doi:10.2533/chimia.2012.826 Chimia 66 (2012) 826–831

Promotion of Science among Youngsters: Chemistry Outreach Initiatives at EPFL

Farnaz Moser*

Abstract: At EPFL, a strategy for organising scientific outreach activities has been developed and a programme comprising various measures and actions elaborated to promote science and technology among youngsters, especially young girls. As part of this programme, workshops and chemistry camps are developed and carried out for children and youngsters aged from 7 to 16 years old. These workshops are adapted to the age of the participants and allow them to discover chemistry in a fascinating way and become familiar with this field, understand how useful it is to society and learn about the professions it opens up. Some of the workshops take place at EPFL and others are organised in schools in the French-speaking cantons of Switzerland during the touring campaign of a bus named '*Les sciences, ça m'intéresse*!' ('Sciences Interest Me!').

Keywords: Careers · Chemistry · Chemical engineering · Fun · Promotion of science · Scientific outreach activities

Introduction

Today we live in a world in which scientific and technological knowledge is implemented everywhere and is essential for the functioning of our societies. In Switzerland, where it constitutes practically our only raw material, its transmission to the younger generations is vital for this resource to remain renewable. The new generation of scientists is thus of capital importance.

Over the coming years, the technological and scientific challenges on a planetary scale will be even greater. We must find the means to ensure the continuity of the human race, while also ensuring the conservation of our environment. This means that we will need new scientific, engineering and architectural talent.

A general understanding of science is necessary in order to enable people to grasp the role of science in everyday life and think about the major issues of the future.

For some years now, there has been a relative decline in young people's interest in science. This trend results in a worrying restriction of the pool of potential students in science and engineering subjects. Despite a global increase in the number of female students in universities, the proportion of girls who turn to these careers remains low. Too many young women thus never enter the fascinating world of science.

Therefore, governments, industries, universities and academic institutions as well as private institutions carry out surveys and studies,[1–6] and based on the conclusions implement measures and actions to popularize science and technology and specially to educate children and youngsters in sciences, technology, engineering and mathematics (STEM). With a grant of €8 million from the European Commission's 7th Framework Programme over a 3-year period, and the support of 26 partners from 16 countries, including seven major industries, inGenious is one of the largest and most strategic projects in science education undertaken in Europe.[7] In Canada, the charitable organization Let's Talk Science has excited, inspired and engaged more than 2.4 million children, youth, educators and volunteers in science, technology, engineering and math.[8] This education is also judged essential in order to foster an innovation culture and strengthen the economy.[9]

Two major areas of action are privileged. The first consists of integration of a STEM-focused curriculum in school programmes and support for classroom teaching and learning in these fields. The second consists of out-of-school experiences such as after-school and summer programmes.

The importance of special programmes for girls in these domains is also recognized. Different programmes are conceived especially to inform young girls about the scientific and engineering fields, to shatter gender stereotypes in these spheres and show that girls are as capable as boys of studying and pursuing careers in these fields.[10-12]

The EPFL Equal Opportunities Office and Unit for the Promotion of Science among Youngsters organise activities to promote sciences and technologies among boys and girls, with special programmes for girls. The aim is to arouse the curiosity of young adolescents, and help them discover their interest in science.

The goal is to:

- introduce youngsters to various scientific and engineering branches, the professions these can open up and their usefulness to society,
- show just how amazing and interesting the sciences are,
- boost the confidence of young girls in their capacities in these domains.

Scientific weeks, scientific workshops, class days and a touring campaign in schools all constitute parts of this programme and over 7500 children and youngsters discover science through these activities during the year. Several girls-only workshops and courses are also organised.

Since parents and teachers have a major influence on the children's decision to choose scientific careers courses for teachers, workshops in classrooms, exhibitions and science with family days are also organised.

*Correspondence: Dr. F. Moser
Promotion of Science among Youngsters Unit EPFL
P-GEC-EGA
EPFL
Station 10
CH-1015 Lausanne
Tel.: +41 21 693 1981
Fax: +41 21 693 1980
E-mail: farnaz.moser@epfl.ch
http://sciences-jeunes.epfl.ch/, http://egalite.epfl.ch

Increasing the Interest of Youngsters in Chemistry and Chemical Engineering

Increasing youngsters' interest in chemistry involves different entities such as academic institutions, chemistry-related companies and governments.

This is highlighted by the following example. Kathryn Roberts reports[13] that nine years ago chemistry was in crisis in the UK. A number of prestigious chemistry departments were closed due to the decrease in the number of students. Following a number of concrete and concerted actions however, the number of acceptances for university chemistry courses increased by 40% between 2003 and 2010 and it is very important to see just how this happened. Academics, industries and the Royal Society of Chemistry pulled together and with the financial support of the government several initiatives were launched.

Of great significance were the Higher Education Funding Council for England's initiatives with the participation of academics as well as chemists working in industries.

This example is extremely interesting, showing the force of outreach activities with the participation of different partners through a clear policy backed by adequate financial resources.

As chemistry is such an incredibly interesting field – one can have fun with chemistry, and it is useful to society – it is easy to use this branch to encourage children to discover sciences in general. Children are captivated by chemistry experiments. An EPFL chemistry student reports[14] about his fascination with chemistry during his childhood: colour changes, foam which looked like a cloud, *etc.* are cited as what interested him and encouraged him to opt for chemistry later. He explains that this fascination was subsequently transformed into the desire to learn and understand and this guided him to choose scientific branches during high school, giving him the possibility of studying chemistry at EPFL. Several students' testimonies are similar to this one. Outreach activities in chemistry such as those carried out during the International Year of Chemistry, or activities developed by the chemistry departments of several universities all around the world are therefore very important. Outreach activities should be considered seriously in order to raise the interest of youngsters in this field and encourage them to understand what lies behind chemical reactions and transformations. It is also of extreme importance to have role models, both men and women, proudly describing their passion and showing what they have become thanks to studying chemistry and how they use chemistry in their professional life.[15,16]

The combination of these actions from the elementary school stage[17] through to high school[18] will encourage our youth to become talented future chemists and chemical engineers working in industry and academia.

The *Chemistry Is All Around Us* project funded with support from the European Commission has the aim to contribute to the promotion of lifelong learning of scientific subjects and of chemistry in particular.[19]

This project is a good example of how one can demonstrate the usefulness of chemistry in our everyday life.

As many youngsters and especially young girls want to help people and make a difference in the world, it is important to highlight the role of chemistry in society.

"Creative science, mainstay of all industries, chemistry is now the central discipline of modern research, at the crossroads of all the natural sciences. Understanding a biological mechanism, dreaming up and producing a new drug, creating a revolutionary material, inventing a safe, clean manufacturing process, imagining new sources of energy for the future of mankind, understanding the subtle harmonies governing our environment in order to protect it: such are the missions entrusted to today's chemists and chemical engineers." This is for example the powerful wording used by the EPFL School of Chemistry and Chemical Engineering[14] to present chemistry to future students.

Chemistry Outreach Initiatives at EPFL

All activities are based on introducing participants to the use of scientific methodology, which means asking questions, formulating hypotheses, collecting information, experimenting, observing, describing and comparing and discussing the results.

The first safety rules are introduced during all activities *via* the wearing of lab coats, gloves and protective glasses. Wearing the same clothes as 'real chemists' is also part of the dream of becoming a chemist!

The image of chemistry portrayed in the media is often a negative one. Pollution and drugs causing problems have contributed to chemistry's unfavourable image but many believe that chemistry's image can be improved through good communication and education. And indeed, thanks to education and communication efforts, a positive change in the public perception of chemistry is gradually becoming apparent.[20] It is thus important to talk with children about safety in the lab and safety measures for protecting the environment. One should show them how a chemist is responsible for environmental protection and that every chemist must take this aspect very seriously into account. It is important moreover to spend some time to show how waste is recovered, treated or destroyed.

Chemistry is Fun: Workshops for 7–10 year-olds

Wednesday afternoon workshops give children aged seven to 10, an opportunity to discover chemical reactions in an entertaining way using safe products. Most of the experiments can be reproduced at home in the presence of parents. One of the ideas is to show that they can have fun with chemistry without risking injury to themselves or others.[20]

Since young children are involved, the first notions focus on the different phases existing in nature: solid, liquid and gaseous.

The carbon dioxide 'rocket' works thanks to a silver photographic film container in which water and an effervescent tablet are placed before closing it, placing it on the ground with the lid facing downwards and moving out of the way. The pressure of the CO_2 sends the container 4–5 meters up into the air.

Another similar experiment: a 500 ml PET bottle containing some sodium bicarbonate powder in the bottom to which is added 20 ml of vinegar is sealed with a child's toy balloon. The balloon swells and the CO_2 remaining in the bottle extinguishes a candle when the bottle is held tilted over the flame.

As we define liquids and solids, we go a bit further with unusual fluids: the children make Slime® by polymerising polyvinyl alcohol with borax and play with cornflour particles suspended in water.

Since chemistry is present in cosmetics, a set of 14 different fragrances (top, middle and base notes) enables us to create an eau de Cologne that children take home. This experiment also touches on the functioning of the brain and sense of smell.

Without the help of any laboratory pH indicators, we use red cabbage juice to analyse kitchen products according to their acidity or basicity.

'The dance of the raisins' again uses vinegar and sodium bicarbonate but this time to demonstrate density. Into a tall glass we put some sodium bicarbonate powder that we cover with a salt-saturated solution, then vinegar. When a raisin is immersed into it, it sinks to the bottom, taking some of the vinegar with it in the folds of its skin, descending through the saline solution without any reaction. Upon contact with the bicarbonate, the vinegar triggers the reaction emitting carbon dioxide in the

pH experiments using red cabbage juice (left). Preparation of Slime® (right).

form of bubbles caught in the wrinkles of the raisin, which can then rise again to release its CO_2 on the surface, and then sink again...

Back to the polymer concept and its application to molecular cooking with an example allowing us to make small pearl-like sodium alginate balls containing any fruit juice we like, resembling a rare sort of caviar.

For each experiment children are invited to give their hypothesis, and to compare and discuss their observations and results. Scientific mediators explain procedures and reactions and broaden the subject using vocabulary adapted to the age of the participants.

Chemistry Camp for 11–13 year-olds

This activity is organised in two versions: mixed (boys and girls) and girls only. The aim of this one-week holiday camp is not only to increase the interest of young girls and boys in science and especially in chemistry but also very often to provide answers to their everyday questions *via* experiments. Our experience shows that boys' and girls' questions as well as the way they ask questions are different. For example, while girls ask how energy can be produced, boys ask how to create a reaction that leads to an explosion! Girls ask questions expressing their uncertainty about how different phenomena occur. Boys do not ask questions which might show that they are not experts. Therefore often when boys and girls of the same age work together, girls ask questions and boys answer even if they aren't sure about it. This leads to a dominating situation where boys act as experts and girls as their assistants. Even though boys and girls are equally interested and enthusiastic during these scientific weeks, girls seem to be much more confident in their abilities during the girls-only camps. In our mixed camps, in order to respect a certain balance, 50% of participants are girls and 50% boys. In addition, our scientific mediators are very careful to avoid dominating situations for example where boys always do the experiments while girls always write down the observations.

These youngsters have no academic knowledge of chemistry at the beginning of this activity. Throughout the week, we lay all the scientific foundations for discussion and understanding of the subjects dealt with in the simplest but most accurate way possible.

The week is spent in a real chemistry laboratory for students, enabling us to manipulate real chemist's equipment in a safe environment.

On the first day of the camp, we deal with safety measures and begin with the reaction for making Slime®. Materials science is thus introduced thanks to this amusing and unusual substance. On the same theme, on another day during the week, we make a bioplastic based on cornflour.

For this first day, participants are divided into several groups. Each group goes to a lab where research in chemistry- or biology-related domains is carried out. Researchers – men and women who act as role models – explain their research subject to the youngsters using appropriate language during one hour. They also show that often a whole research group works on the same subject and that scientists with different backgrounds work together to solve a problem. During the week each group spends one or two hours per day preparing a presentation about what they learnt in the research lab. They can go back to the labs and ask more questions or take some material with them for their presentation. The presentation can be a simple one with slides or a text but it can also be a little play depending on the children's imagination. This part of the programme is also designed to show that chemistry is teamwork and to destroy the image of the isolated chemist working alone in his laboratory

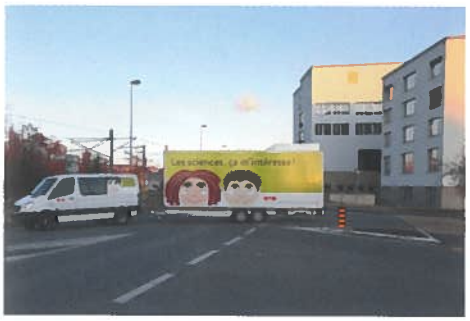
At the end of the first day, participants prepare a photosensitive solution to make cyanotypes during the rest of the week. We thus introduce the notions of energy (light and chemical), ions and colour. Participants draw their negatives themselves on transparent plastic. The unlimited reproduction of images and analogue photographic processes are therefore explained and discussed in relation to digital techniques.

On Tuesday, chemistry is used to begin exploring biology with a visit to the *Université de Lausanne* public laboratory *l'Éprouvette* (see article in this issue, p. 851). The girls extract DNA from buccal cells or onion cells.

To discover the principle of pH, participants prepare their cabbage solution and observe colour variations depending on the products tested (lemon juice, washing-up liquid, *etc.*). Different pH indicators used in the laboratory will then help them determine the pH of a 'mystery' solution.

A day completely devoted to cosmetics allows the children to discover the emulsion technique for example and thus make a lemon-scented moisturising hand cream (they prepare the lemon-flavoured oil themselves too). They can also study the effectiveness of a suntan oil by using titanium dioxide and placing a sheet of paper soaked in cyanotype solution under

Children working in a chemistry lab during a chemistry camp.



The bus '*Les sciences, ça m'intéresse* !' (left). The tent in the front of the bus in a schoolyard (centre). Youngsters visiting the interactive exhibition of experiments (right).

ultraviolet lamps, or make a hair gel thanks to a polymerising agent.

The relationship between light and matter is demonstrated by the chemiluminescence of luminol.

Ions take centre stage once again during electrochemical experiments: the copper plating of an iron nail in a copper sulphate solution *via* a redox reaction, and electrochemical drawing where we again find a coloured indicator (phenolphthalein) that changes colour in blotting paper soaked in saline solution thanks to the application of a potential difference *via* the tip of a nail connected to a battery.

At the end of the camp parents are invited to a ceremony during which the children present the work done during the week and receive a participation certificate. This is also an opportunity to talk to parents about science and chemistry and ask them to encourage their children to go further in these fields.

The youngsters participating in these scientific weeks come from different backgrounds and many parents have had no scientific education themselves and thus little idea about sciences and their applications. Indeed they say that they learn a great deal about different subjects thanks to the presentations of their children. They are very proud of them and begin to consider them capable of choosing scientific fields in the future.

The Bus '*Les sciences, ça m'intéresse*!'

The purpose of the EPFL Bus '*Les sciences, ça m'intéresse*!' is to meet the considerable demand for scientific activities for young people to move beyond the confines of EPFL. It first took to the road in April 2009 and travelled around from 2009 to 2012 to schools in the cantons of Vaud, the Valais, the Jura, Fribourg, Neuchâtel and Geneva. It continues on its rounds with great success.

The aim of the bus is to go and meet young people, parents, teachers and other educational partners, to inform young people – particularly girls – and stimulate their interest in scientific careers.

With this objective in mind, the EPFL Promotion of Science among Youngsters Unit and the Equal Opportunities Office propose meetings with young people *via* experiments and exhibitions while travelling the roads of French-speaking Switzerland.

In order to achieve these objectives, a partnership between schools and those responsible for the promotion of sciences at EPFL is essential. The very idea of this vehicle was in fact conceived during a meeting at EPFL of the headmasters/headmistresses of vaudois schools, who had expressed the wish that activities offered to young people at EPFL should be brought to their schools.

Two programmes are offered, one for 5th and 6th grade pupils (11–13 years old) and the other for 7th, 8th and 9th grades (14–16 years old). We offer the following programme:

The first day consists of an entertaining scientific show (or demonstrations for 8th and 9th grades) of 30 minutes with a question session, a 10-minute presentation of studies at EPFL, and the projection of a short film, showing different labs with female role models. This part of the programme is intended for all classes that are interested, depending on the size of the auditorium.

Second and following days: scientific visits and workshops for pupils (three classes per day) with a two-hour programme per class are proposed. For each class, half of the group guided by the scientific mediators visits the interactive exhibition of 13 experiments prepared by the 13 Sections of EPFL in the vehicle for one hour, during which the other half participates in a practical workshop in the tent in front of the bus. The two halves then exchange places.

School teaching staff members receive an educational file concerning the exhibition prior to the visit of the bus. This file provides them with more detailed information enabling them to answer pupils' questions and, if they wish, prepare their pupils before the visit. Some exercises related to each experiment would allow the activities and discussion to be prolonged within the classes after the visit.

The vehicle stays on the spot for one or two weeks and ten classes per week have the opportunity to follow this programme. Wednesday afternoon is reserved for the visits of teaching staff from other classes that might be interested and any parents who would like to find out more. The scientific mediators are available to answer all questions.

How is Chemistry Presented during the Week?

Chemistry is presented at three levels.

a) During the first day's show, spectacular experiments are conducted.

Mice performing experiments during the show.

b) An interactive chemistry experiment is exhibited in the bus.
c) The cyanotype practical workshop is run in the tent.

a) *Amazing Experiments during the Show*

The show is the story of two mice in a chemistry lab performing different experiments placing them in amazing but sometimes complex situations.

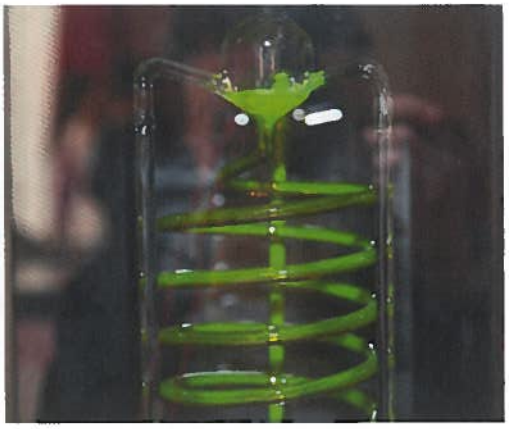
At the beginning of the show, Mouse Alpha mixes hydrogen peroxide with washing-up liquid. When Mouse Beta adds potassium iodide, the mixture begins to foam, foam, foam... The foam rises in the test tube and as it emerges it retains the cylindrical shape of the container – hence the image of elephant's toothpaste! The explanation of the experiments is given at the end of the show by the scientific mediators. They explain that the hydrogen peroxide reacts with the potassium iodide according to what is known as a redox reaction. They also show that the reaction, called exothermic, emits intense heat. It releases oxygen too, which is trapped in the washing-up liquid and makes it foam.

One of the mice mixes potassium permanganate with hydrogen peroxide, and a cloud is created. The dismutation of hydrogen peroxide, producing oxygen and water vapour that condenses in a white cloud, is explained at the end of the show.

During the show a fascinating spectacle presenting a solution which constantly changes colour is produced by the mice. The explanation given is that a chemical clock is a reaction in which the concentrations of certain components increase and decrease in turn over a certain period. The reaction may be accompanied by a more or less periodic change in certain properties of the mixture, such as colour for example. Certain systems display remarkably stable temporal periodicity and thus behave like true chemical clocks.

Chemiluminescence is once more introduced by the manipulations of the mice and captivates the children's attention. It is explained that hydrogen peroxide and luminol are the main participants in this chemical reaction. In order to produce a spectacular light, the reaction needs a 'catalyst', in other words a chemical that increases the reaction speed. In our case, this catalyst is copper. Luminol is used by forensic experts to find minute traces of blood, even if efforts have been made to remove them. In this case it is the iron in the blood that acts as the catalyst for the reaction.

Our experience shows that children are fascinated by the experiments presented during the show and they want to understand how they happen. This is the opportunity to explain that it's not magic – it's science! They retain the experiments and understand well the scientific explanations given using simple words.



Interactive chemical experiment exhibited in the bus.

b) *Interactive Chemical Experiment Exhibited in the Bus*

The experiment consists of a coiled glass tube with, at its upper end, a flask that can contain three different products. Luminol and hydrogen peroxide are added *via* a first push-button, activating dosing pumps. When the two liquids mix as they go down, the reaction takes place in the tube and produces luminescence.

A second push-button allows a fluorescein solution to be added. During the reaction, the excitation energy of the luminol is transmitted to the fluorescein and reemitted in the form of green light. The phenomenon of fluorescence is presented to the children thanks to this experiment.

c) *Workshop for Creation of a Cyanotype in the Tent*

Within the framework of the International Year of Chemistry, we developed a photochemistry workshop, enabling pupils to go away with an amusing image of chemistry that they developed themselves. This workshop initially developed for 11–13-year-old youngsters seemed very much appreciated by youngsters of up to 16 and also by adults during parent–children workshops.

The scientific mediators begin by explaining that photochemistry is a branch of chemistry that studies reactions caused by light.

The production of a cyanotype (blueprint) is an example, the principle of which was discovered in 1842 by Sir John Herschel (1792–1871). This allows the printing of monochrome photographs or other documents in a dark cyan blue colour. It was Anna Atkins (1799–1871) who introduced this process into the field of photography. Considered the first female photographer, it was she who made this process popular. It is a simple and inexpensive procedure permitting the creation of long-lasting large-format prints that are more or less permanent.

When talking about photography, it is amazing to discover that the digital photography generation has no idea about traditional photos.

This one-hour workshop permits a discussion concerning chemistry and photography, introducing the weighing of products and preparation of chemical solutions, mixing of solutions and sensitisation of paper, choice of negative and exposure to light and development of image, rinsing and drying.

Participants learn that the cyanotype printing process uses two chemical products: potassium ferricyanide (chemical formula $K_3[Fe(CN)_6]$) and ferric ammonium citrate ($C_6H_{11}FeNO_7$). 0.35 grams of each product are diluted in 10 ml of water separately and then mixed in equal parts. The mixture is sensitive to light. Cyanotypes can be produced on any surface capable of absorbing this solution: textiles, papers, cards or other absorbent material. They are treated with the solution and dried in a place out of the sunlight. Any photograph, whether taken with a traditional or digital camera, can be transcribed into a negative. The negative is kept in place on the sensitised material and placed in the sunlight for approximately six minutes or, in cloudy weather, in the rays of an ultraviolet lamp. A positive image is obtained from a negative thanks to the photochemical reaction of the iron complex. The surface is then rinsed in water to eliminate the product that has not reacted to light. Vinegar or lemon juice may be added to the rinsing bath to make the blue colour last. To obtain good whites it must be well rinsed in water. Then it just has to be dried. The blue will intensify as a result of contact with the air.

Cyanotype workshop in the tent (left and centre) and examples of images developed by children (right).

Participants go away with images of their choice that they developed using a concrete application of chemistry.

Other Initiatives for Chemistry Outreach at EPFL

The EPFL Section of Chemistry and Chemical Engineering (SCGC) has produced two DVDs consisting of experiments presented by Maurice Cosandey, a passionate chemistry teacher also deeply involved in chemistry Olympiads. These DVDs distributed in high schools are very much appreciated by teachers and students alike.

A chemistry show and different workshops are also organised during the open days and class days by SCGC. High school students can carry out their diploma project (*travail de maturité*) in the field of chemistry with the help of EPFL professors and the SCGC has a fruitful collaboration with high school chemistry teachers.

Conclusions

The activities focusing on the promotion of science among youngsters are very successful. There is a great deal of demand and they are booked long in advance. The short-term effect of chemistry outreach activities is that children are fascinated by chemistry. In addition, the information they are given about chemistry and the attitude of role models change the existing image of chemistry. Participants all say that they would like to become chemists, immediately after the activities. The long-term result consists of motivating children and youngsters to choose scientific subjects, preparing them for scientific curricula at university.

Outreach activities are tremendously important and their organisation requires passionate scientific experts with pedagogical know-how as well as adequate financial resources. Different partners should pool their efforts in order to provide industry and academia with a new generation of scientists and engineers ready to face the technological and scientific challenges of society.

Acknowledgements

We would like to gratefully acknowledge the financial support of our partners and sponsors; NCCRs: Robotics, Synapsy, MICS and QP and the Swiss National Science Foundation, Medtronic Foundation, Leister Foundation, the member companies of the KGF (Kontaktgruppe für Forschungsfragen), BASF, Novartis, F. Hoffmann-La Roche, Merck Serono, and Syngenta, Google CS4HS, L'Oréal Suisse, preci-dip and Honeywell and EPFL Sections and Schools.

The actions presented in this paper are produced by teamwork. Recognition is due to all of the members of the Promotion of Science among Youngsters Unit and the Office of Equal Opportunities of EPFL. The involvement of our scientific mediators: Christophe Perez, Marion Albertini, Andrea Fabian Montabert, Pauline Ruffiot and Olivier Renault in different activities is thankfully acknowledged.

Received: September 16, 2012

[1] Executive Office of the President, The President's Council of Advisors on Science and Technology (PCAST), 'Prepare and inspire: K-12 Education in Science, Technology, Engineering and Math (STEM) for America's future', The White House, USA, Office of Science and Technology Policy, **2010**.

[2] Département fédéral de l'intérieur, Département fédéral de l'économie, 'Pénurie de spécialistes MINT en Suisse : Ampleur et causes de la pénurie de personnel qualifié dans les domaines MINT (mathématiques, informatique, sciences naturelle et technique)', Rapport du Conseil Fédéral, Confédération Suisse, **2010**.

[3] OECD, 'Encouraging Student Interest in Science and Technology Studies', Global Science Forum, OECD Publishing, **2008**, doi: 10.1787/9789264040892-en.

[4] F. S. Becker, *Eur. J. Eng. Edu.* **2010**, *35*, 349.

[5] A. de Grip, E. Willems, 'Youngsters and technology', *Research Policy*, **2003**, *32*, 1771, doi: http://dx.doi.org/10.1016/S0048-7333(03)00079-9.

[6] European Commission, Directorate-General for Research and Innovation, 'She Figures 2012 Gender in Research and Innovation, Statistics and Indicators', *European Union*, **2012**. Retrieved September 5, 2012, from *http://ec.europa.eu/research/science-society/document_library/pdf_06/she_figures_2012_en.pdf*.

[7] InGenious, 'About the project'. Retrieved September 11, **2012**, from *http://www.ingenious-science.eu/web/guest/about*.

[8] Let's Talk Science, 'What is Let's Talk Science'. Retrieved September 11, 2012, from *http://www.letstalkscience.ca/about-us.html*.

[9] Lemelson-MIT Program (2010, January 29), 'Survey Reveals Ways to Enhance Teens' Interest in Science, Technology, Engineering and Mathematics', *ScienceDaily*, **2010**. Retrieved September 5, 2012, from *http://www.sciencedaily.com/releases/2010/01/100128091744.htm*.

[10] D. F. Halpern, J. Aronson, N. Reimer, S. Simpkins, J. R. Star, K. Wentzel, 'Encouraging Girls in Math and Science', IES Practice Guide, NCER 2007-2003, U.S. Department of Education, Institute of Education Sciences, **2007**.

[11] Elles en Sciences, 'Ressources sur l'égalité des sexes dans la société, les sciences, l'éducation et l'orientation', *www.elles-en-sciences.org*, **2010**. Retrieved September 11, 2012, from *http://elles-en-sciences.net/index.php/telechargements/func-startdown/3/*

[12] Association Femmes & Sciences, Association femmes & mathématiques, Association des Femmes Ingénieurs, 'Les femmes et les sciences.... au delà des idées reçues', **2011**. Retrieved September 5, 2012 from *http://www.femmesetsciences.fr/Documentation/Livret_IDrecues2011.pdf*

[13] K. Roberts, *Chem. & Ind.* **2012**, *76*, 34; doi: 10.1002/cind.7601_12

[14] Bureau de l'égalité des chances de l'EPFL, 'Les sciences, ça m'intéresse!, CAP SUR L'EPFL', Bureau de l'égalité des chances de l'EPFL, p. 14-15, **2009**.

[15] A. S. Hinkle, J. A. Kocsis, 'Successful Women in Chemistry: Corporate America's Contribution to Science (Acs Symposium Series)', An American Chemical Society Publication, **2005**; ISBN-13: 9780841239128 - ISBN-10: 0841239126

[16] Times Higher Education (THE), 'A role model who shows chemistry can be a real Kick', **2004**. Retrieved September 5, 2012, from *http://www.timeshighereducation.co.uk/story.asp?sectioncode=26&storycode=190054*

[17] H. J. Tracy, C. Collins, P. Langevin, *J. Chem. Educ.* **1995**, *72*, 1111.

[18] L. Simon, P. Armenante, R. Dave, 'Camp Pharma: A Novel Initiative to Generate a Pipeline of Diverse Student Talents in Pharmaceutical Manufacturing', Spring 2007 ASEE Mid-Adtantic Section Conference, New Jersey Institute of Technology, Newark, NJ, **2011**.

[19] 'Chemistry is all around us', a project funded by the European Commission *http://www.chemistry-is.eu/*

[20] 'The changing image of chemistry', *Chemistry World* **2004**, *1*. Retrieved September 5, 2012 from *http://www.rsc.org/chemistryworld/Issues/2004/December/changingimage.asp*