Science curricula design
Analysis of authors’ ideological and pedagogical principles

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Introduction

A curricular reorganisation at the level of compulsory school (6-15 years old) was implemented in Portugal in the academic year of 2001/2002. The reform was placed in the context of the flexible management of the curriculum and introduced new organizational guidelines and a new curriculum design. This reform sought to put into practice some of the principles that were institutionalised in the Basic Law of the Portuguese Educational System of 1986 and in the Constitution of 1976 (both containing principles of the new political system established by the 1974 Revolution). The new organization kept a collection curriculum but now considered in the perspective of a more school centred educational system and “[…] invited schools and teachers to make choices appropriate to their students and school contexts” (Galvão et al. 2004, 342). Within this curriculum reorganization, two guiding documents were constructed: Essential Competences (DEB 2001) and Curriculum Guidelines (DEB 2002). The former contained the general competences to be developed across the various disciplines and the latter contained the competences specific to each discipline.

This reform, as it stands, raises many questions for research, namely the influence of the ideological and pedagogical principles privileged by the authors who constructed the present curriculum.

The curriculum development is a process of construction that involves people and procedures about some questions (Pacheco 2001): Who takes decisions about curriculum issues? What are the choices made and the decisions taken? How are these decisions implemented? Any curricular change reflects sociological options regarding the ideological and pedagogical principles that are legitimised and for that reason it is important to understand the rationale and direction of that change. As
referred by Paraskeva (2000), “[…] considered as a field of knowledge construction, the curriculum expresses the intentions of a given curricular policy that is constructed on the basis of conflicts and compromises, goings forward and back, the natural expression of a document that should be viewed as a text and as a discourse constructed for and from a practice - regulated - of power” (38).

The curriculum as a cultural, social and political project is constructed on the basis of ideologies, or systems of ideas, values, attitudes and beliefs shared by a group of people who have a significant weight in its construction. The curriculum is not neutral and for that reason the curricular decisions should be discussed as ideological issues and not only as purely educational questions. According to Eisner (1992), “[educational] ideologies are belief systems that provide the value premises from which decisions about practical educational matters are made” (302). Knain (2001) gives three characteristics that are part of the definition of ideology: ideologies are grounded on world views, they have a cognitive element that can influence the beliefs held by a person; ideologies are culturally influenced, they are shared by people in a social group, they can both be produced and reproduced and, in this way, they can regulate a discourse; ideologies are carried by language, they influence what is said and the manner in which it is said and they are also present when the receivers interpret and make meaning of an utterance.

The research that was developed has epistemological and sociological assumptions and is particularly based on Bernstein’s (1999, 2000) theory of pedagogic discourse. The conceptual and transference power of the internal language of description that characterizes Bernstein’s theory allows the application of the concepts derived from the theory to various levels of educational analysis and various analytical contexts. Analysis can acquire a greater conceptual and methodological rigour.

According to Bernstein’s model\(^2\), the general regulative discourse (GRD) is produced in the field of State, as a result of the influences of the fields of economy, symbolic control and international. The GRD represents the dominant principles of society at a given time and translate a set of norms/values that regulate the social order and identity. It is the result of conflicting ideologies, interests and dilemmas. These principles are institutionalised in texts, namely the constitution and the basic laws. In
the case of education, the official recontextualising field (represented by the Ministry of Education and its agencies) is a field where the GRD is recontextualised to produce the official pedagogic discourse, which is institutionalised in texts, namely syllabuses and curricula. Such a recontextualising process is influenced by the field of economy, the intellectual field of education (part of the field of symbolic control) and the international field and is mostly directed by the ideologies of curriculum authors, who are themselves part of the official recontextualising field. In the case of the present study, none of the authors were permanent agents of the Ministry of Education, rather they were asked by the Ministry of Education on a temporary basis to make the curriculum. They were given total autonomy, but clearly constraints by the GRD always exist. Authors of curricula and syllabuses are those who make the selection of the what (knowledge and competences) to be learned and the how to be learned in an arena of conflicting ideologies, i.e., norms, values and beliefs. That selection is made on the basis of the scientific knowledge produced in the field of symbolic control and of the educational knowledge produced in the intellectual field of education. The model shows therefore that the pedagogic discourse is not the mechanic result of the dominant principles of society as recontextualisings can occur at the various levels of the official pedagogic device. These recontextualisings create spaces of change and for that reason the discourse that is reproduced does not correspond with rigour to the discourse that is produced. Reproduction decreases as recontextualization increases.

Also according to Bernstein (1999), scientific knowledge has a hierarchical structure, where development is achieved by the selection and integration of distinct concepts towards a common body of knowledge with a greater level of abstraction and power of explanation. Other kinds of knowledge have a horizontal structure that is characterized by parallel languages and where development is achieved by the construction of a new language strongly classified from other former languages. This is the case, for example, of sociology and of education. Thus, the what to be learned, in the case of the sciences, corresponds to a hierarchical structure of knowledge with the exception of the metasciences that correspond to horizontal structures of knowledge. The how corresponds also to horizontal structures of knowledge. This means that distinct groups of educators can privilege distinct educational theories at the same given time. Within the educational theory privileged by an author, s(he) shows to possess recognition rules when s(he) is able to recognize learning contexts that are in
accordance with that theory and shows to possess realization rules when s(he) is able to produce pedagogical texts appropriate to those contexts.

This study is part of a broader study (Ferreira 2007) that analyses the sociological message transmitted by the Official Pedagogic Discourse (OPD) of the new curriculum. In that study, the what of the OPD referred to the knowledge of the process of science construction and to the scientific knowledge and competences. The how of the OPD considered the following characteristics of scientific learning: the relation between discourses of the same discipline (intradisciplinarity) and the explication of the OPD in the Ministry of Education/Teachers relation (evaluation criteria)\(^4\). The level of conceptual demand of the OPD was another characteristic that was considered in the study and that was the result of characteristics of the what and the how\(^5\). The study was then centred on four specific characteristics of scientific learning: process of science construction\(^6\), intradisciplinarity, evaluation criteria and level of conceptual demand. The selection of these characteristics derived from the results of former studies (e.g. McComas, Clough, and Almazroa 1998; Morais and Neves 2001; Morais, Neves, and Pires 2004) which have pointed out to their importance in the promotion of high levels of scientific learning.

The results of the analysis of the sociological message transmitted by the Official Pedagogic Discourse of the Natural Sciences curriculum had shown that the characteristics that seem to promote a meaningful scientific learning may be at stake. In fact the analysis of the Natural Sciences curriculum for middle school presents the following characteristics: a low level of conceptualization of a limited range of science dimensions; a low level of intradisciplinarity between scientific and metascientific knowledge and also between distinct kinds of scientific knowledge; a high level of conceptual demand for the scientific dimension, but mostly derived from the complexity of competences only; and implicit guidelines of the text to be transmitted/acquired in the context of the Ministry of Education/Teachers relation. It should be noted that, whilst the curriculum may be open to many readings, the above analysis is a specific one, derived from particular theoretical assumptions. Furthermore, teachers make distinct readings of the curriculum according to their own ideologies or even the contexts where they work.
The results from the curriculum analysis are important in themselves but we wished to go further by concentrating on the study of the influences of authors' ideology on the structure and message of a particular curriculum. Figure 1 presents the relations analysed.

![Diagram of the relations analyzed in the research (Ferreira 2007).](image)

This study is focused on the discipline of Natural Sciences for middle school and addresses the following problem: *What is the extent to which the sociological message transmitted by the OPD of the curriculum is a result of the ideological and pedagogical principles of its authors?* From this problem derived the following two research questions: (1) What are the ideological and pedagogical principles of the authors of the two documents of the curriculum? and (2) What is the relation between these principles and the ideology that underlies the curricular documents they produced, in a context of curriculum flexibility?

In the context of this study, we considered authors’ ideology as including what we called ideological and pedagogical principles. The former underlie broad aims of education. The latter underlie characteristics of the pedagogic practice that are valued in the science teaching-learning process. For this study four ideological principles were selected, two principles related to general educational aims - *education for all* and *teachers’ autonomy* – and two principles related to specific science education aims - *scientific literacy* and *science construction*. The principle *education for all* is institutionalised in the Basic Law of the Educational System and in the Constitution and is also one of the guiding principles of the reorganization of the curriculum for compulsory school. *Teachers’ autonomy* is closely linked to schools’ autonomy, also a
guiding principle of the curriculum. As referred by the text “Flexible Management of the Curriculum” (DEB 1999), “the curriculum management implies a greater autonomy and responsibility of schools and teachers, that must assume the leadership of the process” (13). The principle scientific literacy derives from the principle of equality in school and society institutionalised in the Basic Law and in the Constitution. The principle science construction derives from the importance of promoting a relevant science education for all citizens (e.g. McComas, Clough, and Almazroa 1998). This is a principle that is part of one of the ideologies presented by Säther (2003) – epistemology. With regard to the pedagogical principles, we considered the following: introduction of the various dimensions of science construction; complexity of scientific cognitive competences; complexity of scientific knowledge; intradisciplinarity between distinct kinds of scientific knowledge; intradisciplinarity between scientific and metascientific knowledge. The selection of these principles was based on their importance for a relevant scientific learning (e.g. Morais, Neves, and Pires 2004; Morais and Neves 2011).

Methodology
This study used a mixed methodology, which has characteristics associated to qualitative and quantitative approaches (Tashakkori and Teddlie 1998; Creswell 2003; Morais and Neves 2006). For instance, the use of an interview is a procedure of data collection more associated with qualitative approaches. However, its construction was guided by categories of analysis defined on the basis of the study’s theoretical framework, therefore following a rationalist approach more associated to quantitative methodologies.

The subjects of the study were selected from the thirteen authors of the curriculum. Three authors, one higher education teacher and one secondary school teacher working temporarily in the university, both from the area of Biology/Geology, and one higher education teacher from the area of Physics and Chemistry, were used for piloting the interview. From the remaining ten authors, the five with a scientific background in the area of Biology/Geology were selected, as the study was centred on the discipline of Natural Sciences. Although two of these authors did not wish to answer the interview, the study was centred on four authors because it was possible to obtain data of one of
them (the coordinator of the curriculum construction) from the analysis of texts and articles of her authorship. Table I presents data related to the selected authors.

Table I – Curriculum authors selected for the study

<table>
<thead>
<tr>
<th>Authors</th>
<th>Curricular document(s) constructed</th>
<th>Professional experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author A</td>
<td>Essential Competences</td>
<td>Middle and secondary school teacher Working in the Ministry of Education on a temporary basis.</td>
</tr>
<tr>
<td>Author B</td>
<td>Essential Competences Curriculum Guidelines</td>
<td>Higher education teacher</td>
</tr>
<tr>
<td>Author C</td>
<td>Essential Competences Curriculum Guidelines</td>
<td>Middle and secondary school teacher Working simultaneously in the Ministry of Education and in the University on a temporary basis.</td>
</tr>
<tr>
<td>Author D</td>
<td>Essential Competences Curriculum Guidelines</td>
<td>Higher education teacher Coordinator of the construction of the two curricular documents</td>
</tr>
</tbody>
</table>

The characterization of authors’ ideological and pedagogical principles was based on data obtained through an interview and/or from texts and articles about the process of curriculum reorganization written by the authors (e.g. Freire and Galvão 2004; Galvão 2001, 2004, 2005, 2006; Galvão and Abrantes 2002; Galvão and Freire 2004; Galvão et al. 2006; Lopes 2003).

Interview

A semi-structured interview consisting of three parts was constructed. The first part was made up of eight open questions whose objective was to obtain information about the constitution of the authors’ team. It also intended to obtain data about the process of the documents’ construction, namely the degree of autonomy given by the Ministry of Education to the authors and the influence of each one of the authors on the decisions that were taken along the whole process. The second and third parts of the interview contained questions that would allow inferring respectively the ideological and pedagogical principles of the authors.

The second part of the interview contained nine questions organized in function of four ideological principles: education for all (two questions), teachers’ autonomy (three questions), scientific literacy (two questions) and science construction (two questions). The questions started from the analysis of texts related to aspects of the organization
and curriculum development in sciences (e.g. national and international curricula excerpts; excerpts of articles about the curriculum; and activities taken out of curricular documents). In order that the interviewees were not influenced, for example, by the desire of creating a favourable impression – what Tuckman (2002) refers to as the distortion of the answer by social expectation – the questions were constructed in a way that the information about each one of the ideological principle was indirectly obtained. That construction took into account data obtained from the piloting of the interview. For example, the answers to the questions related to the ideological principle ‘education for all’ suggested two distinct understandings for this principle – ‘education for the success of all students’ and ‘education for the success of some students’. They also suggested two main research indicators for constructing the questions of the interview: (1) contextualizing of learning and (2) changing the sequence of the various kinds of knowledge. Exemplifying, the following are two questions of the interview concerning that ideological principle and when the indicators ‘contextualizing of learning’ and ‘changing the sequence of the various kinds of knowledge’ are respectively considered.

**Question 1**

The principle of curriculum flexibility is expressed on the text ‘Flexible Management of the Curriculum’ in the following way (DEB, 1999):

“The project of the Flexible Management of the Curriculum intends to […] ensure that all students learn more and in a more meaningful way” (6).

“The Flexible Management of the Curriculum means the possibility of each school organize and manage autonomously the teaching/learning process, within the limits of the national curriculum. This process should adapt to the differentiated needs of each school context, including the introduction in the curriculum of local and regional components” (7).

What is the extent to which this curriculum, by adapting to each school context and being therefore inserted in the flexible management of the curriculum, may be successful with regard to the success of all students? Justify. What are the potentialities and limits of the contextualization of learning in terms of the scientific learning for all? Justify.

**Question 2**

Look at the following excerpts taken out of an international science curriculum equivalent to the Portuguese middle school (New York State Education Department, 2004):

“The order of presentation and numbering of all statements in this document are not meant to indicate any recommended sequence of instruction” (p. 3). For instance, in Living Environment section, teachers can decide to explore concepts of key idea 7 previously to concepts of key idea 6.

Introduction of key idea 6: “ […] Living organisms interact with and are dependent on their environment and each other. These interactions result in a flow of energy and a cycling of materials that are essential for life. […]” (17).

Introduction of key idea 7: “Population growth has placed new strains on the environment – massive pollution of air and water, deforestation and extinction of species, global warming, and alteration of the ozone shield. […] Resolving these issues will require increasing global awareness, cooperation, and action. […]” (19).

What are in your view the potentialities and limits of this change on the sequence of the knowledge to be learned, in terms of the scientific learning of all students? Justify.
This last question was explored considering that, when the teacher changes the sequence of knowledge, some concepts essential to science learning may not be taught. In the above sequence change, the teacher may put at stake the scientific learning of all students, as for the understanding of the key-idea 7, the concepts contained in the key-idea 6 are needed, namely those that are related to the theme of the flow of energy and cycling of materials (e.g. the environmental problem of deforestation).

The third part of the interview, which was centred on the authors’ pedagogical principles, contained questions organized in terms of five components of scientific learning: (1) *introduction of the various dimensions of science construction*; (2) *complexity of scientific cognitive competences*; (3) *complexity of scientific knowledge*; (4) *intradisciplinariness between distinct kinds of scientific knowledge*; and (5) *intradisciplinariness between scientific and metascientific knowledge*. For each one of the components, the interview started with the analysis of three hypothetical situations related to the teaching/learning science process (one of which valued the pedagogical principle that has been suggested by research as being more favourable to scientific learning) with the objective of understanding the pedagogic principle valued by the author. Briefly, the structure of the interview, for each one of the components, can be explained by saying that it continued in terms that depended on the author’s answer. If the pedagogical principle valued by the author was totally or partly in accordance with the principle valued by the research (she possessed recognition rules for that characteristic, in a high or a medium degree, respectively) but that principle was not present in the curriculum, the interview proceeded with an attempt to understand the justifications/constraints that were behind that absence. If the pedagogical principle valued by the author departed from the principle valued by the research (she does not possess recognition rules) and that principle was not present in the curriculum, the principle was given to her through the analysis of a text, for example the excerpt of an article, before proceeding with the interview by asking for justifications/constraints. If the pedagogical principle valued by the author was totally or partly in accordance with the principle valued by the research and was similar to the curriculum principle this part of the interview would be finished.
The answers given in the second and third parts of the interview were analysed through content analysis, which considered the dialectical relation between our theoretical propositions about the ideological and pedagogical principles and the empirical data obtained by answers. The analysis of the interview can be clarified by the examples that follow. For the ideological principle *education for all*, excerpts of answers are organized in terms of authors’ principles, when the indicator ‘contextualizing of learning’ is considered. With regard to the pedagogical principle *intradisciplinarity between distinct kinds of scientific knowledge*, the excerpts show the position of one of the authors.

**IDEOLOGICAL PRINCIPLE: Education for all**

[1] “[…] to match the curriculum to the context […] I have many ways […] I cannot follow the same path […] the same activities, the same strategies… This is what means to be flexible, isn’t it? It is to make it according to the students. Although I know that I must make sure that all […] is going to be achieved by the end of the year. […] I have an X number of essential concepts that I must teach in my lessons in order to guarantee that I develop […].” (Author A)

[2] “[…] in terms of knowledge, if [the teacher] develops it in greater or lesser extent. […] that is going to depend on students’ interests, if students begin to show more interest for one or some given themes and if they want to explore them further, why do not then pay more attention to those themes than to others they do not show the same interest. […]” (Author C)

Excerpt [1] makes evident that the author values the principle ‘education for the success of all students’ and the excerpt [2] makes evident that the author values the principle ‘education for the success of some students’. In fact, this last author privileges students control over selection with the consequence of depriving most students of the legitimate text of the school – students interests are always the interests of the few.

**PEDAGOGIC PRINCIPLE: Intradisciplinarity between distinct kinds of scientific knowledge**

[3] “[…] I think that continuity should exist, isn’t it? […] in the understanding […] that they are getting about the natural world, for example in the case of the Sustainability of the Earth, when we start to teach the structure and functioning of the ecosystems, there are many things that can be recovered from the 7th year [knowledge related to Geology] and that can be used as an articulation for a start… […]” (Author A)

[4] “[…] It was perhaps too exhaustive and heavy to tell in all themes and sub-unities: something from the 7th year can be brought in and inter-related here, something from the 6th year can be brought in and inter-related here. […]” (Author A)

These excerpts show that author A values an intradisciplinary relation that follows the research results (possesses recognition rules in a high degree) and also show the reasons/limitations she pointed out for the absence of this principle in the curriculum.
Analysis of documents

The characterization of the authors’ ideological and pedagogical principles was also made on the basis of a documental analysis of texts/articles produced by authors and related to the curriculum reorganization process. In the case of three of the authors the data obtained from the documental analysis was used to complement the data obtained from the interview. In the case of the author who did not answer the interview (Author D), her ideological and pedagogical principles were only obtained from the documental analysis. The analysis was focused not only on texts of her authorship but also on texts in co-authorship with authors who were interviewed and with authors who were not interviewed. The documental analysis used the same categories defined for the interview. Eleven texts were analysed (mentioned in references): one text by author A; one text by authors B, C and D; one text by authors B and D; one text by author C; and seven texts by author D.

The analysis of the texts can be clarified by the examples that follow, one of them related to the ideological principle teachers' autonomy, when the indicator ‘clarification of concepts and activities’ is considered, and the other related to the pedagogical principle complexity of scientific cognitive competences.

IDEOLOGICAL PRINCIPLE: Teachers’ autonomy

[5] “It is now schools and teachers’ role to decide what should be taught, how, when and why, within the limits of the national guidelines, in order that it is possible to work with specific groups of students. […] With the Flexible Management of the Curriculum […] schools and teachers have the opportunity of selecting the knowledge and activities […] that they think are essential and organize them in terms of time and methods, taking into account the school contexts and the educational community.” (Author C, Document 4, 8-10)

PEDAGOGIC PRINCIPLE: Complexity of scientific cognitive competences

[6] “New curricular demands are based on the development of general competences as it is the case of learning to learn, problem solving, decision making, arguing, imagining, cooperating, debating, communicating”. (Author D, Document 5, 9)

These excerpts show that author C values the principle ‘greater degree of autonomy to teachers’ and that author D values a complexity of scientific cognitive competences that follows the research results (possesses recognition rules in a high degree).

Data analysis

With regard to the ideological principles considered in the study – education for all, teacher’s autonomy, scientific literacy and science construction – the results show that the main differences between authors respect to the principles education for all and
teachers’ autonomy and occur between authors with distinct statuses in the curriculum construction. The author who, among the four, had a clear lower status (Author A) was the one who showed to have, as ideological principles, an “education for the success of all students” and a “lower degree of teachers’ autonomy”. In fact, this author defended the idea that, in science education, all efforts should be made to guarantee that all students acquire scientific concepts and competences at a high level even if the teacher is to attend students’ local context (school/community context) (see excerpt [1]). This idea seems to make evident that the author possesses the ideological principle of an education for the success of all students and not an education for just the access of all students. Furthermore, this author expressed the idea that the scientific knowledge and competences to be developed in science education should be clearly explicated in the curriculum, particularly if we wish that “great discrepancies in terms of our students’ education” do not exist. This idea points to the author valuing, as an ideological principle, of a lower degree of teachers’ autonomy. The following excerpt from the interview reinforces this author’s position:

[7] “[…] when it is said that the teacher is autonomous in the curriculum management, s(he) must know, s(he) has the professional duty of making sure that his/her students acquire those concepts and develop those competences. However, I can do it in a variety of ways.” (Author A, Interview)

This excerpt shows that for author A, teachers’ autonomy should be restricted to learning strategies. Contrary to this position, the other three authors tend to value, as an ideological principle, an “education for the success of some students” and a “greater degree of teachers’ autonomy”. All of them defended the idea that, when the teacher takes into account the student’s local context, the emphasis and degree of depth of a given knowledge should depend on her/his students (see excerpt [2]). According to this idea, we can think that the ideological principle of an “education for the success of all students” is not being valued by these authors. Since not all students will have access to an education that promotes a high level of scientific literacy, an effective success will be limited to some students. Furthermore, these three authors believe that the curriculum should be explicit with regard only to the competences to be developed and little explicit with regard to the knowledge (particularly its degree of depth) and to the activities to be organized by the teacher, as these should be adequate to the context of each school (see excerpt [5]). These results seem to suggest that these authors defend, as an ideological principle, a
greater degree of teachers’ autonomy. When we consider the curriculum message with regard to these two general educational principles, it is possible to tell that the principles that prevailed are the principles of the three authors with higher status.

With regard to the ideological principle *scientific literacy*, the results suggest that all four authors seem to value the idea that science education should promote a “high level of scientific literacy”, privileging scientific knowledge and competences with a high degree of complexity and the existence of relations of intradisciplinarity between distinct kinds of scientific knowledge. The following excerpts are examples that illustrate this position:

[8] “[…] Science is complex, science is complex. So, if we are simplifying it too much how are we… approaching science? […] I don’t think it is wrong to reach more complex ideas [in science education]. What we have to do is to find ways to arrive there.” (Author C, Interview)

[9] “The understanding of the role played by science and technology in our day lives requires an informed population which has enough knowledge to understand and to participate in debates about scientific and technological issues, as they are implied in many decisions they take as individuals and members of a society.” (Author D, Document 9, 4)

However, the results obtained with respect to the principles *education for all* and *teacher’s autonomy* point out to the conviction that, for three of the authors, this high level of scientific literacy will be limited to some students. And this is also what is in fact expressed by the curriculum.

When we consider authors’ position with regard to the ideological principle *science construction*, the results show that all of them seem to defend the inclusion of science construction on science education across all thematic units, even supporting the presence in the curriculum of metascientific knowledge and competences together with scientific knowledge. The following excerpt exemplifies this position:

[10] “I think that all this perspective of science, technology and society and the nature of science should be embedded across the curriculum. It is more valuable and important for me than have a separated block: Today we are going to study STS! […] In the course of lessons, when teaching the knowledge, whatever we are doing, looking for examples that lead precisely to that level.” (Author A, Interview)

Yet this position, that shows the defence of a lower degree of autonomy of the teacher with respect to this aspect of scientific learning, was not present in the curriculum. In fact, the results of the analysis of the curriculum with reference to the control between the Ministry of Education and the teachers (Ferreira 2007; Ferreira and Morais 2010) had shown that a high degree of control is given to the teacher about *the what* of the
metasciences and about the how at the level of the intradisciplinarity between scientific and metascientific knowledge.

The results obtained from interviews and texts, with regard to the pedagogical principles, show that the authors seem to defend similar principles. However, the analysis of the message contained in the curricular documents point out to discontinuities between authors’ principles and the principles contained in the OPD of the curriculum. With regard to the principles introduction of the various dimensions of science construction and intradisciplinarity between scientific and metascientific knowledge, the authors defended a same status for the distinct dimensions of the process of science construction and a relation, of a same status, between scientific and metascientific knowledge (possess recognition rules in a medium degree). However, the external sociological dimension of science has higher status in the curriculum when compared to other dimensions10 and the relation between scientific and metascientific knowledge has a low representation (Ferreira 2007; Ferreira and Morais 2010), which shows that the authors’ principles were not passed on to the curricular text. The excerpts that follow illustrate the position of two of the authors in relation to these two pedagogical principles and some of the reasons/limitations they encountered when constructing the curriculum.

[11] “Yes [science education should give the same emphasis to all science dimensions]. Because for me they are all related. It doesn’t make sense to emphasise one more than another, they are all related. Why highlight some in relation to others?” (Author C, Interview)

[12] “[...] It was also taking into account all the suggestions we were being receiving, taking into account the direction that was being followed in other countries, all that was on the table and contribute for the way the Curriculum Guidelines were written [with more emphasis in the STS relation].” (Author C, Interview)

[13] “Clearly situation 3 [equal status of the two types of knowledge]. [...] We want that students learn scientific knowledge, [...] the scientific knowledge currently accepted. But we also want them to [...] think about that scientific knowledge. [...] it [the curriculum] must clearly have scientific knowledge, but metascientific knowledge must also be studied.” (Author B, Interview)

[14] “[...] We hadn’t that perspective of being exhaustive to all the various kinds of knowledge... In fact the curriculum would be totally unreadable [if those intradisciplinary relations were presented].” (Author B, Interview)

The analysis of the principle intradisciplinarity between distinct kinds of scientific knowledge showed that the authors believed that relations should be made between distinct themes of the curriculum and not only within the same theme (see excerpt [3]). This means that they possess recognition rules in a high degree. Again this principle is
not present in the curriculum, where intradisciplinarity is mainly made within the same theme (Ferreira 2007; Calado and Neves, submitted).

With regard to the principles complexity of scientific cognitive competences and complexity of scientific knowledge, the results showed that the authors seem to believe that a balance should exist between the development of both simple and complex competences and that the understanding of unifying themes should be present and should be achieved through the understanding of knowledge of both simple and complex order. It is possible to say that the authors possess recognition rules in a high degree for these two principles. Also in this case the authors’ principles are not present in the curriculum as it calls mostly for the development of knowledge of a complex order and of complex competences, particularly in the document Essential Competences (Ferreira 2007; Calado and Neves, submitted). The following excerpts show the position of two of the authors in relation to these two pedagogical principles and the reasons/limitations they encountered when constructing the curriculum.

[15] “the objective that we should try to achieve [in science education] is clearly the understanding of more complex concepts. That’s it, because science is complex. […] and if we want to develop scientific literacy we shouldn’t stay in the basics. […] For me it is always to start from the simpler [concept] to reach the more complex [concept]. […]” (Author C, Interview)

[16] “[…] we started from the conviction that students have already studied science before and also the knowledge and concepts to be now developed. […] It is in that sense and in the sense that the level is not be lowered down.” (Author C, Interview)

[17] “[…] We should attempt to achieve the competences of a more complex level, but we need such things as simple as memorization. […]” (Author A, Interview)

[18] “It’s to go up, because there is [the document Essential Competences calls greatly to complex competences]. But that’s how it is, in order to be able to achieve the complex we must firstly have the simple, isn’t it? It’s perhaps not clear to others. […] Because that’s it, if we are lowering the level we then never… arrive there.” (Author A, Interview)

Summarizing, through the analysis of the justifications given by authors, it was possible to find out reasons for the discontinuities that were encountered between authors’ pedagogic principles and curriculum principles. For example, in order to justify the higher status of the external sociological dimension given in the curriculum, the authors mentioned that they intended to follow the present trends in science education that emphasise the STS relation (see excerpt [12]) and also that this relation allows for a good contextualization of learning as defended by such views as curriculum flexibility and constructivism. With regard to intradisciplinarity, the authors
claim that the curriculum could not be too much exhaustive and for that reason they needed to summarize the relations between scientific and metascientific knowledge and between the distinct kinds of scientific knowledge (see excerpts [4] and [14]). They also pointed out to the importance of giving more autonomy to the teacher as the justification for a smaller explication of the curriculum in this particular aspect. Most of these justifications tend to follow new trends that are emergent in the field of education and that are focused on the key-words autonomy, decentralization and territorialization (Apple 1999; Morgado 2000). With regard to the discontinuities at the level of the complexity of scientific knowledge and competences, authors’ justifications are essentially a consequence of believing that the level of those knowledge and competences should be high in order that the curriculum makes clear that science education should promote a high level of scientific literacy (see excerpts [16] and [18]).

**Conclusions**

This study analysed the extent to which the sociological message transmitted by the middle school curriculum for Natural Sciences is an expression of its authors’ ideological and pedagogical principles. The main objective of the study was to explore empirically Bernstein’s model of pedagogic discourse (1990, 2000) at the level of the discourse production, by considering the importance of the dominant principles of society (GRD) and the principles related to the field of symbolic control (intellectual field of education) in the legitimization by curriculum authors of given educational principles, particularly in science education, and in the presence of those principles in the official pedagogic discourse of the curriculum.

The data from the study suggests that the authors involved in the process of curriculum construction have distinct ideological principles and that the principles valued by authors with higher status prevailed in the message of the curriculum. The authors shared similar pedagogical principles but such principles had not always been passed on to the curriculum. The study suggests therefore that curriculum authors do not always act according to their principles, which gives origin to discontinuities between their ideologies and the ideologies they apply.

When attention is focused on the ideological principles related to general educational aims – education for all and teachers’ autonomy – the results show that the curriculum
reflects the principles of the authors with higher status, that is, the valuing of greater teachers’ autonomy and of an education that departs from an education for the success of all students. Although the current dominant discourse at the national and international levels defends a greater degree of teachers’ autonomy, authors’ ideological principles may differ in the form they view that autonomy, as it is the case of the authors with lower and higher status in the team. The principle “education for all”, the universally accepted principle contained in the dominant discourse of present democratic societies, has been viewed either as education for the success of all or education for the access of all. Authors’ ideological principles can be seen within this perspective. Whereas the author with lesser status believed in lower teacher’s autonomy and in educating for the success of all students, authors with higher status believed in greater teachers’ autonomy and in educating for the access of all students, as for them education for all is mostly associated with the success of some.

The results of the study show that the authors with higher status believe that the teacher should have greater autonomy, for example on the selection of scientific knowledge, changing for example its emphasis and depth, in order to meet students’ local context. This ideology, when transported to the curriculum, as it was the case, may, in defence of flexibility and autonomy (as principles of individual and institutional freedom), lead to the absence in the classroom of scientific concepts essential to scientific literacy and may open the way to the promotion of distinct levels of conceptual demand by distinct teachers to meet the specificities of students, schools and geographical contexts. By defending a greater teacher’s autonomy, the authors’ ideology, with regard to education for all, may put at stake the success of all students, in terms of an education that promotes a high level of scientific literacy. This is a most crucial aspect in curriculum development that raises issues related to the meaning that distinct protagonists of curriculum development (authors, teachers) accord to the ideological principles related to general educational aims (e.g. education for all and teachers’ autonomy) that are part of the dominant discourse in present democratic societies. It is clear that, beyond distinct understanding of principles, there is also the question of authors’ awareness of the implications that such distinct understanding may have on the construction of a curriculum.
When attention is focused on the ideological principles directly related to science education (scientific literacy and science construction), it is interesting to observe that options taken by the authors team do not totally reflect the importance that they all accord to the inclusion of science construction on science education and to the promotion of a scientific literacy based on the development of competences and knowledge of various levels of complexity and on strong relations of intradisciplinarity. The principles they value are in accordance with the dominant principles of society that, being influenced by the international field and by the field of symbolic control, emphasise the importance of a critical and intervenient citizenship through the promotion of a scientific and technological culture. It is possible to hypothesize that the discontinuities that were found between these authors’ principles and the message of the curriculum are related to various difficulties of the authors to put into practice the principles they defend. For example, the discontinuity between authors’ principles and curriculum principles with regard to science construction and its relation to scientific knowledge may be related to the distinct structure of scientific and metascientific knowledge (Bernstein 1999). In fact, all authors are science educators, having had a primary academic socialization in hierarchical structures of knowledge, and may find it difficult to make an effective introduction of metascientific knowledge and mostly of its integration with scientific knowledge, when constructing pedagogic texts.

If we now consider the relation between authors’ pedagogical principles and the curriculum message, it was evident that those principles followed some current trends in science education but were not present in the sociological message of the curriculum the authors constructed. A possible explanation for these discontinuities is the difficulty of putting into practice, in the form of a monologic text, some aspects of scientific learning. It is possible to hypothesise that the authors possessed recognition rules for the specific contexts of scientific learning analysed in this study but that they did not possessed realization rules to produce curriculum texts appropriate to those contexts. However, it is also possible to think that the authors possessed realization rules but, in face of the context of curriculum flexibility where the Natural Sciences curriculum was constructed, they decided to construct little explicit texts in order to give to teachers a greater degree of autonomy in the curriculum implementation. This explanation is based on the defence by higher status authors, whose ideologies prevailed in the curriculum, of the ideological principle of teachers’ autonomy.
To summarize, the study points out to the influence of distinct authors’ position when constructing the curriculum, where the ideological principles of the authors with higher status would have had a more significant weight on decision making. Considering that the authors’ team had been given a great autonomy by the Ministry of Education, evident in the absence of clear guidelines about the construction of documents (namely with respect to the specific characteristics of scientific learning analysed in this study), that is an important aspect to take into account when the principles that prevailed in the curriculum are analysed – lower level of scientific literacy in terms of intradisciplinarity, science construction mostly limited to the external sociological dimension and great autonomy of the teacher in the Ministry of Education/Teachers relation. Since the curriculum principles are mostly the principles of the authors, who are actors in initial teacher education (as higher education teachers), and those are principles which are not favourable to the scientific learning of all students (e.g. Domingos 1989; McComas, Clough, and Almazroa 1998; Morais and Neves 2011), it is possible to question the legitimacy of the curriculum in terms of its relation to the dominant principles of society about students’ equality of access and success and in terms of the appropriation by student-teachers of ideologies that do not contribute for a change in a science education that can lead to a society of equality and social justice.

The study also points out that, although the dominant principles of society are in general reflected on the ideologies of curriculum authors, they are recontextualised in terms of the meaning that is given to those principles and that depends on the theories of the intellectual field of education that are defended by particular authors. These are theories that correspond to distinct languages of the area of educational knowledge, which is characterized by a horizontal structure and that will guide options taken in the construction of a curriculum. Options are also conditioned by other factors such as, for example, the nature of social relations that characterize the authors’ team, which constructs the curriculum and the intervention space that is given by the Ministry of Education to that team. As it is evidenced by Bernstein’s model of pedagogic discourse, the production of any pedagogic text (as it is the case of curricular documents) involves relations of interest, compromise, conflict. It is the result of these relations that determines the nature of the message contained in that text and explains
the continuities and discontinuities that exist between the principles defended by each one of the authors and the principles underlying the curriculum message.

The study raises the question of author’s identity. Most authors were curriculum authors for the first time, which makes difficult to talk of authors’ identity and of their ideological positions as consistent and fixed over time. Rather, they are situational and influenced, to a certain extent, by a net of relations, evident throughout the study, between some of the authors. However, it was clear that they have their own positioning and their own ideologies as teachers, if not as authors.

Although the results of the study are based on only four authors, data about other authors may support the conclusions that were reached. On one hand, the three authors who made up the sample for the piloting study, provided data that, although not formally analysed, support the conclusions. On the other hand, most of the secondary school teachers who were working temporarily in the Ministry of Education and/or in the university were doing research with the higher education teachers of the two samples and/or had been invited by them to be part of the team. For these reasons it may be legitimate to infer that they would share similar principles.

Another interesting point to be discussed is related to the invitation directly or indirectly made by those in charge of curriculum development at the time in the Ministry of Education to the leading elements of the team. Given that education can be considered as a horizontal structure of knowledge, with distinct parallel languages shared by distinct groups of people, it is legitimate to think that both those in the Ministry of Education and the authors shared the same language, i.e., the same ideological and pedagogical principles. Although informal data can confirm this belief, the analyses made in this study did not go that far and for that reason this aspect should be left for further research.

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NOTES
1. A former version of this article was published in Portuguese by the journal Educação & Realidade.
3. The field of symbolic control is the field where discursive resources are produced.

4. With regard to the relation between discourses of the same discipline, we considered the degree of relation between distinct kinds of scientific knowledge and between the scientific and the metascientific knowledge. With regard to the Ministry of Education-Teachers relation, we considered the degree of control given by the Ministry of Education to teachers – degree of explication of the OPD. Classification and framing were used to characterize respectively relations between discourses and between subjects.

5. The level of conceptual demand of the OPD transmitted by the curriculum was analysed in two dimensions, scientific and metascientific. In the case of the scientific dimension, we considered three parameters: complexity of scientific knowledge, complexity of scientific cognitive competences and intradisciplinarity between distinct kinds of scientific knowledge. In the case of the metascientific dimension we considered only the complexity of the metascientific knowledge.

6. This study used Ziman’s conceptualization (1984) of science construction, according to which science is seen as a social institution with various dimensions: philosophical (science methods), historical (science evolution), psychological (scientists’ characteristics), internal sociological (relations inside scientific community) and external sociological (relations between science and society). This allowed a detailed analysis of science construction, that is, of metascientific knowledge, present in the curricular documents, by studying the various dimensions separately.

7. Portugal does not have a specific agency for Curriculum Development. Curriculum Projects are developed by teachers invited by the Ministry of Education for that purpose. In the case of this study, 5 authors of the curriculum were higher education teachers in the areas of science teaching methods (3 in the area of Biology/Geology and 2 in the area of Physics and Chemistry) and 8 were secondary/middle school teachers that were working in the Ministry of Education and/or the university.


9. This analysis was made in terms of the possession of recognition rules for the pedagogic characteristic under analysis. When, for example, the component ‘intradisciplinarity between distinct kinds of scientific knowledge’ was considered, the interviewee showed to possess recognition rules when she selected the situation that expressed the principle “in science education, intradisciplinary relations should exist between scientific knowledge of distinct themes”.

10. The analysis made to the curriculum of Natural Sciences (Ferreira 2007) showed that that curriculum privileges the relations between science, technology and society according smaller importance to other aspects that influence the construction of scientific knowledge.

11. The contextualization of learning is one of the aspects of the principle of curriculum flexibility that is the basis of the current curriculum reorganization.

12. Studies carried out by the ESSA Group have shown a relationship between students’ achievement in sciences, their social background and teacher’s pedagogic practice when the level of conceptual demand of that practice is considered (e.g. Domingos 1989; Morais 1991). The studies suggest that the teacher has a tendency to vary the level of conceptual demand of his/her pedagogic practice according to the social context where s/he teaches in the direction of lowering that level when s/he teaches in a working class school and/or in a country school.

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REFERENCES


Abstract

The study analyses the extent to which the sociological message transmitted by the Official Pedagogic Discourse of the curriculum for Portuguese middle school contains the ideological and pedagogical principles of its authors. The research is epistemologically and sociologically grounded, placing particular emphasis on Bernstein theory of pedagogic discourse.

The ideological principles underlie broad educational aims and the pedagogical principles underlie characteristics of the pedagogic practice. Data was obtained through a semi structured interview with the authors and documental analysis of their publications.

The results suggest that the authors were distinct in the ideological and pedagogical principles they valued and that discontinuities were evident between those principles and the curriculum message. These results are discussed and their consequences in terms of scientific learning are explored.

Keywords: scientific education; curricula; ideological principles; pedagogical principles; social context.