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Abstract

Distance education provides a very adequate way for the continuing training of professionals. In this way, the Spanish distance university offers an open learning programme devoted to train secondary school teachers. We discuss here the design and development of a course of this type about history of chemistry for science teachers, so that they can update their knowledge and improve their pedagogical skills on this subject.

Introduction

Nowadays continuing education is an important issue in educational policies of all countries, due to the rapid changes produced in all areas of social life. In this way, professionals involved in the production process must constantly update, in order to adapt to these changes. Such is the case of teaching staff, because changes in the labour market demand new teaching curricula. In addition, education is one of the main agents to keep our culture and to transmit knowledge, skills and attitudes to new generations, so that the young students should become future professionals and good citizens, conscious of the social values. Therefore, it is necessary a recycling educational methodology, in order that teacher staff would be trained to able to update in last innovations and new teaching strategies too. In consequence, the continuing training of teachers is an essential element of the educational policy, because of the rapid and deep changes in our society.

On the other hand, distance teaching methodology offers many advantages for the continuing training of professionals because its flexibility in time, space and rate of study. In this way, the students can adapt their studies to their occupational and social commitments (Peters, 1994; Foley, 2004). With this in mind, the Spanish distance university (Universidad Nacional de Educación a Distancia, UNED) has introduced since 1985 an open learning programme alongside its official degree courses. The aim of that programme is to train teachers of secondary school, so that they can update and improve their pedagogical skills.

Science teaching

Regarding sciences, a special attention has been paid to science teaching, mainly from the sixties of the last century. And nowadays' scientific-technological development is due, to a great extent, to that fact. Thus, new pedagogical approaches have been employed, such as many and different teaching aids, experimental teaching increase or specific strategies for sciences (Gil, 1996; Abd-El-Khalick et al., 2004; Martín-Díaz, 2006). Concerning that, one of the most interesting and original perspectives is the science-technological-society (STS) approach, which allows the students to understand the inter-relations among science and technology with the social aspects (Solomon, 1993; Osborne et al., 2003). The evolution of science takes place in a non-isolated context and, therefore, many factors (culture, economy, politics, religion...) have a strong influence on this evolution. And the science, in turn, exerts an influence on all these factors. As a result, not only the learning of the scientific contents will be easier, but this will also help the students to perceive the involvement of science in daily life. So, those young citizens will become aware of the benefits and problems of science. In this direction, the history of science constitutes a rich source of examples of this type of relationships (Mathews, 1994; Rudolph, 2003).

With this aim, we have designed and put into practice some courses devoted to science teachers. As an example of the characteristics, development and results of these courses, one of them on the topic of the *history of chemistry* will be discussed here.

A training course on History of Chemistry: structure and methodology

Why have we chosen a course on history of chemistry? First, because this discipline generally does not appear in the study Plans of Chemistry of many universities (Jensen, 1998). Second, because these types of disciplines on history or philosophy of science are important from a didactical and cultural point of view: they present a multidisciplinary perspective by connecting science with arts and sociology, and they also contribute to reinforce the students' education in values (Duschl, 1994; Moore, 1998; Esteban, 2002).

Obviously, this course is developed through distance teaching methodology. It is supported on the basic points:

- Self-study materials
- Tutoring
- Communication media tutor-students

The *self-study material* consists of two written materials: a basic course material and a didactic guide. The former, a textbook entitled "Introduction to the History of Chemistry" (Esteban, 2001) and especially designed for this course, following the methodology for self-study materials.

Regarding the contents, it presents the principle steps of the history of chemistry, so that the students could acquire basic ideas of the evolution of chemistry. Thus, all the contents of this course are developed in this book, although our teachers-students are encouraged to use more information sources, aspect not only convenient, but also necessary. With regard to the didactic guide, it includes the objectives of this course, instructions to integrate all the

study materials, suggestions about how to focus the contents of each chapter and an explanation of the kind of evaluation and requirements to complete the course successfully. Adequate strategies to employ in the classroom are also included, so teachers will be able to use those ideas in their future teaching task. Some bibliographical references for further study are shown in this guide too.

A teaching team carries out *tutoring* and *counselling*. It consists of a director, professor of the UNED (the author of this paper), and a collaborator, in this case a secondary school teacher with experience in distance teaching. It is important to take this point into account, because this type of collaborator involved in secondary school is better informed and more conscious of all the problems at this level of education. Thus, the teaching team orientates the students in their learning task and informs them about possible novelties appeared in the literature.

In relation to *communication*, e-mail is employed with those students that have sent their email address. So, it is possible a quick and easy way of informing and counselling in a personal way. However, as some students do not have an easy access to Internet, the traditional ways through mail and telephone are employed in those cases. Anyhow, it is important to keep a regular communication with students, so that they would not feel alone in their learning, one of the biggest problems in distance education (Holmberg, 1992).

On the other hand, a web page for this course has been with wide information about it (methodology, aims, contents, programme, images, general and latest bibliographical references...). So, more people will be able to know many details about it before registration. We also use radio not to develop the contents, but to discuss some interesting points of the history of chemistry. Besides, a series of ten TV programmes on this topic have been prepared on the TV studios of our university, shown through a public TV channel. The students that have attend to those media, posed their questions and ideas generally by e-mail.

Contents

The main chapters of the history of chemistry -from prehistory up today- have been developed attending to the evolution of the ideas, theories and techniques, as well as the scientific knowledge building process. The relation of that evolution with the social, economic and political aspects is especially remarked.

The contents have been distributed along 14 themes, grouped in turn in three blocks:

- ***I. The first steps of chemistry:*** 1.- The chemists facing their history. 2.- The primitive chemistry. 3.- The first theories in chemistry. 4.- The alchemy.
- ***II. The steps towards science:*** 5.- The medical chemistry in Renaissance. 6.- The chemistry of Boyle. 7.- The phlogiston and the pneumatic chemistry. 8.- Lavoisier and the new chemistry.
- ***III. The steps of the new chemistry:*** 9.- Dalton and the atomic theory. 10.- Development of the physical chemistry. 11.- Classification of the elements. 12.- Resurgence of the organic chemistry. 13.- Evolution of the inorganic chemistry and

the analytical chemistry. 14.- The chemical industry and the relationships science/technology/society.

Development of the course

This course began in 2001 and finished in 2008, so it has taken place for seven academic years. The number of students has always been low, between 6 and 20. This fact can be due to two reasons. First, because of the great quantity of training courses offered for science teachers at our university (about 40). Second, Internet and all the new technologies allow traditional universities and other educational centres to give courses through distance methodology, so nowadays the offer of continuing teacher courses has increased very much. Anyhow, science teachers seem to be not too much interested in the history of chemistry. Although the importance of this subject is increasing among educators and scientists, teachers prefer other topics (as didactic in chemistry, experimental tasks in chemistry or even more specific ones, as cosmetics or plastics), maybe because they seem more “adequate” and attractive for sciences. However, the teachers involved in our course were very satisfied, as it will be discussed later.

In relation to the teachers-students, all they were chemists with exception of three physicists, two biologist, two psychologists and a historian. As far as the number of women and men registered, it was more or less similar.

In order to be *assessed* in this the course, each student has to prepare a small research about a topic related with the history of chemistry, such as a significant scientist, an important discovery, a theory and its evolution... This study has to be accompanied by a discussion about how to incorporate all these data -or some of them- as a teaching support in the classroom. In this way, this type of evaluation constitutes another element of the training process, because it involves a good teaching exercise.

Conclusions

We had a great interest in knowing the opinions of our teacher-students about this course. With this purpose, a questionnaire was designed with some key-questions: about the materials, tutoring assistance, information, type of assessment, benefits for their teaching practice.... Through the answers to this questionnaire we drew the conclusion that, in general, they were very satisfied with this course, with the study materials, the communication established among them and the teaching team and assessment. Many of them affirmed that they have acquired new teaching strategies. However, it is not easy to get some statistic conclusions, due to the low number of registrations.

On the other hand, the use of new technologies has been very positive, most of all the web page that also allows updating the information to the students, both the real and the potential ones.

We hope, anyhow, that the interest of the society in this kind of humanistic topics will increase in the future.

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