518300-LLP-2011-IT-COMENIUS-CNW

# The motivation of students to learn Chemistry

**Olga Ferreira[1], Adília Silva[2] and Filomena Barreiro[1]**
[1]Polytechnic Institute of Bragança, [2]Secondary School S/3 Abade de Baçal
Bragança/Portugal
oferreira@ipb.pt, adiliatsilva@gmail.com, barreiro@ipb.pt

## Abstract

*This work describes important aspects related to the motivation of secondary school students to learn chemistry. The topics were discussed considering our experience in a polymer chemistry education project and science communication activities involving the Polytechnic Institute of Bragança.*

*Starting from the recognition that there is a generalized lack of interest of young people to study chemistry due to its negative image, both in society and at school, we present a Portuguese secondary school example where context based approaches are currently being used to teach Chemistry. Additionally, the importance of laboratory instruction is emphasized as it improves students' attitudes and cognitive growth. Studies suggest that inquiry-type experiments lead to more positive attitude towards learning chemistry when compared to confirmatory-type experiments. Also, in terms of laboratory learning methods, students are more enthusiastic learning through collaborative and peer tutoring work. Non formal educational activities also play a very important role. From our experience as a tertiary education institution, several science communication activities can also be very effective in promoting chemistry, namely, the visit to R&D projects and the contact with researchers. These short visits can be complemented with one week internships in research laboratories during the event "Science in the summer at IPB" (Agência Ciência Viva, 2009-2011). The 2011 International Year for Chemistry was also a successful experience where numerous IPB researchers have participated in the local implementation of European initiatives such as "Researchers' Night" and "Night of Chemistry".*

## 1. Introduction

Despite the importance of chemistry in technology and in most aspects of our everyday life there is a generalized lack of interest of young people to study chemistry. Three relevant factors can be pointed out [1]:

1. The negative image of chemistry in general society;
2. The type of curriculum, teaching strategies, didactic resources and lack of teacher's dynamic actions to incentivise the involvement of students into the discipline;
3. The formation of teachers, their conceptions and convictions.

The first two factors will be briefly discussed in the following sections with a focus on their relation with the motivation of students.

## 2. Chemistry and chemicals in society

Relatively to the first factor, a recent editorial from Nature Chemistry describes the very negative connotation often given to the "chemical" word by the press [2]. Most times, it is associated to "leaks", "poisonings", "incidents", "weapons" and "pollution"; on the other side, the chemicals that benefit society are usually identified as medicines or polymers, for example [3]. Another case is the misinformation related to the anti-chemical propaganda from the products labelled as natural [2]. The Editorial from Nature Chemistry also

Lifelong Learning Programme
This project has been funded with support from the European Union.
This material reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

points the interesting perspective that, unlike physics or biology, chemistry lacks champions, role models and grand challenges to inspire potential students. Examples are given for the other two disciplines such as "Physics sets out to unlock the secrets of the universe" or "Biology attempts to unravel the mysteries of life" [2]. Definitely, a need exists to transmit to the general public that chemistry applications are numerous and completely integrated in our everyday life in areas such as food, medicine, new materials, environment, etc. An important question is how to teach chemistry beyond this negative awareness, motivating students. A few possible answers, non-exhaustive, are mentioned in the next section.

## 3. Selected curriculum, teaching strategies and didactic resources

### 3.1 Context-led approaches

Recently, the context-led approaches to chemical education are being developed and applied in schools worldwide [3, 4], including Portugal. Some evidence exists that they motivate students in their science classes enhancing more positive attitudes to science [5]. Our national secondary school chemistry program presently follows a context-based approach [6].

We will now focus on the 12th year programme (students aged 17), as the Polytechnic Institute of Bragança (IPB) and the Secondary School Abade de Baçal were involved in a common science education project concerning topics from that specific year [7]. The general theme of the programme is "Materials, their structure, applications and implications of their production and use", divided in three units [6]:

- Metals and Metallic Alloys;
- Fuels, Energy and Environment;
- Plastics, Glasses and New Materials.

During the development of these units, the possibility of establishing relations between Chemistry and Technology was given to students through the execution of laboratory activities involving problem resolution proposals. At the end of each didactic unit, the following laboratory project activities were developed:

- - Construction of batteries with determined difference of potential.
- - Biodiesel preparation from used food oil.

These projects go beyond the school laboratory walls involving students in Science Road Shows and battery recycling and used food oil campaigns. To reinforce attractiveness of chemistry taught at school and to increase students' motivation, a broad and wide spread "Chemistry outside" activity, presenting inhabitants and schools of Bragança city the different levels of education (teaching strategies), not only the 2 mentioned projects but also activities with a high experimental interaction. The visitors were indulged by the "magic" of chemistry and understood the importance of this science in the school, technology, social and environmental contexts.

This way, the idea of authors that developed the program contents [6] is emphasised where the materials were chosen according to several social, economic, cultural, historical, environmental, ethical and scientific criteria in order to integrate the science-technology-society perspectives followed in the previous years of secondary school.

A very important aspect of teaching chemistry in context is its potential to motivate students even for conceptual learning during and after their academic studies [4]. And how to choose the contexts? Jong [5] presents some characteristics: contexts should be well-known and relevant for students (both girls and boys), not distract students' attention from related concepts; not be too complicated or confusing for students.

Lifelong Learning Programme

This project has been funded with support from the European Union.
This material reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

For example, in a Portuguese study (Costa, 2001 in [4]) involving 272 students attending a Chemistry discipline from the first year of a Public University, they were asked to choose amongst 24 chemical-related themes, which ones they would like to study in chemistry classes. Some preferences were revealed: Greenhouse effect, atmospheric pollution, RRRR's (reduce, reuse, recycle, rethink), nuclear energy and petroleum crisis. These students came from 88 different secondary schools where they had studied chemistry.

Finally, it should be mentioned that a learning environment where students feel comfortable to expose their views and the opportunity is given to exchange ideas between students and teachers, contributes for their development and motivation affecting the way students build knowledge and develop competences [8].

### 3.2 Chemistry Laboratory Education

Hofstein [9] presents a review about the importance of laboratory activities in chemistry education. From the point of view of student's attitude towards school chemistry laboratory work, it is reported that laboratory activities (effectively organized) have a large potential to promote social interactions that can improve attitudes and cognitive growth. Our experience as university teachers in chemistry laboratories confirms this statement. The type/methodology of chemistry experiments is of course an important factor. Inquiry in general, including practical work, in science education, is considered essential for achieving scientific literacy [10]. For example, a study showed that students that performed inquiry-type experiments developed a much more positive attitude towards learning chemistry then students participating in confirmatory-type experiments [11].

In terms of laboratory learning methods, another recent study [12] showed that students learning through collaborative and peer tutoring were more enthusiastic about chemistry when compared to students learning individually with hints. Also, peer tutoring was more effective than collaborative learning in generating the interest and confidence of students to pursue their chemical studies in the future [12].

### 3.3 Activities with IPB researchers

In this section, we would like to describe IPB experience, alone or in cooperation with other institutions, to promote science divulgation activities, designed to reach many different publics.

As mentioned above, the Secondary School Abade de Baçal and IPB were involved in the science education project called Polymer Laboratory [7]. One of the activities developed to enhance the attractiveness of polymer chemistry was the study tours to the R&D polymer related projects at IPB, some of them in cooperation with industry. Moreover, IPB has locally implemented several initiatives devoted to secondary school students such as "Chemistry Olympics" (Sociedade Portuguesa de Química, 2006-2011), and "Science in the summer at IPB" (Agência Ciência Viva, 2009-2011). In this last event, during a week, students experience scientific work in diverse laboratories accompanied by researchers. During the 2011 International Year for Chemistry, numerous IPB researchers have also participated in three events open to the general public, in collaboration with Centro Ciência Viva in Bragança: "Days with Chemistry", "Researchers' Night" and "Night of Chemistry".

## 4. Conclusions

Motivation of students to study chemistry can be increased by improving the image of chemistry in society and in school. Several non-formal activities, with the participation of researchers ("Researchers' Night", "Night of Chemistry", "Science in the summer at IPB", etc.), can be very effective in demonstrating the numerous positive applications of chemistry and, also, to approximate the work of scientists to general society.

Inside school, the type of curriculum and teaching strategies are essential factors. Some studies point that teaching chemistry in context seems to motivate students in their classes. That approach is currently being

Lifelong Learning Programme

This project has been funded with support from the European Union.
This material reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

followed at Portuguese secondary schools. An example was presented, subject to the theme “Materials, their structure, applications and implications of their production and use”.

Chemical laboratorial activities, by promoting social interactions, can also improve attitudes and cognitive growth. Studies indicate that inquiry-type experiments lead to more positive attitude towards learning chemistry. In terms of laboratory learning methods, students show more enthusiasm learning through collaborative and peer tutoring work. The importance of a learning environment where students feel comfortable to expose their views and exchange ideas with their peers and teacher should also be stressed as it contributes for their development and motivation affecting how they learn and develop competences.

## References


[1] I. P. Martins, M. O. Simões, T. S. Simões, J. M. Lopes, J. A. Costa, and P. Ribeiro-Claro, “Educação em Química e Ensino de Química – Perspectivas curriculares”, *Boletim da Sociedade Portuguesa de Química*, vol. 95, pp. 42-45, **2004**.

[2] Editorial, “Where are the champions?”, *Nature Chemistry*, vol. 2, no. 8, p. 599, **2010**.

[3] D. K. Smith, “From crazy chemists to engaged learners through education”, *Nature Chemistry*, vol. 3, no. 9, pp. 681-684, **2011**.

[4] I. P. Martins, M. O. Simões, T. S. Simões, J. M. Lopes, J. A. Costa, and P. Ribeiro-Claro, “Educação em Química e Ensino de Química. Perspectivas curriculares - Parte II”, *Boletim da Sociedade Portuguesa de Química*, vol. 96, pp. 33-37, **2005**.

[5] O. D. Jong, “Context-based chemical education: how to improve it?”, *Chemical Education International*, vol. 8, No. 1, **2008**.

[6] I. P. Martins, J. A. Costa, J. M. Lopes, M. O. Simões, P. Ribeiro-Claro, and T. S. Simões, “Programa de Química 12º Ano Curso Científico-Humanístico de Ciências e Tecnologias”, **2004**.

[7] O. Ferreira, P. M. Plasencia, M. J. Afonso, A. Silva, and M. F. Barreiro, “Polymer laboratory: teaching polymer chemistry”, in *Proceedings of New Perspectives in Science Education*, pp. 385-390, **2012**.

[8] R. A. Engle and F. R. Conant, “Guiding principles for fostering productive disciplinary engagement: explaining an emergent argument in a community of learners classroom”, *Cognition and Instruction*, vol. 20, no. 4, pp. 399-483, **2002**.

[9] A. Hofstein, “The laboratory in chemistry education: thirty years of experience with developments, implementation, and research”, *Chemistry Education: Research and Practice*, vol. 5, no. 3, pp. 247-264, **2004**.

[10] A. Hofstein and R. Mamlok-Naaman, “The laboratory in science education: the state of the art”, *Chemistry Education Research and Practice*, vol. 8, no. 2, pp. 105-107, **2007**.

[11] A. Hofstein, R. Shore, and M. Kipnis, “Providing high school chemistry students with opportunities to develop learning skills in an inquiry-type laboratory: a case study”, *International Journal of Science Education*, vol. 26, no. 1, pp. 47-62, **2004**.

[12] N. Ding and E. G. Harskamp, “Collaboration and peer tutoring in chemistry laboratory education”, *International Journal of Science Education*, vol. 33, no. 6, pp. 839-863, **2011**.


Lifelong Learning Programme

This project has been funded with support from the European Union.
This material reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.