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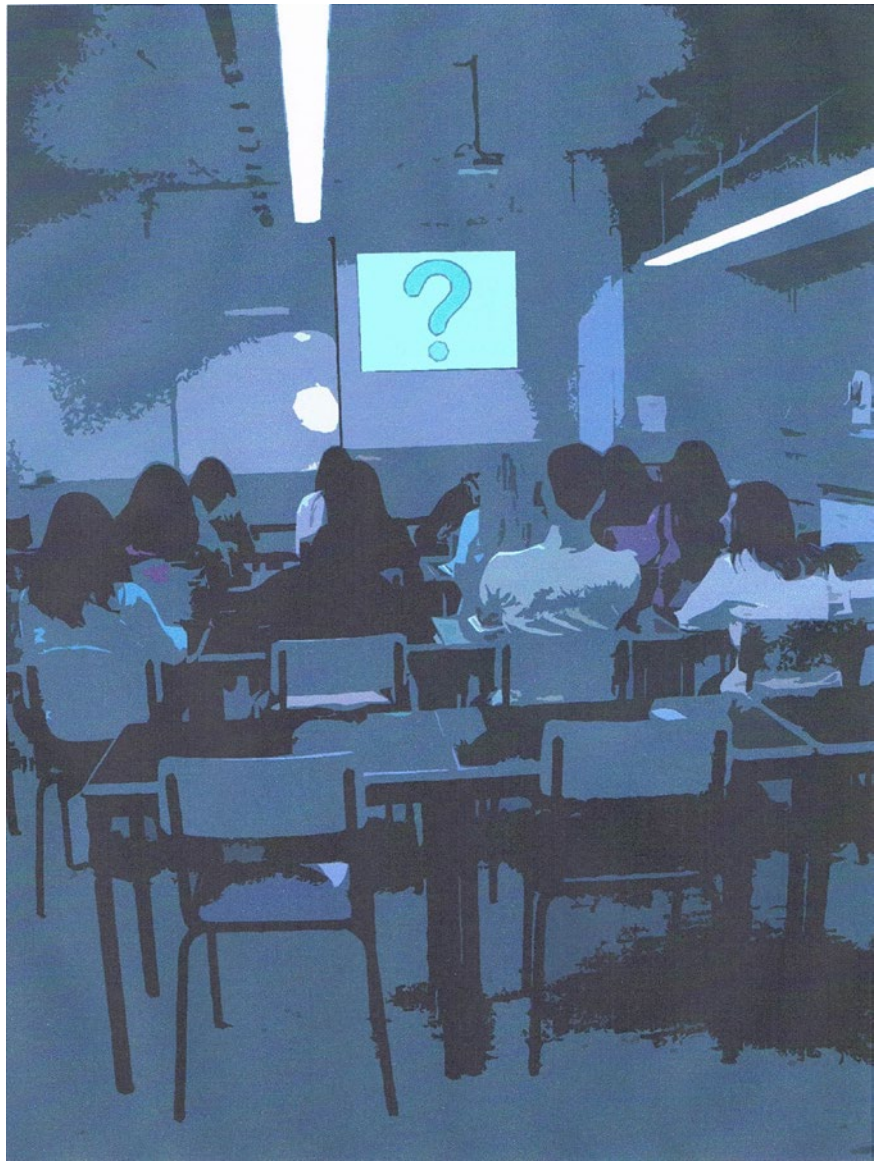

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Uncovering Portuguese teachers' difficulties in implementing sciences curriculum

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Abstract: Many countries recognize the positive and effective results of improving science education through the introduction of reforms in the sciences curriculum. However, some important issues are generally neglected like, for example, the involvement of the teachers in the reform process. Taking the sciences curriculum reform under analysis and benefitting from 10 years of teachers' experiences in teaching sciences based on this curriculum, 19 semi-structure interviews were applied so as to identify the major difficulties felt by science teachers when implementing the Portuguese sciences curriculum in the third cycle of middle school (pupils' age range of 12–15). Some of the difficulties depicted by the data analysis include: length of the curriculum, lack of time, unsuitable laboratory facilities, insufficient means and materials for experimental work, pupils' indiscipline and little interest in learning sciences. Although less frequently mentioned, the lack of professional development was also referred to as a constraint that seems to play an essential role in this process. Some recommendations for improving the success of sciences curriculum reforms' implementation are given: defining and conceptualizing curricular policies by relating the reality of both the schools and the science classrooms; reorganizing and restructuring pre-service teachers' courses; organizing professional development courses for in-service teachers.

Subjects: Education; Information Science; Social Sciences

Keywords: Portuguese teachers; difficulties; implementing; sciences curriculum

Clara Vasconcelos

ABOUT THE AUTHORS

All the authors are Science Educators researchers' with strong linkages to teacher's initial training or their professional development. With academic degrees in different areas of sciences, their common interest is to develop and innovate Science Education Research, from curricula development to its implementation in the schools. The first three authors work more directly involved with Biology and Geology teaching and the two last develop Chemistry and Physics Educational research. Areas like Sustainable Development, Geoethics and Science Teaching Methodologies are also of common interest. Supported in an inquiry-based teaching approach, this research was carried out within the scope of the Research Project "Evaluation of the Physics and Natural Sciences Curriculum, third cycle of Basic Education", funded by FCT—Portugal.

PUBLIC INTEREST STATEMENT

Many countries recognize the importance to the positive and effective results of improving science education through the introduction of reforms in the sciences curriculum. However, some important issues are generally neglected like, for example, the involvement of the teachers in the reform process. The need for dialogue is required because a centralized curriculum may be a cause of less motivation and a reduction in science teachers' self-esteem. Although being a case study and not a representative sample of teachers, we consider the relevance of these teachers' opinions during the interviews and the need to reflect upon their experiences. This study gives a contribution to explain why teachers feel that their involvement in the curriculum design is critical and justifies further research in this area.

1. Introduction

The current Portuguese Physics and Natural Sciences curriculum (where topics in Physics, Chemistry, Biology and Geology are taught), of the third cycle of basic education, began being implemented in 2001 (Law n. 6–18th January). The Ministry of Education adopted a curriculum based in the development of competencies and suggested an inquiry approach to pupils' activities. However, the involvement of science teachers in this reform was neglected, which meant, for instance, that no significant and/or related professional development was ensued, thereby disregarding the fact that the implementation of a curriculum reform implies changing teachers', pupils' and parents' conceptions and practices concerning science education (Dochy, Segers, Bossche, & Struyven, 2005; Osborne, 2003; Šorgo & Špernjak, 2012). Moreover, as Ryder and Banner (2011) suggest, without a body representing all stakeholders (teachers, professional curricular designers, researchers, professional scientists working in universities...), it is not possible to ensure that multiple aims are considered throughout the curriculum reform and, as such, the science teaching community will not be adequately represented. A curriculum reform should, then, involve the commitment of many actors.

The 2001 Portuguese science curriculum reform was prepared so as to improve knowledge of scientific ideas and promote a better understanding of the activities that help scientists to study the natural world (Vasconcelos, Amador, & Torres, 2012). This inquiry-based approach provided pupils with an opportunity to plan empirical experiments and/or search theoretical evidence, directed to one specific problem related to daily life. As suggested by the coordinator of the curriculum design, the latter has to be understood in terms of content knowledge, which promotes a better pupils' learning and follows the European recommendations on new forms of teaching and learning (Galvão, Reis, Freire, & Almeida, 2011). As such, the current Portuguese sciences curriculum presumes an increase in scientific literacy indexes resulting from the application of learning strategies that develop pupils' autonomy which, in turn, encompass a higher number of experimental activities, the analysis and debate of daily life problems and the process of scientifically backing a decision (Martins, 2012). However, the relevant political and social frame that wrapped the Portuguese educational reform made the implementation of the sciences curriculum a difficult reality. The fact is that teachers respond to a specific educational reform as a whole, valuing it in relation to other integrated education policies and related reforms (Ryder & Banner, 2013). Constrains related to different positions taken by in-service teachers, school administrators, pupils and curriculum designers disclosed many difficulties that need to be evaluated within the framework of the current sciences curriculum in Portugal (Vasconcelos et al., 2012).

The present article presents the results of a research undertaken in the north of Portugal, in two public schools. The case study resorted to teachers' interviews and its content analyses were considered as meaningful to understand the different teachers' appraisal of the sciences curriculum implementation.

2. Background

The majority of scientific and technological developments have ethical and moral implications. Thus, the involvement of citizens in decisions that affect their lives asks for an active, critical and scientifically informed participation (Galvão et al., 2011; Osborne & Dillon, 2008). Hence, the convergence of educational reform policies and scientific literacy should be assumed as one of the purposes of science education (Fensham, 2008; Galvão et al., 2011; Osborne & Dillon, 2008; Šorgo & Špernjak, 2012).

Like in other countries and although centralized and top-down in nature, the curricular policies implemented in Portugal in recent years broadcast potentially innovative speeches, in line with international recommendations that arise from research in the areas of education in science and science education (Autio, Kavivola, & Lavonen, 2007; European Commission, 2004; Osborne & Dillon, 2008). However, the implementation of new teaching strategies implies substantive changes in assumptions and practices that have long been rooted in the "*grammar of schooling*" (Tyack & Tobin, 1994) and the routines of daily school life, especially if they are in line with expectations of parents, teachers or school principals, and with their beliefs about teaching (Šorgo & Špernjak, 2012). These necessary changes have been listed around the following dimensions: (i) teachers' action and pedagogical

work; (ii) interrelationship between the students' school knowledge, contextual knowledge and cultural experiences; (iii) planning and conceptualizing different teaching resources that will boost inquiring and critical analysis of problems that reflect the complexity of contemporary society; (iv) teacher collaboration, in order to break with the individualist and solo-disciplinary practices that shape the teaching and promotion of learning processes.

Following this approach, Guskey (2002) and Vaillant (2006) emphasize the relevance and the need for a bigger involvement of teachers in the educational reforms and the improvement of the quality of education. It is indeed essential to achieve higher levels of involvement and accountability, ensuring, nonetheless, both the individuality and the idiosyncrasies of each teacher. Moreover, Tardif (2000) calls for the urgent need for every teacher, including higher education teachers, to observe and problematize their own teaching practices, by developing research, critical thinking and meta-reflections on them, so as to minimize the gap between the prevailing applied theories and those that are recognized as adequate models for teaching other levels of education, but also peer teaching. The assumption of all these mandates broadens the scope of the teachers' action far beyond the mere application and implementation of the prescribed national curriculum, whose operationalization was basically restricted to the fulfilment of a syllabus that sometimes, in practice, coincided fully (or still coincides!) with the study and exploration of the adopted textbook. In other words, with the implementation of the new science curriculum, the teacher is expected to be and act as a reflective practitioner who identifies problems, debates and raises questions about values, observes and understands the political and social context of the school, cooperates in the development of the school curriculum project, ensures curriculum adequacy, management and flexibility according to each group/class, acts with high critical reasoning, is pedagogically creative, and values collaborative work dynamics in terms of both thought and continuing professional development.

Furthermore, the classroom practices of science teachers are influenced by multiple and complex factors (Roehrig, Kruse, & Kern, 2007), especially when the curriculum reform is a top-down imposition just as it happened with the Portuguese sciences curriculum. Reviewing the literature on curriculum implementation and teachers' perceptions about changes, van den Berg (2002) refers that the perceptions that teachers conceive concerning the reform policy often influence their commitment with classroom work. Other factors noted in the literature are as follows: (i) their conceptual knowledge of the subject (Carlsen, 1993; Kruse & Roehrig, 2005); (ii) the structural knowledge of science (Roehrig et al., 2007); and (iii) teachers' beliefs regarding their role as teachers and the pupils' learning process. These beliefs, based on personal judgments and evaluations, are individual and subjective and have impact on teachers' decisions, i.e. on classroom management and how teachers use their pedagogical knowledge in the classroom (Morine-Dershimer & Kent, 1999; Peck, Gallucci, & Sloan, 2010).

Such conceptions end up being reflected in science teaching classes causing many constrains and a bad image regarding the impact of curriculum implementation in many European countries. Jenkins (2000) mentions that after the national curriculum was implemented in England and Wales, pupils were presented with a narrower range of laboratory activities and less time was spent in laboratory practical activities in a significant number of schools. The need that teachers felt to teach more extensive contents increased pressure on time, and many laboratory activities were cut in order to teach the amount of science modules required by the curriculum reform. The same author refers that a substantial number of teachers considered the national science curriculum as insufficiently flexible to allow them to meet the needs of all their pupils and provide them with enjoyable scientific education. Some authors (Jenkins, 2000; Šorgo & Špernjak, 2012) also mention that a curriculum reform implies more than changes in the form and content of the science curriculum. It should also specify the manner in which pupils are evaluated and their teachers held accountable. This fact generally implies a reduction in science teachers' self-esteem by rejecting their professional expertise. In a recent article written by Ryder and Banner (2013), the authors claim that a curriculum reform can go beyond the learning of new knowledge and associated pedagogies so as to involve challenges to teachers' professional identities. In addition, Jenkins (2000) claims that the need for dialogue is required because a centralized curriculum may be a cause of less motivation and recruitment of science teachers. As

such, the same author refers that without a better control by science teachers over the changes caused by the implementation of a new sciences curriculum, the disadvantages of such a reform are likely to far outweigh any benefits.

In Portugal, following the development of an international project (PARSEL), whose main objective was the development of curriculum materials that would foster the adoption of new organizational forms of teaching and learning, Galvão et al. (2011) reported that the success of this project showed that the close relationship between schools and higher education institutions potentiates the change. By creating learning communities, based upon commitment, trust and follow-up processes that reflect their curricular practices, these efforts, in turn, translate into mutual and symbiotic learning processes.

In short, teachers of physics and natural sciences have to face multiple challenges of different nature, as they require an articulated action from policy-makers, researchers, teachers, administrators and community representatives, pupils and parents, that takes in account the need for different levels of flexibility, especially in terms of involvement, time and efficiency of results.

The research reported here resorts to this literature background and to a case study of the 2001 sciences curriculum reform in Portugal. It tries to answer the research question "What are Portuguese science teachers' difficulties in implementing Sciences Curriculum" by summarizing the impact of its implementation and presenting the major difficulties experienced and reported by teachers.

3. Methodology

This paper draws upon teachers' interviews held in 2010–2011 scholar year, 10 years after the sciences curriculum reform. It is important to refer that the Portuguese sciences curriculum covered both physics (Physic and Chemistry) and natural sciences (Biology and Geology) themes, both subjects are taught by different teachers with specific specialization. Although some changes in the Natural Science curriculum have been made in the last three years, the study's findings are considered as valid, since the teachers' involvement in the curriculum design is still critical.

3.1. Schools

The chosen schools for the case study were confined within Oporto and Aveiro, two of the biggest districts from the north of Portugal. Although a convenience sample was used, the selected schools were considered meaningful schools to collect data regarding science curriculum implementation in the north of Portugal.

They are public schools dedicated to pupils in the third cycle of basic education. Although implemented in a non-privileged residential area, pupils attending these schools generally belong to a medium social class, have no specific financial problems, and usually both parents are employed and hold a medium or even high academic degree. The organizational structures of these schools culture favour a nurturing environment, which allows members to perform a successful collaborative work. The teaching practices and relationships among school staff, teachers, parents and pupils contribute to a pleasing school climate. Although not being schools that usually carry out experimental practices during curricular reforms, the school principal, teachers and staff members are strongly committed with reforms to improve pupils' academic performance. Within this framework these schools are considered to be open and active, which embrace instructional changes but are simultaneously concerned with the development of literate pupils capable of performing a competent and active role in society.

3.2. Participants

This study involved all science teachers selected from both schools—19 science teachers, almost equally distributed. Of this sample, 10 were Biology and Geology teachers, while the other 9 were Physics and Chemistry teachers. All of them taught sciences to the third cycle of basic school (pupils with 12–15 years old) and have a professional service time ranging between 18 and 24 years.

All teachers had already worked in these specific schools for more than two years thereby being familiar with the school climate and culture and having participated in the conception of the school project and regulation.

3.3. Procedure

The only aim of the teachers' interviews was the identification of difficulties regarding the implementation of the sciences curriculum in third cycle of basic school. The research study was explained along general lines and all questions were centred in the sciences curriculum. Although some teachers may have referred other aspects of curriculum implementation, they were not considered in this study. It was made clear that it was relevant to give sustained opinions and it was also mentioned the importance of recording the interviews. All interviews took place just before the end of the school year (third term). Each teacher was interviewed alone in a friendly manner and within a relaxed atmosphere. Interviews were administrated in the Portuguese language. To guarantee consistency across all interviews and increase the validity of the data, the same interviewers, following the same interview schedule and keeping the same emphasis on the formulation of questions and acceptance of opinions, conducted all interviews. To evaluate the certainties of the teachers' opinions about a specific difficulty in the curriculum implementation, a counterargument was posed. A script was elaborated to conduct the semi-structured interviews. The interviews were audiotaped for a better and reliable transcription.

3.4. Interview questions

The semi-structured follow-up interviews aimed to generate in-depth profiles of teachers' views of curriculum implementation difficulties and were conducted by the second and the fourth authors of this article. The interviewers followed semi-structured interview script with open questions related to the participants' views on the sciences curriculum and the sciences reform implementation. Follow-up questions where posed whenever interviewees did not focus their answer in the main aims of the questions. The questions and their nature are expressed in Table 1.

The script questions were thought and written by the multi-case research team. They were selected from a previous list, which stemmed from a creative and critical group discussion supported by the literature and various experts' suggestions. Having prepared the interview script, it has been piloted by the research members responsible for this particular study case. The above-mentioned researchers also reviewed the questions so as to verify the clarity of the language and the structure of the interview. The teacher's involvement in the interviews was very satisfactory especially considering it was a not scheduled duty. These aspects increased the researchers' confidence in the data that were obtained and contributed to the validity of the answers.

3.5. Validity and reliability

The process used to analyse the interview questions was carefully undertaken and the experts evaluated how well the questions addressed the intended content area and the purpose of the study. So as to guarantee subsequent and appropriate interpretation of scores, a content validity of the script answers was performed by three experts.

Table 1. Teachers interview questions and their nature

Questions	Nature
How were sciences classes this year? Why?	Curriculum implementation difficulties
Can you pinpoint some negative aspects (pupils, colleagues, time management, curriculum implementation ...)?	
What can be done differently?	Future perspectives
What changes will you introduce next year?	

Following the codification of the answers, if different codes were given to the same answer, other team member independently analysed the process. This procedure was performed in order to guarantee the internal consistency of the codification process. When necessary, the codification process of an answer was debated until a consensus was reached within the research team. The data were organized into codes according to this procedure and then into broader categories and finally into themes. The three experts met to agree on the emergent themes. This approach to thematic content analysis ensured that the links were being made between the empirical data and the claims made by the experts (Green & Thorogood, 2004; Yin, 2009).

3.6. Data treatment and analysis

After the coding process, all teachers' interview answers were incorporated within the following defined themes: (i) understanding the teachers' curriculum implementation difficulties; (ii) perceiving the echo of the teachers' curriculum implementation difficulties in the teachers' future perspectives. The analysis of the answers is presented by theme and some examples of the answers given by the interviewees are also presented for a better understanding. The criterion chosen to present the examples was confined to its content and clarity to express Natural Sciences and Physics teachers' opinions regarding the dimension under analysis.

3.6.1. First theme: understanding the teachers' curriculum implementation difficulties

The poor conditions of the classrooms are referred to as an important cause for failure in science classes since they hamper concentration and heighten indiscipline. Teachers feel social pressure to schedule a large amount of homework and the latter prevents compliance with the programme since much time is required for its review in the classroom. Textbooks, which still provide guidance for many of the classroom activities, are criticized mainly for their lack of information or poor content structure. Photocopies are used to overcome the inadequacies of the textbooks. These are referred to as having been adopted without any prior pilot-experience, which accounts for their many gaps. As a strategic resource school, textbooks rely a lot to media resources and thus, the lack of Internet and/or computers hinders the dynamics of a more motivating science class. The shortage of laboratory practice is justified with the lack of resources (reagents, laboratory equipment, specific rooms ...). Pupils rarely study or learn outside the school compound. Sometimes pupils watch films, but there is pressure for time if the *curriculum* is to be met fully, which does not allow many views or many PowerPoint presentations. Teachers deny giving expositive lectures (which was, however, referred by pupils) but their statements reflect the opposite since the strategies they used are limited and undiversified, an insufficiency that teachers justify because of the lack of time to complete the curriculum. Many teachers recognize dictating information for pupils to write down and also report that classes are expositive because they have no laboratory or material resources. Most consider that "a good school year" occurs if they manage to "fulfil the curriculum" with no major disciplinary problems, thereby forgetting that an adequate science education should promote the development of critical thought, scientific reasoning and meaningful content learning processes that will help problem-solving and promote citizenship. Nevertheless, and although only mentioned a few times, some teachers refer the need for professional development, which would help them implement the initiatives of the science curriculum reform.

Some examples of the answers focusing on the difficulties of the implementation of the science curriculum are presented in Table 2.

3.6.2. Second theme: perceiving the echo of the teachers' curriculum implementation difficulties in the teachers' perspectives to the future

As expectations for the future (Table 3), science teachers mention the need to improve the school facilities, thus benefiting the concentration of both teachers and pupils. They emphasize the need to choose more adequate textbooks, preferably ones that offer many multimedia interactive resources. A prior experimentation of the textbook within a classroom context, prior to the final decision on which

Table 2. Examples of science teacher answers regarding difficulties in the implementation of the science curriculum

Natural science teachers	Physics teachers
Curriculum management	
"If we had more classes per week then we could allocate more time to practical classes, which we do not do because of the lack of time." Teacher E	"We have little time to spend in labs because the programs are very extensive and also due to the fact that we are with students only once a week." Teacher T
"The extension of the curricula of the 7th and 9th grade is a major constraint, since I lack the time to perform more experimental activities." Teacher R	"The program of the 3rd cycle is too long considering the available teaching time, and thus many of the concepts are superficially approached …" Teacher M
Unsuitable laboratory conditions	
"… we don't always have the lab available, and there is also the curriculum that we have to meet … and theoretical preparation is also needed to be applied in some practical moments …". Teacher D	"… We did not have the labs available, and thus this term was a bit bad as far as practical classes are concerned…" Teacher A
"… the reagents are all out of date, they have not been bought in years, and the material is also very easily damaged, the glassware breaks very quickly and is extremely expensive …" Teacher H	"For example, one of the labs has only one tab, and so, if four groups are performing a distillation, I do the setting but only one group will be able to carry it out." Teacher M
Unmotivated students	
"… not even practical work motivated students…" Teacher D	"…sometimes there are exceptional classes (…) and there are others with completely different results, with students that show no interest and are unmotivated." Teacher T
"… it is very difficult for students to work in groups, anything that requires them to work autonomously is very hard …" Teacher F	"… the lack of motivation refers to schooling as such and not to the subject…." Teacher M
Scarcity of resources	
"… lack of technological resources, for instance, multimedia material…, I have to bring my personal computer and amplifiers from home, and then there is always something missing, a cable, an extension cord … even the extension I have to bring from home …" Teacher E	"… Sometimes I used [lab ware] but this year I had no chance; the materials were still in boxes, and there weren't many resources available" Teacher P
"… there are no materials, or there is no staff to wash it; everything is left to the teacher, the teacher has to organize the materials before classes if he wants to do any experiments with students…" Teacher O	"… As far as resources are concerned they were very limited since there were neither computers nor projectors in the classrooms…" Teacher J
Indiscipline	
"… most of the students in the class refused to work (…) the class dynamic is dependent on disciplinary and behavioural issues …" Teacher D	"… The classes I had this year were a bit problematic, especially in terms of indiscipline, and they were very big…" Teacher L
"… they did not work, they did not bring materials, books, notebooks …" Teacher F	"… it is much more difficult to control the class (…) because of behaviour, and they are proud to be the worst class in the school…" Teacher I
Textbook	
"… in the last six years the publisher made consecutive versions of the same textbook; the changes are significant and create huge difficulties (…) at a certain point I had three different versions of the same textbook in the classroom …" Teacher B	"… if we are to have confidence in the textbooks that they use to study we may have a rather unpleasant surprise …" Teacher A
"I always have the textbook with me when I am planning the class, and I use the questions that the textbook raises for the student to follow and guide his own study." Teacher S	"… a given textbook interprets the curriculum and deepens the contents in a certain way, but then I look at another textbook and those very same contents are much less thoroughly dealt with (…) this makes us waste time that should be used in other ways, (…) I try to follow the textbook's structure more because of the students than on account of my belief about the sequence of contents" Teacher T
Professional development	
" … [to work collaboratively with physics teachers] I should have professional development…probably." Teacher G	"… I think that in the past we [teachers] worked more together, now I feel that each of us works more on its own, although there is some cooperation, (…) formerly we used to work more in group." Teacher M
"Currently I'm doing a course in which a colleague is applying ipods, ipads, I really do not know much about it, (…) and I think that this is a huge world, a world I completely know nothing about." Teacher R	"… the training we received for the use of interactive boards came out of time and was out of context (…) … As far as Science Education is concerned I think that we are too trapped and tied up in the contents and the curriculum set by the Ministry, we are too formatted for what comes from above telling us how it is and what is that we have to do." Teacher T

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textbook to adopt, is considered appropriate. Most teachers refer their intent to try to reconcile theoretical lessons with practical classes, promoting more experimental activities without an expositive character. They expect to find pupils that are more motivated, more disciplined and more interested in science. Despite the previously mentioned, references to outdoor activities were minimal (only one teacher), maybe because they are not integrated in the curriculum and thus funding is difficult as well

Table 3. Examples of science teacher answers regarding teachers' perspectives to the future

Natural science teachers	Physics teachers
Classroom conditions	
"... at least the physical space, the classrooms will be much larger, I don't know, I hope that the working facilities will be much better ..." Teacher B	"... I believe that in this school ... we will be able to have experimental classes in the laboratory..." Teacher A
"... next year I hope that the working facilities will better; as matter of fact, this year I even taught lessons in classroom where there wasn't not even a blackboard..." Teacher C	"... it does not mean that all classes must be taught in the lab, but having access to it, one of the good things for me (...) is that I am able to immediately perform an experimental little demonstration ..." Teacher I
Textbook	
"... we are going to choose a textbook for six years without having had any practice with it, we should have the opportunity to choose, practice and decide whether the textbook is adequate or if another should be chosen..." Teacher H	"... I've already talked with my colleagues, I do not know if it is going to be done or not, some changes in the format of the contents... their sequence ..." Teacher L
"... for example, I will not display an image that is exactly the same as presented in the textbook but only in a different colour, if the image is presented in the textbook that is the one to be explored, otherwise one has to look for one." Teacher S	"... that is why I always end up looking at the basic elements first, I reverse the sequence, because the sequence that is established is not logical, in my view it makes no sense ..." Teacher Q
Practical work (lab and out of school settings)	
"...naturally I will try to have more practical classes (...) to do more experimental work ..." Teacher E	"... [In what concerns an increase in lab work] I think it's positive because it is perceivable that when student do lab work they eventually retain the information, and the fact that they do remember the experiments also shows up in tests..." Teacher L
"... next year (...) I am going to walk them there once, have them spend a whole afternoon there, take notes, see how things are done, the kids know nothing about an Waste Water Treatment Plant (WWTP)..." Teacher H	"I will try to increase the number of laboratory classes, the time spent in the lab, (...) because students feel displeased with the little amount of time that I allocate to lab classes..." Teacher T
Parents' collaboration	
"... students stayed home because it was the last school week, they did not care if teachers were going to apply self-evaluation, if they needed to address any specific student, students were allowed to stay home only because it was the last school week. I mean, this says a lot about our society ..." Teacher B	"I sometimes think to myself that parents should be present... we promote meetings with parents and such, but then, in the end, parents should be present..." Teacher P
"These students would need a very close monitoring during basic school, and although the school has made a great effort in terms of extra support classes, often this is not enough (...) I believe this is a social related issue, because it has much to do with the expectations that parents have for their children (...) when we want students to think rather than memorize we feel resistance from parents, because that was not what was in the textbook, because that was not what ..." Teacher R	"... At home [students] do not have the family support that they should..." Teacher N "... we have students to whom we have the possibility of lecturing extra support classes, but which the parents have refused. They [the students] are not seizing the opportunities available to them and the parents are colluding with this." Teacher M
Professional development	
"We have colleagues who are having training, doing Masters and PhD degrees in education, and these colleagues bring to our knowledge new approaches that we debate, discuss and try to adapt. (...) We have had a good cooperation with these colleagues, which allows us to build upon the advantages of updating ourselves both together and in group." Teacher R	"... I was in a teaching program at the University of Porto on how to engage students in research, and then applied it to my own students, who loved the experience, since they experienced a completely different task." Teacher T
"I have a self-evaluation form that I apply at the end of each period, in which students have a space to comment on their own performance, but also on the lessons and I urge them to write something there. Some constructive criticism appears, usually reinforcing their wish to have more practical work." Teacher S	"... I work a lot with my Sciences colleague, Sciences and also Geography, the two of us met and since there are common contents to the two subjects we decided that some of them would be addressed by me and the other by her, in sciences" Teacher M

as obtaining school authorization for their implementation. Teachers expect a higher parent involvement, which would increase pupils' interest in science and motivation to learn in the classroom. Despite the curricular reform goal, teachers persist having difficulties in collaborative work, since they do not share the same planning techniques and thus, in practice, classes are taught independently. The future use of group work, interdisciplinary approaches and the diversification of strategies (especially resorting to the laboratory), is referred to with caution by science teachers, because they fear excessive noise and indiscipline. As such, teachers seem to be tied up in lectures and in reading textbooks, deviating their lessons from the commitment of engaging pupils in the process of science learning and failing to provide them with an inquiry-based teaching.

No major differences were found in the reported difficulties and expectations of natural sciences and physics teachers. A more determined criticism to textbooks was presented by teachers of natural sciences, as they seem to resort more to them in their lectures. On the other hand, teachers of physics referred more strongly to a future use of the laboratory only for experimental and expositive studies. Professional development is to be emphasized as a need to improve the teaching of science, since without it teachers feel unable to fulfil the guidelines given by the curriculum reform.

4. Conclusions

The analysis of the interviews conducted in this case study identifies the following as the major difficulties in managing the implementation of the science curriculum reform that should be considered by education authorities: the extensive curriculum, the unsuitable laboratory facilities, the unmotivated students, the scarcity of resources, indiscipline, reduced quality of textbooks and lack of professional development as an ongoing process of planning and executing the teaching, assessing it and redefining it as necessary.

Despite these difficulties in sciences curriculum reform, science teachers presented some expectations for future school years. Their suggestions point to the improvement of the physical conditions of classrooms, the increase of practical work in the laboratory and in outdoor activities, a better collaboration between parents and school staff and the possibility of having professional development to enable them to improve work and peer teaching in the classroom. The results also highlight the need for parents' collaboration and involvement. As referred in the literature, changing the curriculum also implies changing parents' beliefs concerning education and science education (Galvão et al., 2011; Šorgo & Špernjak, 2012). Moreover, as the same authors refer, imposed top-down curriculum changes do not result in significant improvements in curriculum reforms, and professional development may be quite a determinant or at least a relevant factor of the success of the curriculum implementation. The results of this study corroborate the fact that collaborative work between teachers and teacher training institutions can significantly reduce curriculum implementation difficulties (Blonder, Kipnis, Mamlok-Naaman, & Hofstein, 2008; Galvão et al., 2011).

Although being a case study and not a representative sample of teachers, we consider the relevance of these teachers' opinions and the need to reflect upon their experiences and difficulties as well as to clarify the school management. Nevertheless, this study gives a contribution to explain why teachers feel that their involvement in the curriculum design is poor as justifies further research in this area.

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