising activities.

d) Once the activities had been identified, further analysis allowed the determination of the percentage of activities aiming to develop:

- Initiative and creativity
- Team work
- Reading understanding
- Scientific reasoning
- Information search
- Communication skills
- Problem solving
- Computer use

Finally, the following aspects were qualitatively assessed:

- e) The adequacy of content sequencing.
- f) Scientific accuracy

3. RESULTS

The analysed textbooks of Primary and Secondary Education levels show a relevant presence of atmospheric science related

contents, particularly abundant during the first three years (figure 1 a). In Secondary Education atmospheric science contents increase again in the Natural Science books of the first two years (figure 1 b).

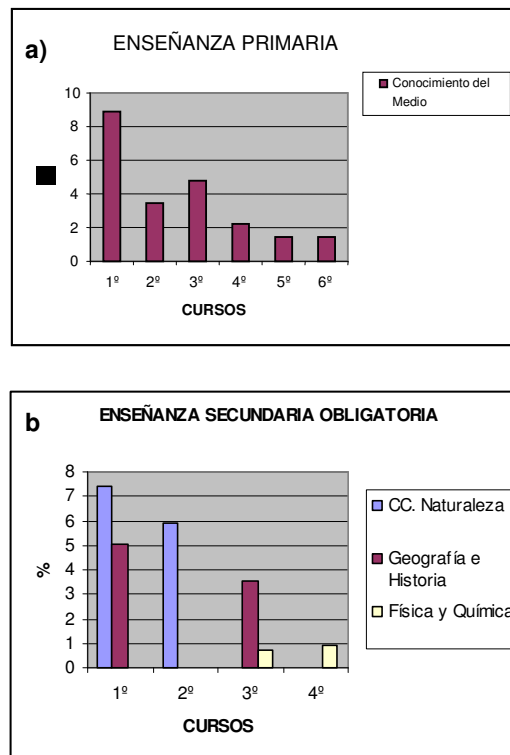


Figure 1. Average extent of contents and activities of Atmospheric Sciences in a) Primary Education and b) Compulsory Secondary education in the different subjects.

Subjects like Social Sciences and Geography present very few Atmospheric Science contents. Even less presence is found in Physics and Chemistry.

Once the contents were identified, the presence of clarifying charts and graphics was examined. In general terms such learning resources are hardly introduced in most years, except for the third year of Primary Education, where abundant pictures and photographs were found. (figure 2).

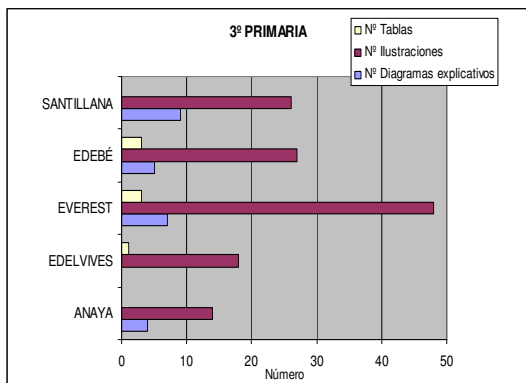


Figure 2. Presence of charts and graphics in absolute figures for General Science in the third year of Primary Education.

The Secondary education textbooks show an increasing amount of charts and explanatory graphs, particularly in the first two years. Tables are more abundant than in Primary Education. (figure 3).

However the textbooks of the third and fourth year of Secondary Education (Physics and Chemistry) hardly make any use of tables and only exceptionally incorporate explanatory charts or diagrams.

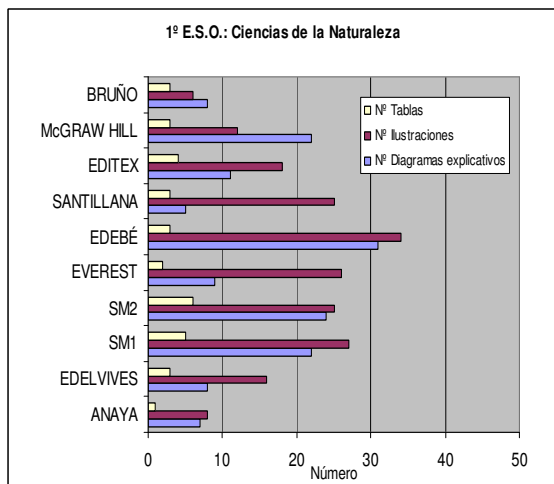


Figure 3. Presence of charts and graphics in absolute figures for Natural Sciences in the first year of Secondary Education.

As mentioned before, the number and type of activities in the Atmospheric Science contents were also analysed. The number of activities in primary education varies significantly from one publisher to another. It is a general tendency to propose revising activities, followed by experiments, sometimes widening activities and

hardly ever problems. Figure 4 shows the details for the third year of Primary Education.

It is surprising how little variety of activities is found in Secondary Education. More advantage could be easily taken of Physics and Chemistry syllabus, where, apart from conceptual learning, team work, creativity, etc could be developed.

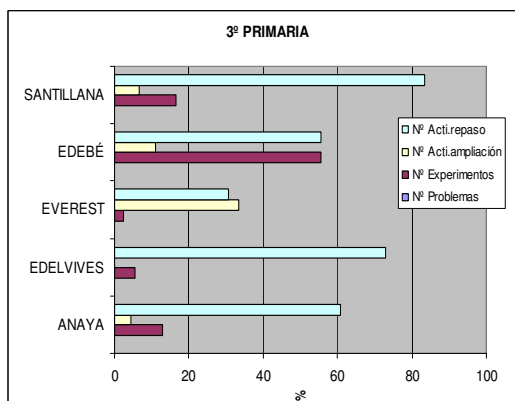


Figure 4. Types of activities found in the third year of General Science in Primary Education..

According to Spanish Education general goals, parallel to conceptual learning, other capacities must be developed in students: initiative, creativity, teamwork, reading comprehension, scientific reasoning, information search, communication skills and the use of computers. It is particularly interesting to mention the potential of modern technologies in the process of acquiring the rest of the above mentioned competences.

In addition to detecting activities aiming at the development of such skills, the promotion of environmental awareness and respect was spotted in the activities proposed in the textbooks.

The analysis carried out shows that publishers tend to incorporate activities that promote two very traditional sort of skills: written communication and scientific reasoning, mainly through revising questions and sometimes open problems.

Figure 5 shows the results for the second year of Secondary Education (Natural Sciences), where the widest variety of objectives is found in activities. Santillana Publishers seems to be the textbook that presents the widest variety of learning objectives in the Atmospheric Science activities, including the use of computers.

Santillana books seem to be the most complete in general. In the first year of Primary Education scientific reasoning is promoted (29% of the activities) followed by writing skills, environmental awareness and reading comprehension. In the second year of Primary Education general communication skills are well introduced (50%), followed by scientific reasoning (27%). For the first time initiative, creativity and information search are introduced.

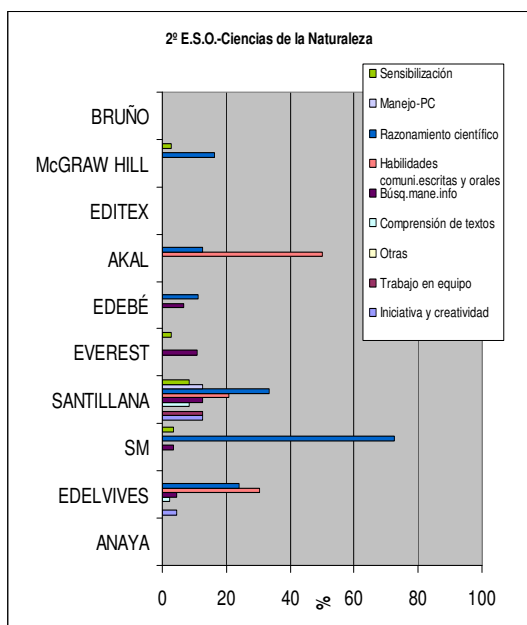


Figure 5. Skill development in the Natural Science books of the second year of Secondary education.

The last part of the present study looks into the sequencing and scientific accuracy of Atmospheric Science contents.

All the textbooks adjust themselves to the contents included in the national syllabus, going beyond the latter in most cases.

In General Science of Primary Education, concepts like water, air, the Earth, the Sun, night and day, seasons and temperature are introduced in the first year. In the second year the water cycle, cloud formation and precipitation are widely dealt with. In the third year, apart from the previously seen concepts, the weather is introduced: temperature, clouds, rain and wind. In their fourth year, primary students learn about climate, air pollution and even the ozone layer. Fifth year develops the concept of climate and climate classifications. Pressure appears for the first time.

As concerns Secondary Education, the first year goes deeper into previously introduced concepts like the rotation of the Earth, the four seasons, the water cycle, the main meteorological variables, air pollution, etc. It is new for students learning about the composition of the atmosphere and the green house effect, cloud classification, acid rain and meteorological charts. Even dew temperature was mentioned in one of the textbooks! Certainly a complex concept that will be hardly understood by low secondary students.

In the second year of Secondary Education, solar energy is widely introduced, as well as radiation balance, heat transfer, albedo and climate change. The rotation of the Earth, the structure of the atmosphere, green house effect, air pollution, acid rain, etc are developed once more. Some textbooks include very updated references like the Kyoto protocol.

Physics and Chemistry books of the third year of Secondary Education centre atmospheric sciences in the concepts of green house effect, air pollution, acid rain and ozone depletion. Only exceptionally electricity is related to thunderstorms and lightings. Geography books relate quite extensively to climate and climate classifications.

In the fourth year, Physics and Chemistry books develop the concept of atmospheric pressure, weather forecasts and isobar charts interpretation.

In general terms, it could be concluded that the sequencing of contents in most textbooks is found adequate: complexity grows with time. However, unnecessary repetition has been detected at times, and certain important concepts could be missing.

In the last part of this study conceptual misunderstandings and errors were detected and analysed. This is a very important issue, as effective learning could be becoming more difficult for this reason. The following were the most common or relevant mistakes we found:

- Temperature is mixed up with heat in some of the Primary books.
- Classification criteria are mixed for the determination of the atmospheric layers.
- Air masses are defined in a very simplistic way
- Green house effect is described as a negative effect of tragic consequences to the planet.

- Reflected radiation and Heat emissions are mixed up when explaining green house effect.
- Climate charts are introduced with no explanation or justification.
- The definitions of high and low pressure centres are often wrong: *High pressure is always above 760 mmHg and low pressure is below 760 mmHg; Low pressure brings warm and cold air masses whose contact produces fronts.*
- Radiation balance is very confusing and wrongly explained.
- As concerns the ozone layer: *between the ozone molecules there are holes through which UV radiation can pass.*
- Ozone depletion: *.....The ozone layer then becomes something like a colander.*
- Water and water vapour are incorrectly employed.
- El Niño effect: *...when trade winds stop blowing El Niño is provoked...*
- Meteorological satellites are described as forecasting tools.
- Isobar maps: An image is worth a thousand words... (figure 6).

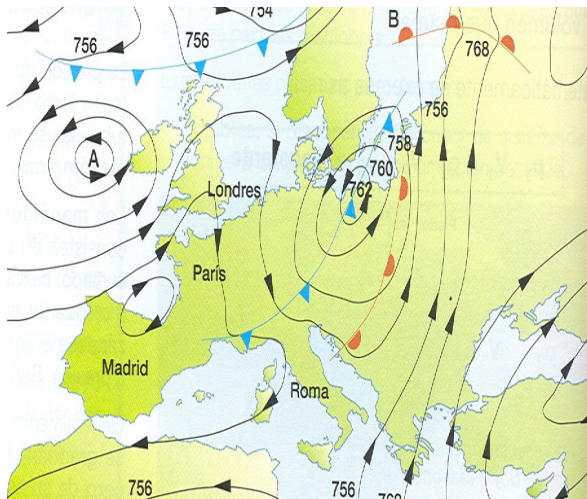


Figure 6. *Wrong isobar chart*

4. CONCLUSIONS & PROPOSALS

The present study concludes that all atmospheric contents which the Spanish Law of Education determines to be addressed are introduced by the different textbooks examined. Even though there are certain redundancies and minor gaps, the most important issue to be

considered is that of the conceptual mistakes present in school books. To avoid this problem, the collaboration of atmospheric science experts seems to be necessary when text books are written.

Additionally, it would be interesting to take more advantage of Meteorology to introduce other related concepts. Meteorology is close and relevant to students, and has been often proved motivating for students. Why not use it to address tougher contents?

It is surprising that Meteorological contents in Spanish textbooks are not at all based in the use of modern technologies, also very motivating for students.

Easy as it seems, hardly any environmental awareness and respectful attitude is promoted through the atmospheric science activities incorporated in textbooks.

And finally, more reasoning, teamwork and creativity could also be easily promoted. It would really be very interesting if textbooks took advantage of Meteorology to do so.

5. REFERENCES

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6. ANEX (Analysed books)

YEAR 1, PRIMARY

Materia: Conocimiento del Medio

Proyecto Ágora (2003), Ed. Everest, pp. 175
Poquito a poco (2003), Ed. Anaya, pp. 173
Conocimiento del Medio (2004), Ed. Santillana, pp. 143
Conocimiento del Medio (2004), Ed. Bruño, pp. 156

YEAR 2, PRIMARY

Materia: Conocimiento del Medio

Proyecto Ágora (2000), Ed. Everest, pp. 191.
Poquito a poco (2002), Ed. Anaya, pp. 187
Conocimiento del Medio (2004), Ed. Santillana, pp. 168
Conocimiento del Medio (2004), Ed. Bruño, pp. 155

YEAR 3, PRIMARY

Materia: Conocimiento del Medio

Conocimiento del Medio (2001), Ed. Edelvives, pp. 167.
Proyecto Ágora (2001), Ed. Everest, pp. 200
Conocimiento del medio (2000), Ed. Edebé, pp. 191
Conocimiento del Medio–CAM (2001), Ed. Santillana, pp. 191

YEAR 4, PRIMARY

Materia: Conocimiento del Medio

Conocimiento del Medio (2002), Ed. EDEBÉ, pp. 199
Conocimiento del Medio (2001), Ed. Edelvives, pp. 167
Proyecto Ágora (2001), Ed. Everest, pp. 187.
Conocimiento del medio (2001), Ed. Anaya, pp. 199
Nuevo Proyecto Tierra (2002), Ed. SM, pp. 187
Conocimiento del Medio (2001), Ed. Santillana, pp. 191

YEAR 5, PRIMARY

Materia: Conocimiento del Medio

Proyecto Ágora (2002), Ed. Everest, pp. 173
C. La Mancha (2002), Ed. Anaya, pp. 199
Conocimiento del medio. Comunidad de Madrid (2002), Ed. Santillana, pp. 197

YEAR 6, PRIMARY

Materia: Conocimiento del Medio

Conocimiento del Medio (2002), Ed. EDEBÉ, pp. 200
La Tierra de colores (2002), Ed. Anaya, pp. 207
Proyecto mundo para todos (1999), Ed. SM, pp. 31
Proyecto mundo para todos (1999), Ed. SM, pp. 239
Conocimiento del medio (2002), Ed. Edebé, pp. 200
Conocimiento del Medio (2002), Ed. Edelvives, pp. 167
Conocimiento del Medio (2002), Ed. Santillana, pp. 207

YEAR 1, SECONDARY

Materia: Geografía e Historia

Geografía e Historia (2002), Ed. Anaya, pp. 263
Geografía e Historia (2002), Ed. Editex, pp. 208
Geografía e Historia (2004), Ed. Santillana, pp. 263

Materia: Ciencias de la naturaleza

Ciencias de la naturaleza (2004), Ed. Santillana, pp. 279
Ciencias de la naturaleza (2002), Ed. Edelvives, pp. 215
Explora (2002), Ed. SM, pp. 223
Proyecto Ecosfera (2002), Ed. SM, pp. 223
Ciencias de la naturaleza (2002), Ed. Everest, pp. 208
Ciencias de la naturaleza (2003), Ed. Edebé, pp. 248
Cuaderno de Trabajo (2002), Ed. Bruño, pp. 128
Ciencias de la Naturaleza (2002), Ed. Editex, pp. 256
Ciencias de la Naturaleza (2002), Ed. McGraw Hill, pp. 214
Ciencias de la Naturaleza (2002), Ed. Bruño, pp. 255
Ciencias de la Naturaleza (2002), Ed. Anaya, pp. 199

YEAR 2, SECONDARY

Materia: Ciencias Sociales, Geografía e Historia

Geografía e Historia (2003), Ed. Edebé, pp. 240
Milenio (2002), Ed. SM, pp. 271
Geografía e Historia (2003), Ed. Anaya, pp. 260

Materia: Ciencias de la Naturaleza

Ciencias de la Naturaleza (2003), Ed. Everest, pp. 216
Ciencias de la naturaleza (2003), Ed. Edelvives, pp. 215
Proyecto Ecosfera (2003), Ed. SM, pp. 223
Ciencias del naturaleza (2003), Ed. Everest, pp. 216

Ciencias de la naturaleza (2003), Ed. Edebé, pp. 256
Cuaderno de Trabajo (2003), Ed. Bruño, pp. 128
Ciencias de la Naturaleza (2003), Ed. McGraw Hill, pp. 229
Ciencias de la Naturaleza (2003), Ed. Santillana, pp. 207
Supernova (2003), Ed. Santillana, pp. 261
Ciencias de la Naturaleza (2003), Ed. Editex, pp. 247
Proyecto Vulcano (2003), Ed. Akal, pp. 351
Ciencias de la Naturaleza (2003), Ed. Bruño, pp. 279
Ciencias de la Naturaleza (2003), Ed. Anaya, pp. 191

YEAR 3, SECONDARY

Materia: Geografía

Geografía (2002), Ed. Akal, pp. 242
Geografía (2004), Ed. Santillana, pp. 286
Geografía. Ciencias Sociales (2002), Ed. Anaya, pp. 287
Geografía (2002), Ed. Editex, pp. 255

Materia: Física y Química

Física y Química (2003), Ed. EDEBÉ, pp. 208
Física y Química (2002), Ed. Everest, pp. 159
Física y Química (2004), Ed. Santillana, pp. 231
Física y Química (2002), Ed. Edelvives, pp. 239
Física y Química (2002), Ed. Bruño, pp. 223
Física y Química (2003), Ed. Mc Graw Hill, pp. 208
Física y Química (2003), Ed. Editex, pp. 283

Materia: Biología y Geología

Biología y Geología - Biosfera (2002), Ed. Vicens-Vives, pp. 169

YEAR 4, SECONDARY

Materia: Física y Química

Física y Química (2003), Ed. EDITEX, pp. 336
Física y Química (2003), Ed. Santillana, pp. 174
Ciencias de la naturaleza: Física y Química (2003), Ed. Edelvives, pp. 239
Física y Química (2003), Ed. Everest, pp. 199
Física y Química (2003), Ed. Edebé, pp. 224
Física y Química (2003), Ed. Anaya, pp. 223
Física y Química (2003), Ed. Bruño, pp. 223
Cuaderno de Trabajo (2003), Ed. Bruño, pp. 225
Cuaderno de Trabajo (2003), Ed. Anaya, pp. 223