CHEMISTRY FOR SOCIETY: NEW EMPHASIS IN EDUCATION

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Abstract

In 2007 the cooperation between the Department of Teaching and Didactics of Chemistry, Faculty of Science, Charles University in Prague and the German members of the project CITIES (Chemistry and Industry for Teachers in European Schools) was established. This paper presents information on the results of the cooperation and on a practical laboratory course developed for the further education of European chemistry teachers. According to the aims of the CITIES project, the new experiments presented in the course focuse on the connections between chemical industry and the school chemistry education and on the contributions of chemistry to the whole society. The course was realized for two groups of Czech secondary school chemistry teachers and the evaluation data were obtained from the questionnaire prepared by the German colleagues.
Key words: *chemistry experiment, CITIES project, chemical industry, science education.*

Introduction

The general awareness of chemistry and chemical industry benefits for man‘s daily life is low in our society. Many people, including students and pupils, do not appreciate the products of chemical industry improving their life and making it possible in its current form; on the contrary, whole chemistry is generally considered to be unhealthy, dangerous and anti-ecological. Where are the causes of this phenomenon? Of course, there is many oversimplifying, modish and sensationalist news in media deforming the society's attitude towards chemistry. But the system of chemistry education bears also a great deal of responsibility. The content of Science education does not sufficiently reflect their technical and industrial applications and benefits. A few classical industrial applications are presented mainly as abstract schemes with a lot of information to be memorized or, at the very most, as samples locked in the show-case on the wall of the school corridor. This leads to lack of relation between chemistry known from school and the contributions of this science for pupils' daily life and strengthens the negative image of chemistry.

The CITIES project (Gros, Drasar, Frankowicz, Maciejowska, Walace, 2007)

Secondary school chemistry teachers play a key role in giving their pupils a correct image of chemistry and its applications. But the obstacles rise – some of these teachers studied chemistry many

years ago and it is often heard that the time for experiments and the supply of appealing teaching material is scarce. These colleagues need educational material and resources for giving their pupils an adequate training and awaken more interest and enthusiasm for chemistry in them. In addition to the usual university science courses, future teachers as well as the secondary school teachers need training and continuing professional development courses which bridge the existing gap between their studies and everyday school life and the "real" industrial and applied research world.

The Comenius project CITIES (Chemistry and Industry for Teachers in European Schools) started in November 2006, launched by ten of European universities and chemical societies. CITIES aims to produce a training package which will help teachers to make their chemistry lessons more appealing by seeing the subject in the context of their daily lives. Beside the basic information of European aspects of chemical industry and chemistry teaching, CITIES will offer course material with "hands on" experiments and a homepage that presents people and products, linking everyday benefits, the making of products and their chemical background in an interactive way. The training package consists of five following modules:

Module 1: Framework Europe. General basic information on EU policies (such as Lisbon strategy or Bologna declaration), with special reference to the context of chemistry and chemical industry and on trends in the European development of an "educational space".

Module 2: Chemistry changes everything. The scope and impact of the European chemistry industry, its workers and employees and of chemistry based products on the European economy, on citizens'everyday life, on the environment, and on the labour market.

Module 3: Commerce and innovation – our future. Current and future development trends in the field of commercial application of chemical innovation, with particular regard to the European area (covering fields such as nano-technology, bio-technology or sustainability of material and energy use, Green Chemistry etc.).

Module 4: Chemistry – bringing it alive. Modern, practically oriented, appealing methodologies of teaching chemistry to a broad spectrum of pupils from different abilities and interests, including those who are heading for a career in chemistry and those who will just be "users" of applications of chemistry and voters in elections.

Module 5: Europe – the educational and training arena. Different approaches to vocational and tertiary chemical education in Europe, with special attention to student work experience and to student mobility, taking into account the question of employability of the graduates in a global economy.

Applied chemistry in school education – bringing it alive

Within the fourth module "Chemistry – bringing it alive", a set of chemistry experiments intended for the further education of chemistry teachers was developed by the German members of the CITIES project. The experiments are focused on the applied and industrial chemistry. Following the former collaboration on the development of the experiments in the microwave oven, the Department of Teaching and Didactics of Chemistry was asked for the verification of the developed experiments in a practical course for teachers. The instructions for the experiments and the questionnaire for the participants (in German) were provided. The results and experience from the course realization will be included in the final version of the CITIES course materials offered to the European teachers.

Practical laboratory course for chemistry teachers

The secondary school chemistry teachers from Prague are interested in a practical laboratory courses carried out from time to time at Charles University in Prague, Faculty of Science, Department of Teaching and Didactics of Chemistry. These courses use to be focused both on the unpretentious experiments with natural substances, food and products of daily life, and on the impressive, appeal-

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ing experiments with motivating function (Šulcová & Böhmová, 2007).

The new practical course was based on the applied and industrial chemistry experiments provided by the German colleagues – such as waste recycling, biofuels or plastics. Some adaptations and even deletion had to be done because of the different chemicals' availability and working conditions at German and Czech secondary schools. The inapplicable instructions were replaced by our older experiments of the similar kind. The printed instructions were translated and prepared. The new course called "Interesting chemical experiments using the everyday substances" was held on 8th February and 14th March 2008.

The experiments were divided into four groups, each group had its own standpoint supervised by a lecturer, who advised teachers and helped if necessary. The course which took three hours (2 – 5 p.m., Friday) was taken by 15 teachers (on 8th February)/10 teachers (14th March). The participants tried out the experiments personally and discussed the results, possible adaptations and related problems with the lecturers. Printed materials with instructions, results and photodocumentation were distributed and put on the web page: http://www.natur.cuni.cz/~kudch/main/JPD3/10experimentu.pdf.

All of the participants answered the questionnaire concerning contribution and level of the course.

Selected experiments presented in the course

The participants practised nine following experiments in the course. The abbreviations mean: "GE" for the experiments provided from Germany, "CZ" for the additional Czech experiments. Some of the most interesting will be described in detail below.

1. Thickness of the aluminium layer (GE)
2. Chipboard (GE, CZ): making urea-formaldehyde resin, resin hydrolysis and product detection in hydrolysate, chipboard recycling and detection of resin components
3. Making polyamide fibre (CZ)
4. Reductive effect of vitamin C (GE)
5. Vitamin C in fruit and vegetable (CZ)
6. Detection of reductive saccharides (CZ)
7. Protein proof in food (CZ)
8. Fluorescence of plant pigment (CZ)
9. Making biodiesel (GE)

Ad 1: Packing materials *(Based on: B. Landsgesell, H. J. Bader, MNU 57/5, 2004, p. 285-289)*

This complex experiment focuses on the TetraPak carton structure: exploring the structure of TetraPak carton, preparing the sample of aluminium foil of the given area and dissolving it in hydrochloric acid, determining the mass of aluminium in the sample using the method of chelatometric titration and counting the thickness of aluminium layer.

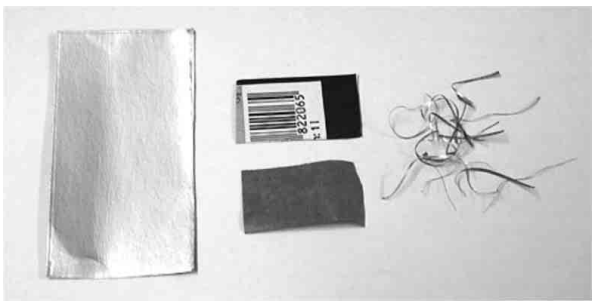

Figure 1. Preparing of aluminium foil form the TetraPak carton.

Ad 2, 3: Plastics *(Based on: H. J. Bader, A. Lühken: Wooden materials with know-how, NiU-Chemie 10 (1999) Nr. 50, p. 33-38; Šulcová & Böhmová: Nontraditional experiments, 2008)*

The topic consists of five experiments: synthesis of urea-formaldehyde resin and nylon fibre, changing resin properties using a curing agent, resin hydrolysis and identification of the resin component, health and ecological aspects – formaldehyde release from resin and chipboard.

Figure 2. Urea-formaldehyde resin with (left) and without (right) a curing agent after the blow.

Ad 8: UV fluorescence *(Based on: Šulcová & Böhmová: Nontraditional experiments, 2008)*

Students get acquainted with the principle of UV fluorescence and different forms of its utilization – protecting elements of banknotes and documents, whitening agents in washing powders, highlight pens vs. felt pens or fluorescent pigments of plants and vitamin B_2.

Figure 3. Felt pens (left) and highlight pens (right) under the UV lamp.

Ad 9: Biofuels *(Based on: V. Baur, I. Melle, H. J. Bader CHEMKON, Weinhweim 2000)*

Simple experiment reflects the current accent on alternative energy sources and fuels. Transesterification of rapeseed oil with methanol is carried out to obtain the biodiesel.

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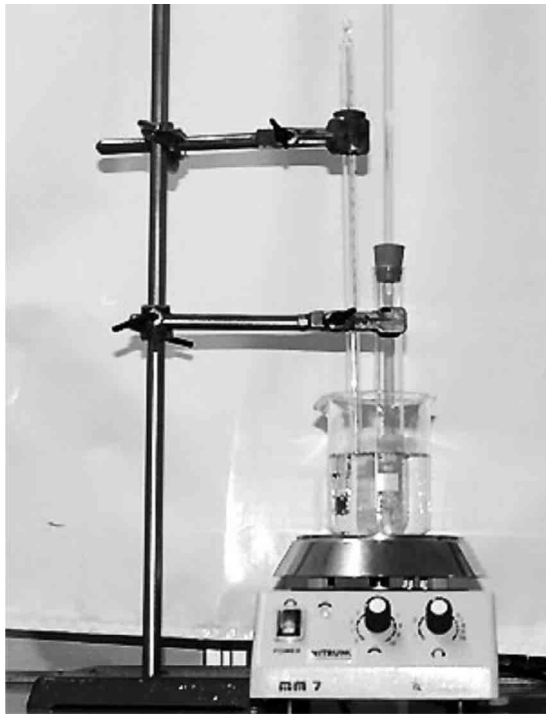

Figure 4. Biodiesel production.

Evaluation results

The 25 participants were mostly female, mid-age, teaching at general upper secondary school (4-year school or 8-year school) with the length of service from 6 to 10 years. The agreement with the statements in the questionnaire was scored on the scale 1 (absolutely disagree) to 6 (absolutely agree). The questionnaire was translated from the German specimen without any modifications, including some topics or formulations unusual for the Czech teachers, so that the results could be directly used by the German authors. The tables below show some of the items from questionnaire.

Table 1. The expectations and preliminary knowledge were reviewed subsequently:

I came to this course to …	Average value
... gain/acquire special knowledge about this subject	5,4
... improve my experimental skills	5,3
... provide higher safety while doing school experiments	3,8
... exchange experiences with colleagues	5,0
... gain new impulse for education	5,9
... get improved in my subject extracurricular	5,3
... gain new methodical stimulations	5,2

Conclusion: *Teachers mostly expected new stimulation for school – according to the announced orientation of the course.*

Table 2. The gains for the teachers were following:

During the course I …	Average value
... improved the experiment implementation.	4,8
... learned new experiments useful for education.	5,6
... exchanged experiences with colleagues.	5,3
... gained high stimuli from lecturers.	5,3
... gained knowledge that overlaps school curriculum.	4,8
... gained high methodical stimuli.	5,1
... fully reached the goal.	5,0

Conclusion: *Teachers gained a lot of stimuli for the education.*

Table 3. The evaluation of the course itself was following:

I am absolutely satisfied with the run of the course.	5,8
My participation in the course will have a positive influence on my students.	5,5
The atmosphere of the course was very nice.	5,8
I am highly motivated to teach these subjects at school.	5,2
The space for practical course was optimal.	5,4
I will use all of the experiments made during the course in my classes.	5,0
The participants became deeply involved in the event.	5,4
The instructions for the experiments are of high-quality.	5,3
There were enough lecturers during the course.	5,9
Lecturers were friendly and readily helped.	6,0
The experiments were proofed and worked without problems.	5,1
The course was too short.	2,7
There were few participants.	1,8
The expertise was too low.	1,6

Conclusion: *The course itself and the work of the lecturers was highly accepted, some of the participants thought the course was short.*

Table 4. The set of questions concerning *the leadership of the course*:

The lecturers …	Average value
... were fully prepared.	5,8
... explained the subject clearly.	5,9
... were concerned all the time.	5,8
... organized the experiment structurally and purposefully.	5,7
... reacted to stimuli and questions in a positive way.	5,9

Conclusion: *The participants were satisfied with the lecturers.*

Nottingham meeting

The results and experience from the laboratory course were presented to the members of the project CITIES during the informative meetings in Nottingham in March 2008 and in Barcelona in October 2008. The results from the questionnaires that teachers filled in after the laboratory course and some unclarities and suggestions to the experiments were included in a report and documented with photos from the course.

Looking at the photos opened the discussion concerning safety in the laboratory and its strict abidance (using the rubber gloves when cutting the apple or lemon). The situation of different practical application of health protection legislative in the countries of European Union showed, that there should also be discussed these questions of safety. It seems the aspect of outlined subject should be involved in the materials which will be/are prepared by CITIES.

Conclusion

Our experience with the courses described above proved, that the participating chemistry teachers are deeply interested in practical courses focused on new stimuli and laboratory experiments for education. The teachers appreciate the new adaptations of practical, applied and industrial chemistry for the educational uses. The intention to use the new experiments directly in the class arises from both the questionnaire and the communication during the courses. Therefore we find the courses and similar activities purposeful and enriching for the students in school classes. These results motivate us to design new experiments and adaptations according to the different teachers needs.

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