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CARLOS FURIÓ & AMPARO VILCHES, *Departament de Didàctica de les Ciències Experimentals i Socials. Universitat de València, Valencia (Spain).*

JENARO GUIASOLA, *Departamento de Física Aplicada I. Universidad del País Vasco, San Sebastián (Spain).*

VICTOR ROMO, *Escuela Preparatoria, Universidad de Zacatecas, Zacatecas (México).*

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Contact Adress:

Jenaro Guisasola

Escuela Universitaria de Ingeniería Técnica Industrial

Departamento de Física Aplicada I

Avenida Felipe IV - 1

San Sebastián 20011

Spain

E-mail: wupguarj@sp.ehu.es

Tel: (34) 943 45 50 22

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ABSTRACT: The purpose of this work is to find out teachers' opinions regarding the goals and objectives of the teaching of science, within the frame of educational reform. We attempt to disclose to what extent educational thinking gives priority to the training of the students in scientific concepts, laws and theories needed in further courses (propedeutic training) and how this thinking pays less attention to the so-called scientific literacy which is meant to be the main object of the teaching of science according to the designers of the curriculum. To achieve this, we carried out a multiple and convergent experimental design with a number of samples of teachers. We found a confirmation that in secondary education, the curricular emphasis of teachers focuses on the propedeutic training of students.

Introduction

Many curricular reforms that have been taking place since the 1980's in scientific education within compulsory secondary education are targeted to the so-called scientific literacy of future citizens. As Hodson (1993) points out, in previous decades curricular concerns focused almost exclusively on acquiring scientific knowledge, in order to make students familiar with scientific theories, concepts and processes. However, in the eighties-nineties the trend has been changing so that now the curriculum must include issues that guide the teaching of science toward social and personal aspects of the student himself (National Research Council, 1996). Thus, it is along this line that are situated many of the new trends in science curricula, trends which are interrelated as well. Among many things we can point out those concerning the movement 'science, technology and society' and those that strive for 'science for all' or scientific and technological literacy for everybody as a core part of any citizen's basic training (Bybee, 1997; Solbes & Vilches, 1997; Laugksch 2000; Deboer 2000).

This scientific literacy would mean that most people have the necessary scientific and technological knowledge to get along in daily life, to contribute to the solution of basic problems and needs related to health and survival, to become aware of the

complex relationship between science and society that will enable them to take part in the decision making and, in short, to consider science as a part of the culture of our times (Furió & Vilches, 1997). Logically, the teaching of science must contribute to reaching these objectives by understanding the knowledge, procedures and values that enable students to take decisions and perceive both the utility of sciences and their applications to the improvement of citizens' quality of life on the one side, and the shortcomings and negative consequences of their development on the other.

Nevertheless, the fact that educational administrations propose curricular changes does not ensure that they will be applied in practice, however well grounded they be on results of education research. Actually, science education research itself (Cronin-Jones, 1991) has manifested the importance of the role of teachers in implanting the reform, as well as the need to involve teachers in the reform process if it is to be carried out conveniently (Lederman, 1992; Gil et al., 1998a). It is for this reason that it is important to know teachers' ideas concerning the goals of science in compulsory secondary education, so as to take them into account and to prevent them from deterring the achievement of the objectives of these reforms.

This article will focus on this core objective, that is, the attempt to identify physics and chemistry teachers' ideas about the reasons for instructing these subjects in compulsory secondary education and to determine to what extent there is a cognitive distance between this thinking and new scientific literacy objectives or 'science for all' that curricular reforms foster (Bell, 1998).

Our central work hypothesis will be the assumption that teachers teach physics and chemistry mainly in order to train students as if they were all to become physics or chemistry specialists in a near future. That is, teachers will be concerned about fulfilling such priority objectives as students' knowledge of concepts, principles and laws within these disciplines. Therefore, the basic goals of physics and chemistry education will focus on the scholarly training of future scientists (Pozo, 1997). However, according to new curricular trends, a terminal function of science instruction must also consider among its goals teaching sciences in order to prepare students for life, to achieve their scientific and technological literacy. We believe that this involves preparing future citizens so that they can acquire democratic values and become respectful and careful about the environment, within a type of education meant to achieve sustainable development in our planet. This way, we shall be contributing to their training in being able to make grounded decisions when it comes to facing environmental and social problems, to solv-

ing daily problems, to improving their self-esteem and autonomy as well as their critical interest in science.

Educational reforms and scientific literacy

As we said in the introduction, the reform of secondary education means an important change in the goals of scientific education. In the case of the Spanish reform, this change bumps into an obstacle, i.e. the academic tradition of science instruction in the so called “middle education”(12-18 year old).

In the Spanish Educational System previous to the 70's, both boys and girls were only taught four basic rules until they were 10 years old. From this age on, a minimum part of the school population (approximately 3%) went on to secondary education until they were 16. During this stage there were two global exams, one at the age of 14, which meant the end of lower secondary education, and one at the age of 16, which meant the end of higher secondary education. After succeeding in the latter they were allowed to go on to what was known as a pre-university year at the age of 17 /18, a course necessary to entering university. In 1970 was put into force an educational reform which generalised basic compulsory education until the age of 14. This education was called General Basic Education (EGB). In the mean time, Teachers' Training Schools, where teachers were trained to instruct pupils until they were 10 years old at first, and then after the reform until they were 14, became university schools. After finishing the EGB education, students could go on to BUP education (Polyvalent Unified Baccalaureate) for three years and then to the pre-university year which became COU (University Guidance Course) and which was in fact just another year to achieve Baccalaureate. Those students that did not pass the EGB certificate or those that had some difficulties in it were “punished”, (that was the social perception of it) and, had to continue their education in elementary vocational training or just left the school for good. As a consequence of this perception most students, about 80% , were preparing Baccalaureate in public or private high-schools.

In the 70's were set up within universities what were called Educational Sciences Institutes (ICE), to provide initial and permanent teachers' training. Initial teachers' training for secondary education teachers consists of a scientific university degree and a one-year Pedagogic Aptitude Course where they do one module in general psychopedagogy, one in specific didactic and a short practicum where teachers in training practise

in secondary education schools with actual teachers (Dumas-Carré et al., 1990). Throughout these years, the Spanish tradition concerning the goals of instruction in the various scientific disciplines was to prepare students for university. Science education was assigned one single basic function that was exclusively propedeutic, i.e. a function of preliminary studies for acquiring a scientific level or basis. And this has not only been the case in our country. Science education research has shown that this has been the main target in other countries as well (Hodson, 1993).

In the 90's, the educational reform proposed in our country is more in tune with advances in education research and means to eliminate discriminating barriers within the school population at the age of 14. So, it expands compulsory education to the age of 16 and states among the priorities of secondary scientific education the scientific and technological literacy of pupils (Membiela, 1997), thus calling into question the exclusively propedeutic function of science instruction in secondary education.

Why should we teach sciences in Secondary Compulsory Education?

Science education, and in particular scientific literacy for all, has become an urgent demand according to both experts' and politicians' general opinion (Gil et al., 1998b; Reid & Hodson, 1993). The USA administration, for instance, has acknowledged this and has made the effort for scientific education one of its main priorities as is stated from the very first page in the National Science Education Standards, supported by the National Research Council (1996).

In fact, the need for scientific literacy, that is the need to teach science for all in schools, constitutes one of the goals of physics, chemistry and natural sciences that has been pointed out in some countries that have been implementing educational reforms in recent years. In the case of the Spanish educational reform, general objectives of these sciences have been included, the aim being to make compulsory secondary education students understand the contribution these sciences have made and still make to the evolution of our society (rationalism, communication, agriculture, energy, medicines, new materials, machines, etc.), thus starting the analysis of the complex interactions among science, technology and society (Furió & Vilches, 1997). Another objective listed by the authors is getting to know the problems derived from an unplanned use of science: air-pollution, heating of the planet, using up of energetic resources, etc. so as to foster re-

spect and care for the environment as well as a rational management and use of existing resources.

All these aspects belong to conceptual contents and objectives of such disciplines in order to guarantee for all citizens, the technical and scientific knowledge needed to understand the growingly technified world. Procedural objectives and contents are also included so that pupils learn what is science and technology and how they work, and that they acquire skills enabling them to reason better and solve daily-life problems. We also propose attitudinal objectives and contents which aim at awakening students' interest in scientific activity, by developing a more critical interest in such activity and generating attitudes that enable them to assess the role science plays in our lives. In this way, the path is prepared for them to participate collectively, in future, in the solution to problems facing the society they belong to.

Sciences have crucially contributed to better knowing the origin of life and its preservation. Since all life processes happen because of chemical changes, the understanding of chemical reactivity makes it possible to understand life better and so it contributes to knowing issues that humanity has always worried about and that concern other fields of knowledge such as history or philosophy too. The contribution made by physics and chemistry throughout history to the understanding of the world, to the change in ideas, to the modification of the environment, to the progress of the world, gives sciences and their huge development and applications a crucial role in nowadays' culture, and its study will help to better understand the universe surrounding us as well as the place that corresponds to us in it.

It is important that people know that their quality of life and the increase of their life expectancy are directly attributable, among other reasons, to technological advances in sciences. But they must also know and consider some not so positive aspects, such as the fact that technological applications of some developments may have polluting effects on the environment, that the production of energy through the use of fossil fuels provokes the formation of air and water-polluting waste that pollutes living beings as well, that radioactive waste from nuclear stations will remain active for decades or that certain doses of some chemical products in the environment may be harmful for living beings. Evaluating the benefit of a particular application of chemistry or physics in relation to the risks its use generates has become an element common to countless decisions that affect us all. Some of these decisions are taken on our behalf by technicians or poli-

ticians. Others are decided by us through social movements or organisations or directly through voting.

Today, there is concern about polluting substances, additives, waste, by-products and in general, about any substance resulting from a chemical reaction taking place in a laboratory or as a consequence of a technological change. This fear is partly due to a lack of information, it is fear of the unknown. One has a feeling of powerlessness in what refers to the control of these substances and other technological products, as well as to their effect on the environment and on health, and then one does not trust those who produce, distribute or use it. Education should reduce this feeling of insecurity regarding science on the part of citizens, in such a way that it could contribute to an optimum balancing of risks and benefices, that we could enjoy the growing benefits of science and technology but guaranteeing at the same time the protection of health and the environment, by contributing through knowledge to the decision-making about developments and their consequences.

Every time decisions are taken, they should consider the global effects of problems on the living beings that live in the planet and the need to favour most of the population, and not just a part of it. Along with this, it seems that we are beginning to understand the seriousness of the problems facing humanity today as a consequence of a hugely accelerated social economical development ruled by private short-term interests which act irresponsibly as if the Earth's capacities were unlimited (Gil et al., 1998b). It will then be necessary to have a correct perception of the problems affecting the future of humanity if we are to make citizens' involvement in the decision-taking a possible thing. Scientists and educators share a critical responsibility in this field in order to provide information and the possibility to discuss about problems and possible solutions.

Therefore, scientific literacy will be necessary to contribute to forming citizens able to cope with a world like the one we have, citizens who know the important role science plays in their personal and professional lives and in our societies. These citizens need a training that enables them to reflect and make appropriate decisions about topics related to science and technology (Aikenhead, 1985; Bingle & Gaskell, 1994; Gil et al., 1991; Solbes & Vilches, 1997) thus contributing to the development of a critical awareness towards them, and showing both their potential and their limitations. It will be necessary to improve the scientific instruction of the overall population, starting it as soon as possible in schools, if we are to change the public image of science which today most people see as something remote, out of reach or dangerous, something to be

distrustful about sometimes, and for sure something that is not perceived as a part of the culture, contents and knowledge any well-instructed person must have. But science is a part of human culture, a result of the rational effort of many people, accumulated throughout generations in an attempt to answer the many questions humanity has always posed itself about the world surrounding us.

The implementation of curricular reforms requires the involvement of teachers

Nevertheless, the objectives and goals that teachers aim at in their instructional practice often disagree with the ones we have mentioned above. Science Education research has manifested the existence of marked differences between the objectives and goals aimed at by curriculum designers and what teachers really put into practice (Cronin-Jones, 1991). Some scholars justify this situation on the grounds of the little participation of teachers in reform processes and in the setting-up of the new curricula, usually elaborated following a "linear-expert" model (Mc Donald, 1975), consisting in a series of meetings of experts who elaborate the new curricula through the establishment of some general considerations accompanied with a series of contents in which they try to include the subjects they consider fundamental.

These differences between objectives pursued by curriculum designers and those actually put into practice by teachers, have highlighted the importance of the influence of teachers in the implementation of the curriculum as well as the need for a better knowledge of the process. Some results show the importance of taking into account teachers' ideas and conceptions regarding the goals of education, how students learn, their role in the classroom etc. (Gil et al, 1998a) when it comes to designing the curriculum, as well as the need for their involvement in the construction of new didactic knowledge and in the process of transformation of such conceptions.

Teachers have ideas, behaviours and attitudes regarding different aspects related to the teaching-learning process based on a long 'environmental' training during the time they were students. These behaviours have a huge influence on their teaching practice because they obey to experiences repeated for years and which have been acquired as obvious and natural, thus acting as a true hindrance if we attempt to renew the teaching-learning process. (Gil et al., 1991).

So, when proposing curricular reforms it will be important to know teachers' ideas and behaviours in order to prevent these ideas from becoming a hindrance to the achievement of the objectives set. But even if this constitutes a crucial requisite for incorporating teachers to reform processes (Bell, 1998), science education research has shown that it will also be necessary that teachers take part in the construction of new didactic knowledge, addressing the problems faced by instruction (Furió & Gil, 1999). Without this participation it will not only be difficult for teachers to embrace changes and put them into practice, but there can also be refusal situations based on organisational, union or labour problems, to mention but a few.

Teachers and the goals of science instruction

As we have stated above, scientific literacy is one of the goals set by a series of curricular reforms currently in course in many countries. However, we think that a large part of the teachers that have to carry forward these reforms does not share some of their objectives, and this is the reason why we decided to research (Romo, 1998) into teachers' ideas related to why we teach science, i.e. into the goals of physics and chemistry teaching in compulsory secondary education. We attempt to find out whether teachers regard science as a core part of culture that everybody should learn at school as we pointed out earlier, or on the other hand whether their teaching is orientated towards the preparation of students for higher courses so that they can follow scientific studies, that is, assuming that all their students were to become chemists or physicists. Some previous research (Boyer & Tiberghien, 1989) manifested the importance physics teachers paid to the fact that students obtained the knowledge prescribed in programs.

Thus, our working hypothesis is that most teachers will think the objective of teaching science is to train future scientists, and so they will be worried about the starting level students have when they reach their class and will teach with an eye on the following year too. Therefore, they will assume the role of "student selector" and the idea that science is a difficult thing that not all students can understand or master, but rather something only those with some particular qualities can acquire, and thus they will be contributing to an elitist vision of science. Moreover, this idea would foster a view of curriculum where length is more important than depth, since it will be necessary to know much about physics and chemistry, the more the better, in order to control

properly the conceptual knowledge of the subjects, which becomes an obstacle to achieving a duly in-depth study of the subjects.

Experimental design

In order to find out about teachers' views concerning general goals and objectives of science curriculum we conceived an experimental design to be carried out with teachers of physics and chemistry in secondary education, both in training and actual teachers.

The design consisted, first, in an open questionnaire (Document I, in annexes) to find out ideas held by teachers of physics and chemistry at secondary education level about the goals of the curriculum and it was applied to 58 teachers. The answers were categorised according to the hypothesis set. These categories were used to design new questionnaires (Documents II, III and IV, in annexes) with closed items, applied to 56 teachers in a series of secondary schools and to 96 teachers in training doing the Pedagogical Aptitude Course.

In the first closed questionnaire (Document II) are collected the big targets set for secondary education by science education research into scientific education and new science curricula. The next questionnaire was intended to collect teachers' opinions about general objectives aimed at through the inclusion of the science curriculum in secondary education (Document III). The last questionnaire (Document IV) proposed excluding sentences, formulated in positive, so as to find out teachers' opinions about the problem and extension of the curriculum and the need for a deeper insight in order to achieve a better understanding of concepts.

Finally, to complete the work we designed an interview (Document V) that was applied to a sample of 37 teachers so as to study in depth teachers' attitudes and ideas concerning the goals of a science curriculum, that is, to know their views on the goals and objectives of science instruction in secondary education.

Presentation of results and analysis

The first questionnaire (Document I) contains four items dealing with the goals aimed at when including sciences in secondary education, so that we can note priorities pointed out by teachers when they value the various choices proposed. Findings were grouped into goals concerning scientific training, i.e. preparing students for further

courses on the one hand, and those related to society and to the student itself on the other.

TABLE I

1. What arguments account for students having to learn sciences in secondary education?	
Goals aimed at through science instruction.	% Teachers (N=58)
A. Goals focusing on students' scientific training	68.0
B. Goals focusing on students' personal and social training	36.0
C. No answer	14.0
2. Express what general training objectives should, in your opinion, be pursued in science instruction at secondary level	
General training objectives in science instruction	% Teachers (N=58)
A. Conceptual objectives	65.8
B. Procedural objectives	29.3
C. Attitudinal objectives	29.3
D. No answer	17.9
3. When selecting the contents of the subject, do you consider that priority must be given to presenting a wide view of the subject or, rather, to a less extensive and deeper approach?	
Priority must be given to:	% Teachers (N=58)
A. Presenting a wide view of the subject	63.6
B. Less extensive and deeper approach of the matter	32.9
C. No Answer	3.5
4. What innovation do you consider should be introduced in the sciences curriculum at secondary level to improve instruction?	
Aspects related to:	% Teachers (N=58)
A. Inclusion of contents that improve interest. Relationship between science and daily life and the role of science in people's lives.	37.2
B. Teacher training to achieve the improvement of the quality of instruction.	35.5
C. Infrastructure support	27.0
D. Teachers' behaviours and attitudes toward the teaching-learning process of sciences	20.5
E. Carrying out practice in laboratories	21.2
F. Interdisciplinarity	14.3
G. No answer	19.0

In Table 1, concerning item 1, we have grouped the various goals pointed out by the subjects surveyed. We highlight that 50% of the answers correspond only to goals concerning students' scientific training. In the results obtained for item 2, we show the various objectives pointed out by teachers. In this case, 35.7% of the answers refer to aspects related to conceptual objectives and none of the surveyed refer to the three objectives simultaneously. Next, we show the results for items 3 and 4.

Results of the open questionnaire reveal that most teachers give more importance to goals focusing science -the structure and methods of science- and on the other hand much lesser importance is given to scientific literacy, to the role of science

as a basic element of our time’s culture. Thus, in item 1, 68% of the surveyed (Table I) refer to the need to know laws and theories that constitute scientific knowledge, in order to follow studies without difficulty. Examples of this type of answer would be:

“Knowing the basic laws of sciences so as to follow a scientific career later”

“Learn methodologies and theoretical aspects as well”

“Knowledge essential to their future scientific training”.

These results support those obtained for item 2 with regard to the objectives of sciences instruction (Table I), where most teachers gather around the objective of acquiring scientific knowledge (concepts, laws and theories) that will be useful for following their studies, the percentage being above those regarding procedural or attitudinal objectives such as acquiring a critical interest attitude toward the role of science as a part of culture, for example. Cohering with these answers, in item 3, teachers surveyed tend to agree more with a curriculum that gives priority to extension over depth.

Finally, when it comes to suggesting innovations to improve the teaching of science (Table I), teachers *are* aware of their need for teachers’ training, of the importance of including contents that increase interest and improve the students’ attitudes –such as activities connecting science and daily life, the relationship between science, technology and society or of carrying out laboratory practice.

On the other hand, when we pose and analyse the answers to closed questions, we get results apparently in contradiction with the former ones. In Documents II and III (see anexes), containing a total of 10 closed questions, teachers are asked to assess the importance of objectives and goals pointed by science education research. Both samples give importance to all the aspects mentioned (Table II and III), even though in the case of goals, the lower values are given to the fact that science instruction must contribute to acquiring democratic values of the social environment in which students evolve. Goals focusing on science itself (on the learning of knowledge and processes) in order to get a proper training for further courses are highly valued again. We observe that, on paper at least , teachers consider all the objectives and goals suggested are important.

TABLE II
WHY TEACH SCIENCE IN SECONDARY EDUCATION?

Value attached (from 0 to 10) to the goals of Science teaching: So that students will	Training Teachers (N=96)	Actual Teachers (N=56)	Teachers total (N=152)

1. Know the subject and learn how scientists work	7.3	7.8	7.5
2. Learn the concepts and theories, in order to achieve training enabling them to follow studies successfully.	7.2	8.3	7.6
3. Achieve the psychological development corresponding to their age	5.9	7.1	6.3
4. Acquire the democratic values of their current social environment	4.5	6.6	5.3
5. Acquire scientific literacy	7.6	9.1	8.2

TABLE III
WHAT GENERAL OBJECTIVES DOES SCIENCE INSTRUCTION PURSUE FOR SECONDARY EDUCATION?

Value attached (from 0 to 10) to general objectives of the teaching of Sciences:	Training Teachers (N=96)	Actual Teachers (N=56)	Teachers total (N=152)
It must be concerned that students			
6. Acquire appropriate knowledge (facts, concepts, laws and theories)	7.4	7.2	7.3
7. Learn the process of scientific methodology (intellectual, procedural skills)	8.1	8.4	8.2
8. Learn how to solve daily life problems	8.2	8.9	8.5
9. Develop positive attitudes and increase their interest in science and in learning it	8.2	9.2	8.6
10. Be able to make critical assessments and decisions concerning respect for the relationship science/society	8.2	9.0	8.5

In Table IV, we show the results found for Document IV and we can observe that the most valued statement is the one related to preventing students from finishing their studies without having studied important chapters, so, their scientific training is achieved by giving priority to the extension of contents over their depth, even though in the case of teachers in training there are no significant differences, perhaps because both statements are affirmative.

TABLE IV
EXTENSION OF THE CURRICULUM

Value attached (from 0 to 10) to the extension and depth of the science curriculum	Training Teacher (N=96)	Actual Teachers (N=56)	Teachers total (N=152)
Priority must be given to			
11. Extensive presentation of the subject	6.5	8.5	7.2
12. Less extensive, deeper approach of the subject	6.3	7.2	6.6

Thus, in this Document we also noticed some contradiction in the answers given to the assessment of the extension or depth of the curriculum, since, despite some differences these are not as we had expected from the contrast in items. Because of this, we carried out an interview later on, so as to get a deeper view of the results obtained in questionnaires.

Regarding the interview carried out with teachers (Document V in annexes), results converge with those found in the open questionnaire. Thus, the most common answers to the first item (27 out of 37 teachers) refer to the importance of the goals that enable students to achieve enough preparation so as to follow studies and they attach less importance to their training as persons or as future citizens, a goal only 10% of the teachers interviewed refer to. Below you will find some examples of the answers to this item that stress propedeutic training of students:

“I think the main goal is to train them to enter university”

“To acquire skills so as to become in future true researchers”

“To disseminate the knowledge built in each discipline ... introduce the student in scientific methodology”.

“So that the child becomes familiar with everything related to research”

Through the interview we could get deeper knowledge of the answers obtained in questionnaires. In this respect, we looked into the reasons given by teachers in item 2 about why science education should focus on preparing students for further courses. Thus, 24 out of 37 teachers interviewed support a mostly propedeutic role of the teaching of sciences, they insist on the need to prepare students in each course for the studies afterwards. The reasons argued by teachers were related to the importance of preparing students for future science courses or for continuing their studies. Among other examples, they referred for instance to:

“It’s necessary to continue studying”

“It’s the final goal”

“There is great concern about it”

The thirteen other teachers pointed out other aspects to explain it, for instance:

“The interest to foster scientific culture”

“Due to the training teachers have received”

“Education is not understood as something terminal”

“Fear to call teacher’s ability into question”

In item 3 we told teachers that, in spite of the fact that instruction has a basically propedeutic orientation in its objectives, students still do not overcome learning difficulties and we asked them which priority objectives should be fixed to overcome this situation. Cohering with the answers obtained for the open questionnaire, 10 teachers point to conceptual objectives, 12 to attitudinal and conceptual objectives, and 8 refer to the

training needs teachers have in order to achieve the goals pointed out, mentioning objectives related to the importance of the teacher's good grasp of the subject, of his keeping knowledge to day and, above all, they attach importance to the use of new methodologies and to teachers' attitudes and expectations. Some examples of answers concerning conceptual objectives:

"The main objective would be that students must get hold of basic concepts, since that will help them go on to further studies"

"That students acquire knowledge and become able to connect theory and practice"

Other examples of attitudinal-like answers we got were, for instance:

"Motivate students, try to encourage them to study sciences"

And finally, those answers concerning the need for teachers' training, as a sort of self-criticism or self-assessment of their role in education and the training they need in order to face changes taking place in this field:

"Updating learning processes so as to: break monotony in the exposition, renewal and updating of our pedagogical practice..."

"That the teacher should have a good grasp of his subject, know how to impart it and how to motivate students"

Thus, the interview made it possible for us to go deeper into the study of teachers' views concerning goals of scientific education, by providing us with results that confirm our hypothesis and the results found for the open questionnaire.

Conclusions and implications for teaching

Most of the teachers consulted, as well as student teachers in practice, assume the basically propedeutic characteristic of science instruction in secondary education, which involves their need to prepare students for higher courses. This leads them to give priority to conceptual objectives over attitudinal or procedural ones in order to achieve the goals set.

The absence of perceptions that scientific literacy (acquisition of life knowledge and skills) should be the backbone of science instruction will lead teachers to thinking that the student beginning his science instruction must be previously interested in the matter. So, motivating students is not an usual objective found in programs in order to foster more positive attitudes towards science and to reach a better learning.

Therefore, the goals and objectives of the curriculum are focus on learning scientific knowledge and processes, disregarding the interests of both students and society. Also, along with this idea, teachers think that the scientific training of students will be achieved by giving priority to the extension of conceptual contents over the depth of knowledge. That is, importance will be given to teaching a maximum amount of concepts and laws and to achieve that, they will need as much time as possible.

The question we should inquire about next is whether it is possible to modify teachers' ideas concerning goals and objectives of the sciences curriculum, in such a way that they would assess the importance of scientific literacy for future citizens, and among them future scientists, as one of the core goals of secondary education. That is, what actions or activities can be fostered so that teachers get aware of the need to redirect their teaching in a way that pays attention to such essential aspects of the curriculum as the significant learning of concepts, the students' getting familiar with those strategies that belong to the scientific inquiry, the setting into context of scientific activity or those aspects concerning the affective dimension of learning (as for instance, the classroom climate or attitudes and values).

To achieve this change of perception among the teaching staff, with regard to the purposes of the curriculum, is a complex thing and it requires institutional and social supports. It will be necessary to program, for example, courses or other teachers' training activities that aim at reflecting collectively on what curricular changes can contribute to improving education and, more precisely, to raise the question about why we teach Sciences in the compulsory curriculum (Guisasola et al. 2001). It will mean to consider scientific education as an important part of education and scientific and technological literacy as one of the purposes of a common basic education for all citizens.

But, as we pointed out earlier, if the efforts made in curricular reforms are to be efficient, organising courses to disseminate new proposals will not be enough. Research findings point out the need that plans meant to incorporate teachers into curricular changes go beyond their doing some training course. Those strategies that are more likely to succeed consist in getting the teaching staff involved in research into the teaching-learning problems that arise during their own teaching activity (Gil et al, 1998b, Furió & Carnicer 2001). These strategies will have to be presented not as contrary to their practice, but rather as answers to instructional problem situations, that are grounded in educational research. The practice of new orientations will demand a continuing

work for which every teacher should find the necessary support and guidance (Carnicer, 1998).

Furthermore, society has to understand that it is important for its immediate development to obtain quality scientific education for all and for it, suitable conditions must be created that facilitate the scientific literacy of the school population. The role of the instructor's activity in education has to be reconsidered in this context. This reconsideration demands the acceptance on the part of society that the educational work should consist not only in preparing and playing their role in the classroom correctly but it should also include the teacher's involvement in activities of educational innovation and research, which needs to be seen as 'natural'. This is the only way that it will be possible to have the teaching staff reflect and accept as theirs the new directions, and participate in the curricular changes concerning, in this case, both its purposes and objectives.

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ANNEXES

DOCUMENT I

QUESTIONNAIRE TO FIND OUT SECONDARY EDUCATION TEACHERS' IDEAS CONCERNING THE GOALS OF THE SCIENCE CURRICULUM.

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1. What arguments account for the fact that students have to learn sciences in secondary compulsory education?
 2. Express those general objectives of training which, in your opinion, sciences instruction should pursue at the secondary level.
 3. When it comes to selecting the contents of the subject, do you think priority must be given to the presentation of an extended view, or else to a less extensive, deeper approach? (Explain why).
 4. What innovations do you think would be necessary to introduce in the physics and chemistry curriculum in secondary education to improve their instruction?
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DOCUMENT II

QUESTIONNAIRE ABOUT TEACHERS' IDEAS, ATTITUDES AND EXPECTATIONS CONCERNING THE SCIENCE CURRICULUM

WHY TEACH PHYSICS AND CHEMISTRY IN SECONDARY EDUCATION?

Value from 10 (full agreement) to 0 (full disagreement)

1. So that students know these subjects and learn how scientists work, so they will be better assessed when they will have to select their university courses
2. So that students learn fundamentally scientific concepts and theories and thus get enough training to be able to pursue their studies successfully
3. So that students achieve psychological development corresponding to their age, fostering their personal self-esteem and autonomy
4. So that students acquire democratic values of the current social environment in which they evolve.....
5. So that students acquire scientific and technological literacy as an essential element necessary in any citizen's culture nowadays.

DOCUMENT III

WHAT GENERAL OBJECTIVES DOES SCIENCE INSTRUCTION AIM AT FOR SECONDARY EDUCATION?

Science instruction at this educational stage must see to it that students:

6. Acquire the proper scientific knowledge (facts, concepts, laws, theories, etc.)
....._____
7. Learn specific processes of scientific methodology (intellectual skills, procedures, etc....._____
8. Learn to solve daily life problems (find out how an event takes place, how a device works, etc.)
....._____
9. Develop positive attitudes and increase their interest towards science and towards learning it....._____
10. Be able to make critical assessments and make decisions concerning the relationship between science and society (positive and negative aspects of scientific and technological development)....._____

DOCUMENT IV
CURRICULUM EXTENSION OR DEPTH ?

11. We must prevent students from finishing their studies without having studied important chapters of physics and chemistry which, besides their academic interest, they may need in subsequent studies. This calls for the presentation of a wide view which gathers the fundamental chapters of the disciplines
....._____
12. Understanding scientific knowledge takes time, needs dealing with it in depth. It is thus necessary to select the part of the subject to be studied without attempting to see every important thing, which would lead to treating them superficially and deforming science, besides not providing lasting knowledge....._____

DOCUMENT V
INTERVIEW ABOUT TEACHERS' OPINIONS AND IDEAS CONCERNING GOALS AND OBJECTIVES OF SCIENCES INSTRUCTION

1. Which do you think could be pointed out as aims or final targets (goals) to teach sciences in secondary education?
 2. More precisely, the goal that teachers are more concerned about is preparing students for the next academic year. What do you believe are the reasons for this thinking?
 3. Which priority objectives do you think science teachers should set so that their students achieve the goals expressed before?
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