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What do science teachers think about developing scientific competences through context-based teaching? A case study

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ABSTRACT

In this paper we explore the views and opinions of four secondary education science teachers regarding the teaching of scientific competences. Their views were gathered in the context of a training programme in which they had to design, implement, and assess their own teaching unit for developing students' scientific competences by means of context-based learning. Analysis of the data yielded a set of 14 categories distributed across 5 areas: scientific competence and context-based teaching; the teacher and his/her professional environment; implementation in the classroom; development of the teaching unit; and assessment. This process also identified the aspects which teachers believed either facilitated or acted as an obstacle to the development of scientific competences through context-based teaching. We discuss the implications of our findings and suggest ways in which a shift towards a context-based approach to teaching scientific competences can best be achieved, and consider a series of factors related to teachers' professional identity that may influence this process.

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Scientific competences; context-based science education; science teacher training; secondary education

Introduction

Since the mid-1990s a number of different initiatives have been developed within the world of education and training in an attempt to meet the challenges posed by the knowledge society (Gilbert, 2007) in all spheres of everyday life, especially the employment context. Notable examples include the Definition and Selection of Competences (DeSeCo) of the Organization for Economic Cooperation and Development [OECD] (OECD, 2002) and the Program for International Student Assessment [PISA], (OECD, 2006). The results of these projects led to the emergence of the concept of key competences for a successful life, which was attributed a central role within education. These competences are considered to be highly important for making sense of, and functioning well inside, a world that is increasingly diverse and interconnected – one in which individuals need to master changing technologies and process vast amounts of information. There are also great collective challenges, such as the need to balance economic growth with environmental sustainability, and prosperity with social equity (OECD, 2005).

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The European Union (EU) has also exerted a notable influence in the development and dissemination of the concept of key competences. In 2000 the Lisbon European Council set out the *Education and Training 2010* work programme, while 2004 saw publication of the document *Key Competences for Lifelong Learning – A European Reference Framework* (COM(2005)548final). This formed part of the implementation of the above mentioned work programme, and it defined eight key competences, including those related to science and technology (Table 1). Two years later the EU recommended that its member states introduce these key competences into their education systems (COM (2006)962/EC).

PISA 2015 (OECD, 2016a) applies the notion of competence to its four areas of assessment: reading, mathematics, science, and financial literacy. In the case of science, the use of the term *scientific literacy* rather than *science* 'underscores the importance that the PISA 2006 science assessment places on the application of scientific knowledge in the context of life situations, compared with the simple reproduction of traditional school science knowledge' (OECD, 2006, p. 23). In PISA 2015, scientific competences are the main component of the assessment scheme for science (OECD, 2016a).

Due, among other factors, to the influence of these programmes, the key competences approach has spread rapidly to the educational systems of various countries (DeBoer, 2011). Thus, in our country, Spain, the most recent primary and secondary school curricula (Ministry of Education, 2006, 2013) include the development of key competences and take as their reference the proposals described above. The incorporation of competences into the curriculum enables educators to place the emphasis on those aspects of learning that are considered essential from an integrative perspective that is geared toward the application of acquired knowledge. These are the competences which young people need to have developed by the time they complete their secondary education if they are to achieve personal realisation, be actively involved as citizens, make a satisfactory transition to adult life, and be equipped to engage in lifelong learning (Ministry of Education, 2006, 2013). The seven key competences identified in the Spanish curricula include *mathematical competence and basic competences in science and technology* (Table 1).

In our view, an approach to teaching that is based on the development of key competences constitutes an important step forward within the Spanish education system. We regard an approach of this kind as an appropriate way of organising school curricula

Table 1. The relation between the key competences defined in the European Union (COM (2006)962/EC), in Spanish curricula (MEC, 2015) and in PISA 2015 (OECD, 2016a).

Key competences European Union/Spanish curricula	PISA (2015)
Communication in the mother tongue[a]	Reading
Communication in foreign languages[a]	
Mathematics and basic competences in science and technology	Mathematics Science
Digital competence	
Learning to learn	
Social and civic competence	
Sense of initiative and entrepreneurship	
Cultural awareness and expression	
	Financial literacy

[a]In the Spanish curricula, these two competences appear under the heading of 'linguistic communication'.

designed to prepare competent and socially responsible citizens (Hurd, 1998) for the enormous challenges posed by today's societies, which are both highly globalised (DeBoer, 2011) and heavily dependent on technology and knowledge (Gilbert, 2007).

In the specific case of scientific competences, the object of the present research project, various studies (Gil & Vilches, 2006; Hernández, 2006; Tonda & Medina, 2013) and the results of Spanish students in PISA (OECD, 2016b) show that the development of competences is not an habitual practice in this country, either in the teaching of science or in the assessment of student learning. The implementation of a competence-based approach implies important changes in both the curriculum and teaching, not least in terms of how teachers view learning, since the traditional emphasis has been on the reproduction of knowledge rather than its transfer to real-world situations. These changes therefore rely on the support of teachers, and it is necessary to take into account not only their attitudes and beliefs but also the knowledge and skills they will require in order to implement and assess the outcomes of the new approach (Wallace & Priestley, 2017). Attention must also be paid to the influence of external factors, such as the ways in which schools function and the nature of the educational system itself (Ryder, 2015; Ryder & Banner, 2013).

With the aim of identifying both obstacles to, and potential drivers of, an educational practice that seeks to develop competences through context-based learning, the present article describes a case study designed to explore the views and opinions of four secondary science teachers with regard to this educational approach.

Literature review

In order to provide the necessary background for the study this section reviews the literature with regard to three aspects. First, we consider some of the challenges involved in developing a competence-based science curriculum. Second, we argue that context-based learning is a suitable approach to the development of scientific competences. And third, we examine the difficulties that teachers encounter when faced with the changes associated with the introduction of a competence-based curriculum.

Science education and competences

Several reports in Europe (Confederation of Scientific Societies of Spain [COSCE], 2011; Hazelkorn, 2015) proposed that scientific literacy should be developed within the framework of scientific competences, and have highlighted its importance not only for future scientists but for all citizens. In this context, it is worth noting a point made by Fensham (2007), who argues that the development of competences raises the immediate need for research on the teaching of science.

Although references to competence have featured for some time in the field of science education (Kauertz, Neumann, & Haertig, 2012) it should be noted that the concept of key competences as it is used today is rather detached from the everyday work of science educators and teachers (Fensham, 2007). This is mainly due to the fact that many of the key competences defined are of a generic nature, and it is unclear how they might specifically relate to the different areas and subject matter taught in school science curricula (Blanco-López, España-Ramos, González-García, & Franco-Mariscal, 2015; Fensham, 2007).

A large number of these generic competences have been identified, such as critical thinking, managing information, working as a team (Blanco-López et al., 2015), problem-solving, and investigating, and are included in the school curricula in many countries. To develop these competences, more attention must be paid to them in the classroom. However, according to Fensham (2007), this should not be done at the expense of other sets of competences that are specific to particular domains or subjects, such as those related to the sciences. Indeed, Fensham argues that the development of competences raises the immediate need for research on the teaching of science, such that

> … the next task for science education research, in close conjunction with teachers and students in real classrooms, is to extend our understanding of appropriate scientific competences to aim for at each stage or level of schooling, and to find how contexts, content and pedagogies will make them learnable by large numbers of students. (Fensham, 2007, p. 117)

But what are these scientific competences? The most widely used definitions are the ones made by the European Union (EU, 2006) under the title of 'basic competences in science and technology' and by PISA (OECD, 2006). The first time the term 'scientific competence' appears in the PISA project was in the 2006 assessment (OECD, 2006) in which science was the main area of evaluation. The definition of the assessment model starts from the question 'What is it important for citizens to know, value, and be able to do in situations involving science and technology?' (OECD, 2006, p. 20). Obviously, the idea of scientific competence looms large in any response to this question, and it underpins PISA's concept of scientific literacy, that is, the ability to 'identify scientific issues', 'explain phenomena scientifically' and 'use scientific evidence'. Recently, PISA 2015 (OECD, 2016a) has reformulated its assessment model; in this edition, scientific competences appear as the ability to 'explain phenomena scientifically', 'evaluate and design scientific enquiry' and 'interpret data and evidence scientifically'. These competences require students to demonstrate their knowledge and cognitive skills, and also their attitudes, values and reasons for responding to science-related problems.

A considerable amount of research has been conducted in specific areas of science education, notably the nature of science, explaining, inquiry, modelling and argumentation. All the facets mentioned are clearly linked to the three scientific competences set out in the PISA assessments. Assessing and integrating these competences can help us to make proposals and reach decisions about the numerous scientific and technological questions that form part of students' lives and of the society in which they will soon engage as adult citizens (Fensham, 2009).

Context-based science education and competences

Although there are different ways of teaching science so as to develop competences we believe that the most suitable approaches are those derived from context-based teaching (Gilbert, 2006; Pilot & Bulte, 2006). This approach features widely in the literature (Bennett, Lubben, & Hogarth, 2007; Campbell, Lubben, & Dlamini, 2000), and it has underpinned the reform of many science teaching programmes. The main goal of this approach is to foster scientific literacy among all students, and the outcomes achieved have been analysed in a number of publications (De Jong, 2008; Gilbert, Bulte, & Pilot, 2011; Overman, Vermunt, Meijer, Bulte, & Brekelmans, 2014), as has the crucial contribution that teachers make to this process (Gilbert et al., 2011; Van Driel, Bulte, & Verloop, 2008).

Research on the development of this approach thus provides a useful starting point for considering how students link scientific concepts to the real-world (Bennett et al., 2007; Gilbert, 2006; Gilbert et al., 2011; King & Ritchie, 2012) and how they integrate their knowledge and develop their scientific skills, both of which are key components of scientific competences (Blanco-López, Franco-Mariscal, & España-Ramos, 2016; Fensham, 2009).

The use of real-life contexts that are relevant to students also serves to encourage important educational interactions in the classroom, thereby providing teachers with information about the pedagogical structures and resources involved in the construction of teaching and learning (Stolk, Bulte, De Jong, & Pilot, 2009a, 2009b). In this regard, the evidence derived from evaluations of teaching programmes based on this approach suggests that, compared with traditional methods which focus on the transmission of scientific knowledge, context-based programmes are not only better at motivating students to study science but also foster a more positive attitude towards the discipline (Bennett et al., 2007).

The question, therefore, is whether the context-based approach to teaching are truly useful in helping students develop their scientific competences. Answering this question requires data from the evaluation of programmes developed and implemented with this specific purpose in mind.

With respect to student assessment, a guiding premise of the PISA model is *the needs of citizens* (OECD, 2006), and this should equally apply to the way in which they are taught. If, when they reach the age of 15, students are required by PISA to demonstrate their scientific competence in relation to real-life situations and contexts (Fensham, 2009) then it would seem logical for them to have developed these competences in the same contexts. Therefore, classroom work should be focused on dealing with those situations and/or problems that are regarded as important for the citizens of today.

Science teachers and curriculum reform based on competences

It is widely acknowledged that teachers have a key role to play in educational reforms (Ryder, 2015; Wallace & Priestley, 2017). Indeed, the success of the reforms depends to a large extent on teachers' knowledge, skills and practice. Moreover, teachers are intelligent decision-makers who interpret and modify the official curriculum according to what they consider to be the needs of their students (Wallace & Priestley, 2017). Teaching new and innovative curricula requires a redefinition of teachers' roles and obliges them to adopt new, often very different practices (Avargil, Herscovitz, & Dori, 2012). Needless to say, these new demands may well meet with resistance (Anderson & Helms, 2001; Donnelly, 2000; Ryder, 2015).

During processes of change and reform, science teachers often encounter a series of difficulties in carrying out their professional role (Anderson & Helms, 2001; Donnelly, 2000; Ryder, 2015; Ryder & Banner, 2013). These difficulties reflect their own perspective on scientific knowledge and their interactions with others, and result from an interaction between both internal and external factors. They can be grouped into three broad categories (Ryder, 2015):

(a) Those associated with personal factors (the *teacher focus*) encapsulating the concepts, theories, and knowledge that underpin their usual decision-making and practices, and which are therefore difficult to modify. Thus, if the goal is to promote the development of scientific competences among students, then teachers are obliged to make decisions on issues related to their own understanding of such competences, how to address them in the classroom, and how to assess them (OECD, 2006; Pinto & El Boudamoussi, 2009), and consequently these aspects must be incorporated into their training (Lupión-Cobos & Blanco-López, 2016). In addition, promoting scientific competences through a context-based or STS approach to teaching poses a challenge for teachers with regard to its incorporation into their classroom practice (Bennett et al., 2007; Herreras & Sanmartí, 2012).
(b) Difficulties related to internal factors (the *school focus*); the characteristics and aspirations of the students and of their parents may affect the ways in which teachers carry out and modify their practices. The practices of the departments where they work and the culture and the leadership style of schools also exert a strong influence (Ryder, 2015).
(c) Those related to external factors (the *systemic focus*) that affect teachers' professional commitment. This commitment to educational reforms is often undermined by the limited participation of teachers themselves in the reform process, by the feelings of disenchantment that many teachers acquire over the years, and, in many schools, by the lack of a context in which such reforms might actually be implemented.

While a great deal of research has been carried out to determine how science teachers respond to curriculum reforms (Ryder, 2015; Wallace & Priestley, 2017, among others), the development of key competences has not always constituted the main focus of attention, perhaps because, as stated above, competence-based approaches are relatively recent. Given the multidisciplinary nature of the concept, its effective integration into the educational process depends on teachers receiving adequate training, which must address the different elements of their professional identity (Korthagen, 2010) and promote a fundamental change in (among other things) their value and belief systems regarding science and how it should be taught – a shift that is generally difficult to achieve (Witz & Lee, 2009). This research aims to identify which aspects (both old and new) are important for science teachers in their role as curriculum makers (Wallace & Priestley, 2017) when they approach the development of competences from a context-based perspective to teaching.

Research questions

In light of the above, the present study sought to address the following questions:

(a) In the opinion of practicing science teachers, what are the elements that impact on the use of a context-based approach to the development of scientific competences?
(b) Which of these elements do they see as facilitating the teaching and learning process and which are regarded as obstacles?

Study context and design

As part of a broader research project designed to help Spanish science teachers to develop scientific competences among their secondary education students (12–16 years) we devised a six-month training programme aimed at helping them to design, apply, and assess the outcomes of their own proposals for teaching scientific competences in the classroom (Blanco-López & Lupión-Cobos, 2015; Lupión-Cobos & Blanco-López, 2016). This programme was implemented on three occasions between 2010 and 2012.

A key issue in the design of the programme was the choice of a training approach that would enable them to help their students to development of competences through context-based teaching approaches. The current trends in teacher education and professional development are oriented towards methodologies that pursue a balance between classroom practice and theoretical knowledge (Jeanpierre, Oberhauser, & Freeman, 2005; Van Driel, Meirink, van Veen, & Zwart, 2012). A wide-ranging bibliographic review (Desimone, 2009), identifies the following important aspects in the training of teachers to improve their practices and increase student achievement: (a) a content focus, (b) the promotion of active learning, (c) an awareness that activities of professional development require time, and (d) the collective participation of the teachers involved.

In the field of context-based approaches to science teaching, various studies (Coenders, Terlouw, Dijkstra, & Pieters, 2010; George & Lubben, 2002; Stolk et al., 2009a, 2009b, 2011) have highlighted the importance of involving teachers in the design, implementation and evaluation of their own teaching proposals. These approaches view the science teacher as a reflective professional and support the development of curricula that give teachers considerable scope for decision-making (Wallace & Priestley, 2017). Drawing on the studies just quoted, the programme in the present study addressed the following three aspects: the concept of scientific competence and how to teach it; context-based science teaching and its use in developing scientific competences; and the design, implementation, and assessment of the teaching units proposed by the teachers. We believe that enabling teachers to develop, implement, and assess the outcomes of their own proposals is a good way of providing them with practical experience of this approach and of transferring knowledge to the classroom. Therefore, as part of the programme teachers were required to design a context-based teaching unit on a scientific topic or problem of their own choosing, and to demonstrate how their proposed approach and the learning activities included would provide students with opportunities to develop their scientific and other key competences. We structured the programme across four stages (Figure 1), including both face-to-face and online sessions.

Stage 1. Stage 1 began with a lecture by a science education scholar which aimed to draw participants' attention to the differences between their initial beliefs and current expert knowledge on key aspects of competences and their development. Participants were asked three questions: In what ways could the idea of 'competence' help to rethink our practices in teaching science? How does this idea change the vision of what should be learnt and how it should be taught? And what consequences does it have for ways of carrying out assessment?

Then, in two 3-hour sessions, two teaching units which had been designed for the research project and had been previously tested were analysed from the perspective of context-based teaching. Focusing on everyday problems or situations (Blanco-López

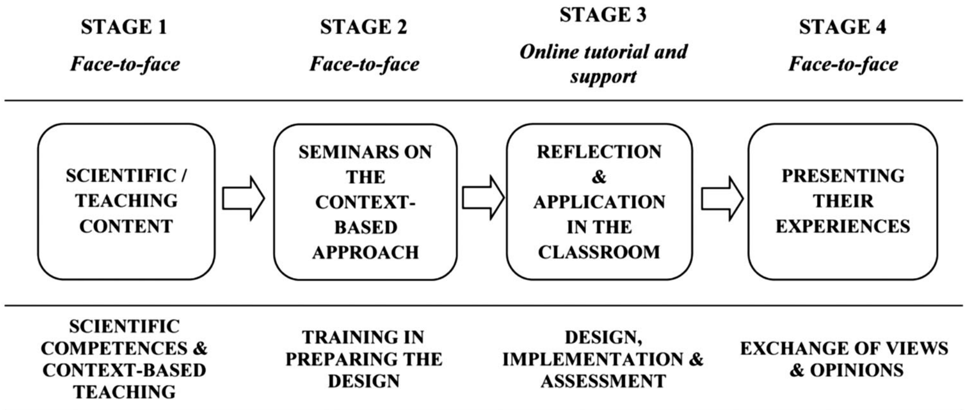

Figure 1. Stages of the training programme.

et al., 2016), these units were designed to show participants ways in which the concept of scientific competences might be applied in specific teaching situations. The units were called 'Do we really need to drink bottled water?' (Blanco-López, Rodríguez-Mora, & Rueda-Serón, 2011) and 'Save energy. You can do it!' (López-Velasco, Blanco-López, & Haro-Collado, 2011). They both focused on issues relating to personal behaviour, and required the participants to take a position on them. The units included a series of questions that guided and structured the activities. For example, in the first unit the questions were: (a) Is bottled water better than tap water? (b) Is bottled drinking water necessary? In the second, the questions that the participants had to answer were: (a) Have we always used the same amount of energy? (b) Should we use less energy? Why? (c) Can you save energy? How?

The units began with activities to guide the students and to encourage them to express their initial positions on the problem. Then, via the presentation of news reports, videos and advertisements related to the central problem of the unit, participants carried out a variety of tasks designed to make them consider other facets of the problem, to gradually empower them to build their learning, and to allow them to develop their scientific competences in an autonomous way. All the activities included in the units were associated with the development of scientific competence. The teachers were provided with a chart displaying the different aspects of scientific competences that are listed in the Spanish curriculum (Ministry of Education, 2006) and the PISA science assessment (OECD, 2006).

Stage 2. Two 3-hour workshops were given to help teachers design their own teaching units. They were encouraged to think about how their designs might include the key aspects mentioned in Stage 1, and how they might integrate these aspects in the context-based approach to science teaching; for example, (a) by selecting contexts that are of relevance in everyday life (at personal, social or global level), are of interest to students, and are included in the curriculum (Gilbert, 2006); (b) by combining the study of the chosen context with the learning achieved using powerful conceptual models of science teaching at school; (c) by highlighting the importance of an adequate use of scientific language and distinguishing it from everyday language; and (d) by encouraging autonomous work. The workshops also addressed specific aspects of the use of teaching strategies, and participants were required to write a report in which they gave an overall assessment of the experience. In order to guide teachers through the design of their teaching unit (the initial task in Stage 3 of the programme) we set up a system of online tutorials and support which provided them with relevant documentation.

Stage 3. In Stage 3, teachers designed their teaching units and implemented them in the classroom. After a certain time, a face-to-face 3-hours session was held with the trainers in which participants discussed their impressions.

Stage 4. In Stage 4, the reports on the teaching units and their implementation were pooled and discussed in a 3-hours session, and an overall evaluation of the activity was made.

The programme was led by a training team composed of five members of the research team, who all had extensive teaching experience in secondary schools and also in initial and in-service teacher training. The team worked together in a coordinated fashion from the beginning of the design of the programme, applying a collaborative advice model (Sánchez & García, 2005) to encourage participants to apply the methodological approaches discussed during the training programme in their teaching. In Stage 3 of the programme, each member of the training team took charge of two or three of the participating teachers, conducting online and face-to-face tasks with them and providing tutoring and follow-up regarding the design and implementation of the teaching units.

Methods

In order to capture the diversity of experiences among teachers on the training programme the present study uses a qualitative and interpretative methodology based on a case study approach (Paige, Zeegers, Lloyd, & Roetman, 2016). From the researcher's perspective, this methodology makes it possible to carry out a more qualitative analysis, to detect differences in individual points of view, to make comparisons, and to obtain an overall group view of the study topic (Callaghan, 2005). By analysing the difficulties that teachers may face when carrying out their professional role (Coenders et al., 2010; Jeanpierre et al., 2005) they are given the opportunity to reflect on and make explicit their own practical knowledge (Solís, Porlán, & Rivero, 2012). In the present study we paid particular attention to the debate that emerged during a focus group (Bloor, Frankland, Thomas, & Robson, 2001), analysing and evaluating individual priorities (which at times converged, but were sometimes opposed), as well as other elements that derived from the comparison of the different group members' comments (Osborne & Dillon, 2008).

Participants

The study included a representative sample of the teachers who took part in the training programme. In selecting participants we took into account aspects such as how long they had been teaching, their previous experience in the design of teaching materials, and any prior involvement in educational research or innovation programmes. The teachers chosen for the focus group were 4 of the 19 who had taken part in the training programme in 2011; they had all completed the programme tasks and had developed and applied their own teaching unit in the classroom. The professional profiles of the four teachers, as well as outlines of their proposed teaching units, are shown in Table 2.

This was a convenience sample in which the teachers participated in the research on a voluntary basis. They authorised the researchers to observe their classes and to interview them, and to use the reports and other teaching materials they designed during the training programme for the purposes of the research. Of course these teachers are not representative of all secondary school science teachers, and this might be considered a limitation of the study; however, they are representative of a sector of the teaching staff who show interest in their training and in taking on the challenges of reforming school science curricula (Ministry of Education, 2006).

Data collection

The data collection process is outlined in Figure 2.

The following instruments and procedures were used:

Initial questionnaire. The aim of the questionnaire was to record the teachers' views on the teaching and learning of scientific competence, and on the context-based approach to the teaching of the sciences, prior to the start of the study. It was also designed to record their experience in the design of teaching materials and in the management of Information and Communication Technology.

Observation of participants. The aim of this procedure was to get to know the participating teachers during Stages 1 and 2 of the course in order to select the sample for the investigation. In each session a member of the training team carried out the observation in accordance with a set of previous common guidelines.

Individual interviews. Two semi-structured interviews were conducted individually with the four teachers selected. Protocols were developed for the interviews, which were

Table 2. Professional profile of the participating teachers and an outline of their respective teaching units.

Teacher	Academic qualifications and teaching and professional experience	Proposed teaching unit
1	■ Degree in Chemistry. ■ First year as teacher of Physics and Chemistry. ■ No experience of designing teaching resources or involvement in initiatives aimed at promoting innovation in education.	■ Title: Healthy eating. ■ Grade: 9th. ■ Age of students: 14–15 years. ■ Subject: Physics and Chemistry.
2	■ Degree in Chemistry. ■ Teacher of Mathematics, with 5 years' teaching experience. ■ Experience of developing teaching resources. Participation in training activities on key competences.	■ Title: Everyday substances in the home. ■ Grade: 7th. ■ Age of students: 12–13 years. ■ Subject: Natural Sciences.
3	■ Degree in Chemistry. ■ Teacher of Physics and Chemistry, with 8 years' teaching experience. ■ Little prior experience of designing teaching resources, but keen to innovate.	■ Title: Use of cleaning products in the home. ■ Grade: 10th. ■ Age of students: 15–16 years. ■ Subject: Physics and Chemistry.
4	■ Degree in Biology. ■ Teacher of Biology and Geology, with more than 15 years' teaching experience. ■ Extensive experience of developing teaching resources and participation in educational innovation initiatives.	■ Title: Health and our environment. The air and substances that pollute it. ■ Grade: 9th. ■ Age of students: 14–15 years. ■ Subject: Biology and Geology.

	TRAINING PROGRAM				POST-TRAINING PROGRAM
	STAGE 1	STAGE 2	STAGE 3	STAGE 4	
RESEARCH INSTRUMENTS & PROCEDURES	Observation of participants Initial questionnaire	Observation of participants 1st interview	2nd interview Classroom observation	Observation of participants Reports by trainers	Focus group

Figure 2. Data collection tools used in the study.

audiotaped. The first interviews were performed just before the teachers began the design and practical application of their teaching unit (Stage 3). The aim was firstly to ascertain the teachers' views on the aspects discussed in Stages 1 and 2, and secondly to detect any difficulties the teachers might have regarding the work required in the design, implementation and evaluation of their teaching units. The second interview took place at the end of the online phase, before the final session of the training programme (Stage 4). The aim of this interview was to record the teachers' opinions of the experience, the possible obstacles and difficulties they encountered in implementing and evaluating their teaching units, and their assessments of the training programme as a whole and of its impact on their teaching.

Classroom observations. These observations were carried out in some of the classroom sessions in which the teaching units were taught. A set of guidelines was drawn up to help observers to focus on specific aspects of the experience and then to systematise their observations at a later date.

Trainers' reports. Trainers used the information collected with these activities to write a report on each of the participating teachers. These reports aimed to document as accurately as possible the changes in the teachers' opinions of the training programme as it progressed, and also their level of motivation.

Focus group. After completing the training programme the four teachers took part in a focus group. The participants in a focus group discuss and share their experiences of the topic in question, and acquire both theoretical and practical knowledge through this comparing and contrasting of opinion (Barbour, 2013). The session lasted 3 hours and was recorded on video. A member of the research team who had not been involved in the training programme acted as the moderator. The participants were encouraged to share their ideas and opinions through a series of prompt questions about scientific competences, their classroom practice, contexts, the design of teaching units, and the implication of the training they had received for their work as teachers. The moderator was at liberty to ask complementary questions if this seemed necessary in order to clarify or explore an issue in greater depth. After the session, all the interventions were transcribed verbatim.

Data analysis

The views and opinions of the teachers were explored by analysing their individual contributions. Specifically, we considered the teachers' conceptions, beliefs, perceptions, and descriptions of their role and the meaning they ascribed to teaching, learning, and assessment. We considered aspects related to their professional identity, to the functions they believed a teacher should perform, and to the influence that the institutional context can have on these functions.

In analysing the transcript of the interviews and the focus group as well as the written reports (Figure 2), the statements which were regarded as significant with respect to the research questions (termed 'units of meaning') were coded into categories. This was done by means of an inductive approach, frequently used in the health and social sciences (Thomas, 2006). Among the different instruments of analysis available, we opted to use the specialist software package AQUAD (Vázquez-Bernal, Jiménez-Pérez & Mellado, 2007), which enables rapid coding of large quantities of text-based data.

The coding process began with a detailed reading of the documents and the identification of units of meaning. Here, we followed the general guidelines for quantitative coding: (a) a segment of text may be coded in more than one category; and (b) it may be the case that a large amount of text is not assigned to any category as it is deemed not relevant to the research objectives. A code was assigned to each one of the units of meaning thus identified.

After several rounds of discussion among members of the research team (the present authors) a total of five areas were defined and labelled as follows: scientific competences and context-based teaching; the teacher and his/her professional environment; implementation in the classroom; developing teaching units; and assessment. These areas included at least two categories referring to more specific aspects, which were identified by means of a code. The combined set of areas and categories constitutes a framework for analysing teachers' views and opinions on scientific competences and context-based teaching. The meaning of the categories and codes identified is summarised in Table 3. The analysis of the results includes comments from the teachers, in which it is indicated whether the comment referred to an aspect that was seen as facilitating (F) or as an obstacle (O) to the development of scientific competences through context-based teaching.

In order to validate this framework, each member of the research team analysed independently a representative percentage of the units of meaning, chosen at random. The level of agreement in categorisation among the three researchers was above 85%.

Results

The results are presented in two broad sections. The first section presents an analysis of the most salient aspects mentioned by each of the participating teachers in each phase of the training programme. In the second section, we analyse the most important evidences obtained from the focus group.

Teachers' opinions over the course of the programme

Stage 1. Scientific competences & context-based teaching

Teacher 1. At the beginning of the programme, Teacher 1 said that he valued the exchange of views with other teachers regarding scientific competence, and the opportunity to put these views into practice. His main concern was to do with the difficulty of transferring useful teaching proposals to the classroom setting in order to promote the learning of

Table 3. Definitions of the category codes included in the areas.

Area	Category code	Definition
Scientific competences and context-based teaching	COMP	How teachers see the concept of scientific competence, the way in which it is defined in the Spanish curriculum, and how it relates to the teaching of science
	CONT	Implications of a context-based approach to teaching
	UTIL	Relationship between what is learnt and its utility
The teacher and his/her professional environment	ITEA	Teachers' ideas and beliefs about teaching
	COOR	Relationships with colleagues at work
	ESPA	The influence that the education system and parents have on teachers
Implementation in the classroom	TSTR	Use of teaching strategies
	DYNA	Classroom dynamics
Developing teaching units	DETU	Design of the proposed teaching unit
	EVDE	Evaluating the design
	CONS	Consistency between the curriculum and design
Assessment	ALEA	Assessment of students' learning
	AAPP	Assessment of implementation
	CRIT	Criteria and instruments for assessing learning

effective knowledge [DETU, O]. At the beginning of the programme he was not familiar with the context-based approach [CONT, O] (Initial Questionnaire).

Teacher 2. At the beginning of the programme she emphasised her interest in attracting students' attention and increasing their motivation. She considered that the competence-based approach of science education can help to achieve this:

> … [I'm interested in] ways of attracting students' attention and in raising their motivation to learn science. In my experience, today's science books don't motivate students, it's just the same thing over and over again, and they find it very boring […] [we need to find] something that's closer to them, to their context, a center of interest, like this competence-based teaching … [COMP, F] [CONT, F]. (Initial Questionnaire).

Teacher 3. Teacher 3 began the programme with high expectations and a strong desire to learn how to develop the competence-based approach in the classroom and to share her experiences: 'so that the children can acquire scientific competences, [I'm keen to learn about] the different ways this approach can be applied in the classroom … ' [COMP, O] [TSTR, O] (Initial Questionnaire).

Teacher 4. Teacher 4 considered it very important to work on the 'classroom atmosphere' [DYNA, F]. He said that he used a methodology based on constructivism, at both individual and group level, generating a 'real context' within the classroom (in the sense of using the available information and involvement in real tasks) and negotiating the contents with the students [TSTR, F]. He was familiar with the use of everyday contexts in teaching and regarded it as a good way to encourage students to identify everyday problems: 'If we present learning in relation to an issue that is relevant to the student's environment, to the present moment, to the world we live in, they're more likely to be aware of its importance' [CONT, F] [UTIL, F] (Initial Questionnaire).

Stage 2. Training in preparing the design

Teacher 1. After hearing the talk by the expert on the context-based approach, Teacher 1 expressed the view that this approach would help to bring science nearer to his students: 'I believe that bringing scientific knowledge closer to the context of their daily lives will help

… The idea is that they should realise that developing scientific competence will be of value to them in their everyday lives' [CONT, F] (1st interview). He also mentioned difficulties in designing his teaching unit: 'What kind of aspects are being evaluated in the questions?'; 'What format should the questions [Authors' note: the questions in the teaching units] have?' [DETU, O], but he was impressed by the results:

> Although I've had difficulty designing questions, the structure provided was useful as a guide, and gave me a sequence for my teaching unit … in fact the sequence of the teaching is much better defined than it was in last year's course [DETU, F]. (1st interview)

Teacher 2. Teacher 2 also valued the context-based approach positively: 'It helps you to analyze the centers of interest and draw attention to specific scientific issues that emerge from the context' [CONT, F]; she felt quite confident about using it: 'I feel that I can put it into practice, although the way I do it may not be the way it was presented to us … ' [DETU, F] (1st interview). She stressed difficulties with regard to planning: 'One of the difficulties of planning competence-based work is how to combine the learning objectives proposed and the evaluation criteria' [CONS, O] (1st interview).

Teacher 3. Teacher 3 valued the contributions of the scientific competence approach in the overall student development, stressing that 'it promotes a global vision and the ability to analyse it [knowledge]. Its most important contribution, I think, is the capacity for analysis and synthesis' [COMP, F] (1st Interview). However, she was not entirely sure about how to apply it in the classroom: 'I'd like to hear how other colleagues work in the classroom to ensure that their students acquire scientific competences' [DETU, O] (1st Interview).

Teacher 4. Teacher 4 questioned the kind of methodological strategies used in the teaching presented as examples: 'Do they pool their ideas?', or with regard to the construction of contents: 'Wouldn't it be better if we didn't present the content in a pre-packaged form – shouldn't we encourage students to carry out "small-scale investigations"' [DETU, O] (Observation of participants). He highlighted the value of the content as an important motivational factor: 'I think that functional learning, if students feel that what they are learning is useful, also serves as a motivation' [UTIL, F] (1st Interview).

Stage 3. Design, implementation & assessment

Teacher 1. Teacher 1 remained doubtful about the ability of the methodological strategies to pose questions that engage students' interest (as this approach requires): 'In general, students found it difficult to perform tasks using this approach, and the learning outcomes were poor' [ALEA, O] [AAPP, O]. With regard to the planning, he stated that 'there should be a greater variety of strategies for the design and implementation of activities related to the development of competences' [EVDE, O] (2nd interview).

Teacher 2. Teacher 2 valued certain features of the scientific competence approach such as its ability to 'arouse curiosity in the students and encourage them to think about why things happen' [COMP, F]. She felt that her teaching unit was able to attract the attention and interest of her students: 'You should always start with contexts that are familiar to the students. This was the key to getting their attention in class' [CONT, F]. However, she stressed the difficulties facing both students and teachers and the need to adapt to this new approach to study and assessment:

> I think that both they and I have to get used to this approach [...] they have problems because they're not accustomed to working in this way, and I'm not accustomed to this form of assessing and correcting them either [AAPP, O] [ALEA, O]. (2nd interview)

Teacher 3. After the implementation, Teacher 3 noted the strengths of the teaching of scientific competence and the context-based approach:

> The examples provided really help to foster contextualization in the experiences of daily life. And once put into practice, the context and the sequence of teaching both take on a fundamental role; students feel that what they are learning will be useful when they leave school [CONT, F] [EVDE, F] [UTIL, F]. (2nd interview)

However, she was also a little unsure about her implementation of the unit: 'I would have needed more time to think through my unit' [DETU, O] and she mentioned the need to share the work with other colleagues at her school: 'You need to talk to your colleagues about the content that's important, which materials should be included and which shouldn't; these points aren't mentioned at the departmental meetings or in the curriculum design' [DETU, O] [COOR, O] (2nd interview). However, she was satisfied with her involvement in the project in the classroom, because it aroused interest among her students and helped to create a new dynamic:

> The problem with my classes is that some of the pupils get bored if I use the usual style of teaching. They seem to think that their lives and what I tell them have nothing to do with each other. The context-based approach can help them to understand that they are surrounded by many of these things, but at the moment they aren't aware of them [TSTR, F].

She confirmed that the system was motivating: 'They are more motivated now. Obviously the students who normally work hard have continued to do so. But I've found that a part of students who didn't usually apply themselves are more motivated now' [DYNA, F] (2nd Interview).

Teacher 4. With regard to the implementation, Teacher 4 noted the difficulties of adapting the official curriculum to the profile of the students: 'You have to find a balance between the curriculum and what is really relevant to the lives of the students' [CONS, O] (2nd interview). He expressed clear views on the appropriate methodological strategies: 'I think that organizing the teaching units as an investigation makes the experience richer – there are already many teachers who do this, and I think it has a much more comprehensive effect on the development of scientific competence' [TSTR, F] (2nd interview).

Stage 4. Exchange of views and opinions

Teacher 1. Teacher 1 highlighted the difficulties that the competence-based approach might cause with regard to planning: 'One of the difficulties associated is to articulate this approach coherently with the teaching objectives proposed and, the evaluation criteria' [CONS, O] and with regard to assessment: 'The students were involved and had fun, but [...] I'm not sure that they learned all that they were expected to learn ... .' [ALEA, O] (Observation of participants).

Teacher 2. Teacher 2 stressed the difficulties of applying this new system, but also the noted the motivation she saw in her students: 'They aren't used to working in this way [AAPP, O] but they were all very motivated' [DYNA, F] (Trainer's report). She also spoke positively of the classroom dynamic and its relationship to learning: 'I try to provide guidance so that they can become the protagonists of the learning process, and realise that they themselves are constructing their learning' [DYNA, F] (Trainer's report).

Teacher 3. Teacher 3 valued the new teaching strategies positively, stressing the increase in motivation: 'They find it interesting, the classes are more accessible; They feel more involved'[TSTR, F] but also noted the difficulty of achieving a global vision among the students: 'This approach may prevent them from obtaining a global vision […] from extracting the fundamental idea from the context, I think they find this very hard' [CONT, O] (Observation of participants). She expressed satisfaction with the training received and considered that it formed part of her professional development: 'Taking part in this project has helped me to teach the key competences. […] but I still have a great deal to learn' [ITEA, F].

> This context-based approach is a challenge in the classroom. […] The teaching of scientific competence should aim to be useful, to explain the world around the student [UTIL, F]. […] We lack training on how to teach the class, we learn from trial and error, we only know if we got it right when we see our students' results [TSTR, O].

Teacher 4. As achievements, Teacher 4 highlighted the following aspects of the process in the classroom: 'In evaluating the functioning of the group and the subsequent pooling of ideas, the students clearly enjoy working in this way and believe that they are learning' [UTIL, F]. However, the degree of learning achieved by the students may not be so satisfactory: 'The experience is worthwhile, although the results of the examination nay not reflect this; the positive side is seen in the students' attitudes, in the way they present their ideas … ' [ALEA, O] (Observation of participants). Teacher 4′s assessment of the methodological strategies for constructing learning was positive:

> This approach raises the level of the work carried out in the classroom and teaching-learning processes. In my case, I base my classroom organization on forms of cooperative work and strategies for enhancing autonomy in the acquisition of learning [TSTR, F]. (Trainer's report)

Focus group

Table 4 shows the frequencies with which the four teachers in the focus group referred to each of the defined categories. Below we present an overview of the results obtained in the five areas and their corresponding categories, followed by a more detailed analysis of the key categories that emerged in the focus group. This analysis focuses solely on the categories that met both of the following two criteria: (a) they accounted for at least 10% of the units of meaning identified, and (b) all four of the participating teachers referred to these issues at some point during the focus group. The categories that met these criteria were ITEA, COMP, CONT, COOR and UTIL. For these categories we analysed the views and opinions expressed by individual teachers in greater detail; in what follows we illustrate each of the five categories with verbatim statements made during the focus group discussion.

Overall, the results show an uneven distribution of percentages across the five areas. Specifically, the areas labelled 'scientific competences and context-based teaching' and 'the teacher and his/her professional environment' together accounted for more than

Table 4. Frequency of the units of meaning by area and by category in the focus group.

Areas	Category code	Facilitates / Obstacles	Absolute frequency per teacher T1	T2	T3	T4	Total	Absolute frequency by categories	(%)	Relative frequency by areas
Scientific competences and context-based teaching	COMP	F	6	1	8	4	19	27	13.2	37.1
		O	2	1	2	3	8			
	CONT	F	5	3	6	4	18	27	13.2	
		O	1	0	5	3	9			
	UTIL	F	1	1	12	5	19	22	10.7	
		O	1	0	1	1	3			
The teacher and his/her professional environment	ITEA	F	4	3	6	8	21	39	19.0	36.6
		O	1	1	12	4	18			
	COOR	F	2	2	5	2	11	25	12.2	
		O	4	1	5	4	14			
	ESPA	F	0	0	0	0	0	11	5.4	
		O	2	1	5	3	11			
Implementation in the classroom	TSTR	F	2	3	1	5	11	17	8.3	11.7
		O	0	0	3	3	6			
	DYNA	F	1	1	1	2	5	7	3.4	
		O	0	0	1	1	2			
Developing teaching units	DETU	F	0	1	0	2	3	9	4.4	8.4
		O	2	0	3	1	6			
	EVDE	F	1	0	2	0	3	6	3.0	
		O	1	0	1	1	3			
	CONS	F	0	0	0	1	1	2	1.0	
		O	0	0	1	0	1			
Assessment	ALEA	F	0	0	2	1	3	9	4.4	6.3
		O	1	0	3	2	6			
	AAPP	F	0	0	1	1	2	3	1.4	
		O	0	0	1	0	1			
	CRIT	F	0	0	0	0	0	1	0.5	
		O	1	0	0	0	1			
Total		F	22	15	44	35	116	205	100.0	100.0
		O	16	4	43	26	89			

two-thirds of the total, and their respective percentages of 37.1% and 36.6% were much higher than those of the other three areas. We will now consider each area separately.

Scientific competences and context-based teaching

This area comprised three categories, in which very similar results appeared. Together these categories accounted for a considerable number (37.1%) of the comments made by teachers in the focus group. The majority of the aspects referred to under the three categories were seen as facilitating the development of scientific competences.

Scientific competences (COMP). The four teachers dedicated a considerable amount of time to this issue (13.2% of the identified units of meaning). A clear understanding or definition of what a competence is and of how it might be applied in practice was generally regarded as playing a facilitating role, especially by Teachers 1 and 3, the ones with less experience of developing teaching resources or of educational innovation initiatives. This facilitating role was related to the fact that achieving a good level in the development of a given key competence implies that all the other competences will also have been worked on to varying extents (an idea also captured under the CONT category). The teachers believed that a competence-based approach encouraged students to draw upon and make use of the knowledge they had acquired in real-life contexts (a view that was also reflected in the UTIL category).

> Teacher 3: And I think that this is what scientific competences are aimed at, it's so that they can see the utility of what they're learning […] but not something that will be useful when they're adults, for their job, but right now, on a daily basis.

The more experienced teachers (3 and 4) considered the use of contexts to develop competences to be a valid approach, but not more so than others.

> Teacher 4: Working from contexts seems to me to be important, but there's more to it. Organizing teaching units like a piece of research […] using the method of project work […] that seems to me to be much richer and a more comprehensive way of addressing scientific competence. It's not just about starting from a problem that young people can recognize in their everyday life.

Context-based teaching (CONT). The comments linked to this category (13.2% of the units of meaning identified) illustrated that the teachers saw it as facilitating the development of competences, since the contextualisation of curricular content enabled students to adopt a positive attitude towards science, participating actively and more independently in the learning process than is the case with more traditional teaching methods.

> Teacher 1: I think that what you're referring to is that students can discover things; more than about investigating, it's about discovery. And that's not necessarily the same thing. They discover things and learn on their own, and it's different from the typical kinds of investigation, because you're giving them the tools with which to discover things gradually, to build their knowledge, and that's really interesting.

The more experienced teachers (3 and 4) also highlighted a series of potential obstacles under this category: the difficulty of linking certain aspects of content to contexts; the possibility that students fail to achieve an optimum level of competence; and the risk that teachers may end up applying traditional methods when working with a novel approach (which would undermine its teaching and learning potential).

> Teacher 4: The idea of starting from a context is a good one […] you build your teaching unit from here, but then in the classroom you approach it in the same way as if you were using a textbook. So, if this new approach isn't accompanied by some kind of method then we're not really doing anything differently, there isn't really any change in how we're teaching competences, whether scientific or others.

The adoption of an approach or method with which students are unfamiliar may also lead them to reject it if it's only used occasionally rather than consistently in the classroom.

> Teacher 1: It's all or nothing. I'm already thinking that next year I either have to work like this from day one or not at all, because slipping in the odd unit like this just unsettles the students. So either you use contexts to develop competences or you don't, but what you can't do is have a different approach just floating around somewhere in the middle.

Relationship between what is learnt and its utility (UTIL). Almost all the comments gathered under this category (10.7% of the units of meaning identified) suggested that a context-based approach like the one presented in our training programme could facilitate the development of scientific competences. Together with ESPA, this was the category that most polarised opinion, although in this case in favour of a facilitating role. During the focus group discussion, teacher 3 made 12 comments in favour of a context-based approach, many more than any other group member; this was consistent with her contributions in general, which frequently expressed her concern to ensure that the knowledge students acquired was applicable to real-life problems (as well as the positive feedback effect this had on her own development as a teacher).

> Teacher 3: The teaching of competences should aim to make sure that the scientific knowledge students acquire is useful for explaining real life. That's the heart of the matter, that students will know later how to apply the knowledge that we teach them, which otherwise they see as just theoretical.

A potential obstacle in this regard was that the proposed learning goals might not be achieved, which would mean that the teaching objectives were not met either.

> Teacher 4: Teachers, too, sometimes have this ridiculous idea. They need to feel reassured that they've done their bit because they've covered the whole subject, but of course, that doesn't mean that the students have taken it all in or that they've understood it properly.

The teacher and his/her professional environment

The considerable number of units of meaning (36.6%) that corresponded to this area highlights the importance that personal and professional factors play in relation to educational change (Anderson & Helms, 2001; Donnelly, 2000; Ryder, 2015; Ryder & Banner, 2013). The comments made by our participants referred particularly to the categories ITEA (19.0%) and COOR (12.2%), and the ideas expressed reflected both potential facilitators of change and obstacles to it. Although the category ESPA emerged less often (5.4%), it is noteworthy that the aspects mentioned were always regarded as obstacles.

Teachers' ideas/beliefs about teaching (ITEA). This was the most frequent category to emerge in our analysis (19% of the identified units of meaning) and various aspects of this issue were referred to during the focus group. The more experienced teachers (3 and 4) alluded to the potentially facilitating role of competence-based teaching, since it implicitly encourages a greater degree of reflection.

> Teacher 3: I've taught students and we've spent the year working our way through the textbook, from start to finish, and by the time they move up a year, they've forgotten everything. And that's when you realize that this isn't the way to go about things.

However, when weighing up the pros and cons of new approaches to teaching, this same teacher also made numerous references to the obstacles that had to be overcome – for instance, the fact that some teachers may prefer to carry on as before. By contrast, the less experienced teachers (1 and 2) were more likely to favour change.

> Teacher 2: I've come to realize that this is the way forward, and that [...] the competence-based approach will gradually become the norm, at least in secondary education. In my school, we've spent a lot of time discussing what should or shouldn't be treated as basic content, what we should teach.

The lack of critical self-reflection and its repercussions for the evaluation of teaching practice, as well as the sense of unease that some colleagues may feel when a teacher seeks to do things differently (an issue also captured under the COOR category), also appeared as obstacles to change.

Teacher 2: In my mathematics department there's a lot of tension with those people who don't even know what a competence is and see it as just a new fad […] they're not interested in moving forward, they don't want to change.

Relationship with colleagues at work (COOR). The comments gathered under this category (12.2% of the units of meaning identified) drew attention to several aspects, both facilitators of, and obstacles to, the use of a context-based approach to the development of scientific competences. The participants' view was that an overall competence-based approach to teaching required close and flexible coordination among a school's teaching staff and departments in order to optimise the classroom time dedicated to the teaching of different contents (an aspect that was also captured by the ESPA category).

Teacher 3: We shouldn't be afraid of using in a language class a text about, for example, nuclear power plants, looking at whether they're a good thing, pollution, whether the energy they produce is cost effective, a text for discussion, and it can be studied from the linguistic angle but at the same time they're learning about science.

In terms of facilitating aspects, the teachers referred to how content could be selected and ordered into a logical sequence that was consistent with the students' learning needs while avoiding unnecessary overlap and repetition across different subjects.

Teacher 2: In my school we've spent a lot of time discussing what should or shouldn't be treated as basic content, what we should teach. I think right now we're at a crossroads, starting to think about whether we should only teach useful things, about whether or not all the curricular content is important.

An issue already mentioned above, namely that students can become unsettled if a different approach is used only occasionally, was regarded as an obstacle because it often led the more reticent teachers to be critical or unsupportive of their more innovative colleagues.

Teacher 4: When you try to do things differently it can cause small conflicts or provoke a degree of criticism, people see the drawbacks […] and sometimes there'll be a bit of a backlash against what you're doing.

Teacher 3, who was keen to innovate, agreed with the above point made by teacher 4 regarding potential obstacles, but she also felt that coordination amongst staff was necessary and productive, and that in that sense it could facilitate change. Similar to the more experienced teacher 4, teacher 1 also highlighted the gap existing between official guidelines and what teachers actually do in practice.

Teacher 1: Just as my unit has been like an island in the middle of the ocean, I've been an island amidst my colleagues, because everybody does their own thing, and whenever I've mentioned what I've done, their response is, that's all well and good but come next week you'll have forgotten it. That's the general feeling.

This view is consistent with the findings of other studies that have examined the interaction between personal factors and factors internal to the school's functioning, especially as regards working practices in science departments (Ryder, 2015).

Implementation in the classroom

This area, which accounted for 11.7% of the units of meaning identified by our analysis, includes the categories 'use of teaching strategies' (TSTR: 8.3%) and 'classroom dynamics' (DYNA: 3.4%). The aspects referred to under both these categories were more likely to be seen as playing a facilitating role with regard to meeting the objectives of a context-based science teaching unit.

Developing teaching units

This area, which accounted for 8.4% of the units of meaning, comprised three categories: 'Design of the proposed teaching unit' (DETU: 4.4%), which emerged more as an obstacle; 'evaluating the design' (EVDE: 3.0%), a factor that was seen as both a potential facilitator of, and an obstacle to, the context-based teaching of scientific competences; and the extent to which the content of a proposed teaching unit was 'consistent with the curriculum' (CONS), a category that had only a minimal presence (1.0%) in the focus group discussion.

Assessment

This area, which accounted for 6.3% of the units of meaning, includes the category referring to 'assessment of students' learning' (ALEA; 4.4%), as well as two categories with a much more limited presence: 'criteria and instruments for assessing learning' (CRIT; 0.5%) and 'assessment of practical application' (AAPP; 1.4%). The low percentages observed for all these categories indicates that this area did not feature much in the teachers' exchange of views, despite the importance that assessment has for the process of teaching and learning. The minimal attention paid to this aspect may be due to the fact that it was not a central topic in the training programme that the teachers had just completed prior to the focus group, and consequently they focused on more general issues.

Conclusions and implications

This study analysed the views and opinions of four secondary school science teachers regarding the aspects which may facilitate or pose an obstacle to the use of context-based teaching for developing students' scientific competences. The use of different instruments for recording data enabled us to gather a wide range of opinions regarding the topic of interest, which we then organised into fourteen categories distributed across five areas.

The four teachers emphasised the utility of what the students learnt (UTIL), especially the veterans (teachers 3 and 4). All agreed with the need to develop scientific competences (COMP) in students, especially teachers 1 and 3. It was also widely agreed that the approach allowed them to deploy different teaching strategies (TSTRE), improve classroom dynamics (DYNA) and favour student motivation. These majority views were qualified with respect to the context-based teaching approach (CONT). On this point the less experienced teachers (teachers 1 and 2) were clearly in favour, but the veteran teachers expressed reservations for several reasons: Teacher 3 mentioned her hesitance to change her usual practices and adopt this approach in the classroom, and from the outset teacher 4 expressed a clear preference for an investigation-based approach, which he claimed was better suited to achieving the objectives than the examples shown in the training programme.

In general, the teachers considered that the application of a context-based approach to developing scientific competences was influenced by two broad sets of factors:

(a) Factors related to their professional identity, in terms of both personal beliefs and their relationship with the internal (school level) and external (systemic) professional environment.
(b) Factors related to their professional development and the task of designing, implementing, and assessing teaching units. In this respect, it is important to remember that the introduction of key competences into the curriculum and the use of context-based science teaching both require a change of approach by teachers.

The results obtained are consistent with previous studies that have examined the difficulties and obstacles that teachers face in relation to externally driven science curriculum reform (Ryder, 2015). If we look more specifically at the degree of emphasis that our group of teachers placed on each of the categories identified in our analysis, the following aspects emerge as being particularly relevant:

The possible impact of teachers' ideas and beliefs about science, and how it should be taught, on processes of reform and innovation (Witz & Lee, 2009). These personal ideas, which are a key element of professional identity, may either facilitate or act as an obstacle to change, depending on how they relate to the new proposals. Three of the four teachers (T1, T2 and T4) believed that their ideas about science teaching were consistent with those presented in the training programme on scientific competences and the use of context-based teaching. Thus, they considered that an approach of this kind could foster students' engagement with science and help them to see the utility of what they were being taught.

Teachers' views about their professional and social context may act as obstacles, leading to a rejection of change among colleagues and wariness on the part of parents regarding the potential repercussions of a new approach for their children's academic achievement. A more detailed examination of the teachers' comments in this regard revealed a number of possible reasons for this reticence. On the one hand, they believed that the communication gap between teachers and educational authorities hindered discussion of students' educational needs and meant that teachers were invariably reluctant to implement models imposed in a top-down fashion. In addition, they felt that the new legislation did not make clear how competences should be integrated within the curriculum as a whole. They also considered that the educational system did not encourage effective coordination across departments teaching common content, and as a result the amount of time dedicated to teaching this content was poorly managed. A further point was that the lack of available information regarding these new approaches to education meant that their introduction often provoked wariness among parents (and in many teachers as well) due to the potential repercussions for students' academic future.

Given the small sample size, the willingness to receive training in new teaching approaches that we observed among our teachers cannot be directly extrapolated to science teachers in general. With this proviso in mind, we agree with Paige et al. (2016) that the results of studies like this one have a number of notable implications for the following areas:

For the curriculum. Our analysis suggests that the way in which curricular content is organised sequentially needs to be better thought out and agreed upon by planners and teachers so as to ensure that what students learn is of functional and practical value. Teachers would like to see a logical sequence of content, both transversally – across the same educational level – and longitudinally, throughout a given educational stage.

For teacher training. Some of our teachers' comments highlight that the design and implementation of new teaching approaches aiming to develop the competences required in today's society is something that demands ongoing in-service training. This is so both at the individual level (to make sure that the teachers who apply these approaches do not become isolated figures within their own department) and in the wider school context, where a change in attitudes is likely to be needed for the successful implementation of these projects.

For communication with parents and society in general. The education of young people requires a fluid relationship between the three key stakeholders, that is, educational institutions, teachers, and parents. It is important to ensure that the latter understand (1) the reasons for a given educational reform, (2) the goals that are being sought in terms of children's future roles in society, and (3) the teaching methods and approaches that will be used in the attempt to achieve these goals. In this way, it will be possible to address parents' concerns about the potential repercussions of change.

For future research. In this respect we believe it would be useful to examine in greater depth the ideas and opinions of our four teachers, exploring possible associations between the comments made and their professional profiles. In particular, it would be interesting to identify the ideas that serve as the starting point for a given line of argument, as well as the nature of these ideas and which teachers are putting them forward. It would also be helpful to build on the present results by exploring the same issues in samples of science teachers who have not undergone specific training in the use of the context-based approach, in order to allow comparisons with the opinions expressed in our study.

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