CHEMISTRY FOR GIFTED AND TALENTED: ON-LINE COURSE ON TALNET

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Abstract

Education of the gifted and talented children, as potential contributors for the whole society, is emphasized and actively supported in the educational policy of the European Union. The project "Talnet – Online to Science" originated in Czech Republic is one example of a wide scale of extracurricular activities focused on the education of the gifted and talented. The methods used in Talnet are based mostly on the interaction of the experts with the children, primarily in the on-line "T-courses". The paper describes the structure, content and results of a two-semester on-line course "Biochemistry and Natural Compounds" that integrates the problem solving method with the home-made chemistry experiments in the form of an e-learning course. About ten talented high-school students from Czech and Slovak Republic participated in the first semester of the course. According to the evaluation results, the students find the course interesting and enriching. Four final theses were written and will be defended; one of them is intended to be applied for the national Contest for Young Scientists.
Key words: *chemistry experiment, gifted and talented, e-learning, distance learning.*

Introduction

The major goal of the Lisbon Strategy, set out at the meeting of the European Council in Lisbon in March 2000, is to make the European Union "by 2010 the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion" (Lisbon Strategy, 2000). The most important group constituting a basis of European innovation capability and competitiveness are gifted and talented young people with their high cognitive and social potential and creativity. Recognizing the gifted and talented as potential positive contributors for the whole society, the European Parliament adopted a recommendation on education for gifted children in October 1994. It recommends the governments to take account of the following considerations in their educational policies (Recommendation 1248, 1994):

- highly gifted children, as with other categories, need adequate educational opportunities to develop their full potential;
- basic research in the fields of „giftedness" and „talent" and applied research, for instance to improve identification procedures, should be developed

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- teacher training programmes have to include strategies for identifying children of high ability or special talent.
- the ordinary school system should be made flexible enough to enable the needs of high performers or talented students to be met;

In November 2007 the COST (European Cooperation in Science and Technology) Strategic Workshop: Meeting the Needs of Gifted Children and Adolescents was held in Brussels. It gathered prominent European scientists and experts in order to discern the activities in the field of the promotion of the highly gifted European youth and to lay the foundations for future best practice exchange and initiatives in this area. The "Action Plan for the Gifted and Talented – an essential part of the Lisbon Strategy" declared as a result of this workshop speaks about the need of supporting the group of gifted and talented youth to foster properly their capabilities and aptitudes to the outstanding performance. It recommends the European Commission to establish a European Gifted and Talented Working Group with the following tasks (COST Strategic Workshop, 2007):

- management of the communication between all partners involved in gifted and talented education
- creation of a coordinated European gifted and talented network
- support the development and improvement of teacher education and teacher training
- support of gifted and talented projects

"TALNET – Online to Science" (www.talnet.cz)

Most of the high school teachers cannot ensure such individualisation of the school education that would meet the needs of gifted and talented children. Lack of time and space in the class can be compensated by the extracurricular activities focused on the children talents development. One of these gifted children supporting projects in Czech Republic is the project "TALNET – Online to Science".

The Laboratory of Distance Learning of The Faculty of Mathematics and Physics Charles University of Prague realizes the project Talnet where gifted children – identified by their teachers in the classrooms – are learned by using on-line and combined methods. The main aim of the project is to create learning opportunities for children of the age 14 – 19 years to identify their abilities, preferences and to develop their competencies in sciences. There is a scale of different methods used in Talnet based mostly on the interaction of the experts with the children. This interaction is realized primarily in the on-line "T-courses" (for "Talnet-courses") or live during the "T-excursions"(Zelenda, 2008).

The "T-course" starts at the introduction meeting in September. There are seventeen courses with the topics from physics, astronomy, biology, chemistry, geography and mathematics running in the current academic year. The "T-course" consists of four blocks: an autumn/spring collective on-line education in six and six lessons, and winter/summer individual work on the final thesis with its presentation at the winter/summer meeting and its on-line defence. The „T-excursion" is a combined activity that consist of three parts: on-line introduction to the subject, an excursion (field trip) to a research place guided by an expert or a researcher and focused on the practical activities and measuring, and an on-line final part with analysing, interpreting, presenting and discussing the results (Zelenda, 2008).

Biochemistry and Natural Compounds on-line course

For several years, the author has been interested in the home chemistry experiments and the possibilities of their utilisation in the various forms of chemistry education including the distance learning (Böhmová & ulcová, 2007). The integration of problem solving method with the home-

made chemistry experiments is the base of the on-line chemistry course "Biochemistry and Natural Compounds" running on the Talnet. The course is divided into one introductory lesson and five regular lessons with topics from natural compounds chemistry and biochemistry. The structure of a regular lesson planned for one week is following:

- few words as an introduction to the topic enlightening its connection with the daily life
- 1st part – Observation: instructions for the home chemistry experiment and a worksheet for observations and data recording including photo documentation
- 2nd part – Questions: a worksheet with tasks and questions leading to an explanation of the observed phenomena and the chemistry behind them
- 3rd part – Heavyweight: a worksheet with challenging problems connected with the observed phenomena and explanations of their essential principles

There are 9 - 15 gifted high-school students from the Czech and Slovak Republic studying in the course (there is no exact number because some students work only on the first or the second part of the lesson, some of them join only for some selected topics). The completed worksheets can be read, commented and marked by an instructor in the Talnet learning management system. In the case of the Observations worksheet, a grade can be usually assigned directly. In the case of the Questions worksheet, some comments, suggestions or advices from the instructor are often necessary for the student to obtain the full mark. The Heavyweight worksheet requires quite a different form of student's work. The problems are solved by the means of a Socratic/ heuristic dialogue between the student and the instructor, based on the problem introduction and particular questions set in the worksheet. Completing this part of the lesson takes usually from one to four weeks.

Lessons and topics presented in the winter block of the course

1. Introductory lesson

The lesson is focused on the safety problems connected with the work on the home chemistry experiments. The students are told which products and chemical compounds will be needed to carry out the experiments and where to buy them. The first task is to find out the safety and risk information about the compounds used in the course and to make up an analogy of the "lab rules" applicable for the experimental work at home – in the kitchen or bathroom.

2. Acid-Base Indicators – Occurrence and Function

Observation: the student compares the colour changes of four samples of red plant pigments from hibiscus, red pepper, tomato and blueberry in acidic, neutral and basic solution.
Questions: the student classifies the pigments into two groups according to their colour changes and their chemical structure; predicts the colour changes of an unknown red pigment.
Heavyweight: the student explains the principles of the observed colour changes (or colour stability) using the acid-base theory and the theory of resonance.

Figure 1. Red wine (dark blue at pH 12) and red pepper (no colour changes).

3. Starch – Occurrence and Function

Observation: the student explores the presence of the starch in different home products – cereals, plant parts, animal tissues, pastry, cosmetics, and products toughen with the starch.
Questions: the student deduces the function of the starch for a plant and an animal organism and some other household uses of this substance – based on the experimental results.
Heavyweight: the student considers the solubility of the starch using its chemical formula; explains and compares the function of starch in plants/animals in detail.

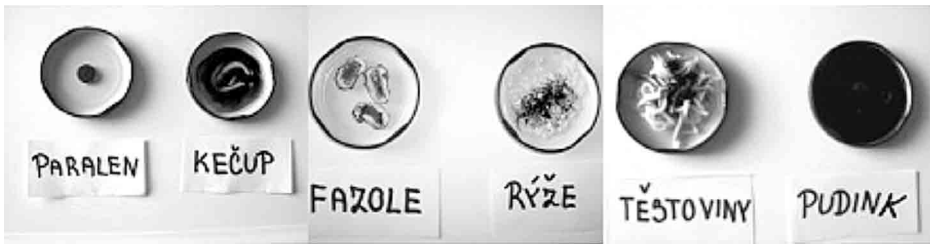


Figure 2. Positive starch test: pill, ketchup, beans, rice, spaghetti, blancmange.

4. Starch - Metabolism

Observation: the student explores an effect of salivary amylase and a boiled amylase on the starch – visualized by the iodine-starch reaction.
Questions: the student explains the digestion of the starch to the glucose.
Heavyweight: the student explains the human metabolism of the starch and glucose in detail, and compares it with the glucose and cellulose metabolism in plants.

5. Starch – Iodine-Starch Test Violation

Observation: the student explores three procedures affecting the positive iodine-starch test – heating of the mixture, addition of a vitamin C and addition of bleach (sodium hypochlorite).
Questions: the student suggests, realizes and interprets a simple experiment to determine whether the negative iodine-starch test was caused by an absence of iodine or starch.
Heavyweight: the student explains the principles of the iodine-starch test violation, writes balanced chemical equations and suggests interventions leading to the positive test result.

6. Enzymes

Observation: the student observes hydrogen peroxide decomposition accelerated by a silver jewel and a fresh potato (catalyse), identifies the gaseous product using a smouldering skewer.
Questions: the student writes a balanced chemical equation of the observed reaction, and names some other occurrences of the catalyse enzyme.
Heavyweight: the student explains the microscopic principles of an enzyme function in detail, using energy diagrams and the conceptions of the thermodynamics.

Figure 3. Hydrogen peroxide (no bubbles), hydrogen peroxide with a silver ring (some bubbles), hydrogen peroxide with a piece of potato (intensive bubbles).

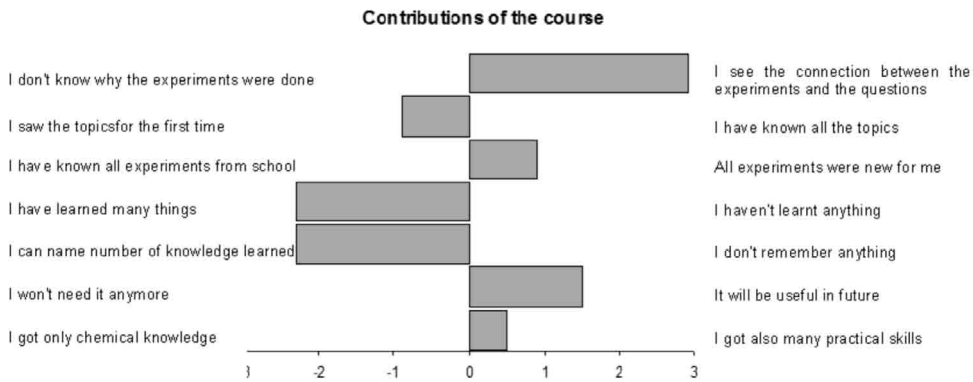
7. Final thesis

Four final theses were elaborated at the end of the winter block of education. The themes were: Anthocyanins and Human Health; The Ink; Amylases in Sprouting Seeds; Biochemistry of Plant Sprouting. The theses are defended on-line during one week in January, any student or instructor can ask a question to a thesis from any course. The presentations of the theses and the defence in front of the committee will follow during the winter workshop in February. One of the theses is intended to be applied for the national Contest of Young Scientists.

The spring block of the education will be run in the forthcoming months. The themes are: kinetics of the enzymatic reactions, tannins, proteins and photosynthesis.

Evaluation results

Nine students who had completed the course (from 15 students starting) filled the questionnaire to share their experience, suggestions and attitudes with the instructors and the author of the course. Each question has a six point scale (from -3 to +3) between two extreme statements. The questions can be divided into three groups – contributions of the course for students, organisation of the course, and students' work attitudes and preferences.



According to the questionnaire, the students have gained a number of useful chemical knowledge (both theoretical and practical) and some practical skills in the course. The progress can be confirmed by the instructors working with the students during the winter educational block. The real long-term contributions will be objectively examined during the spring lessons, when the knowledge from the winter lessons will be used.

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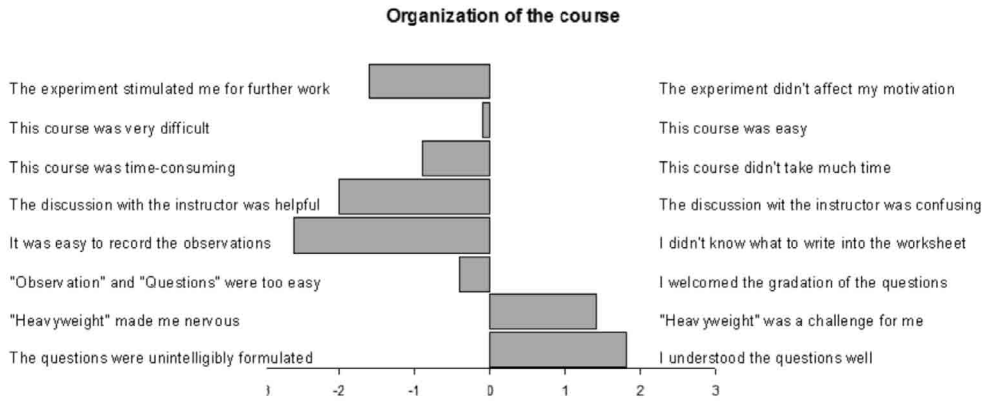
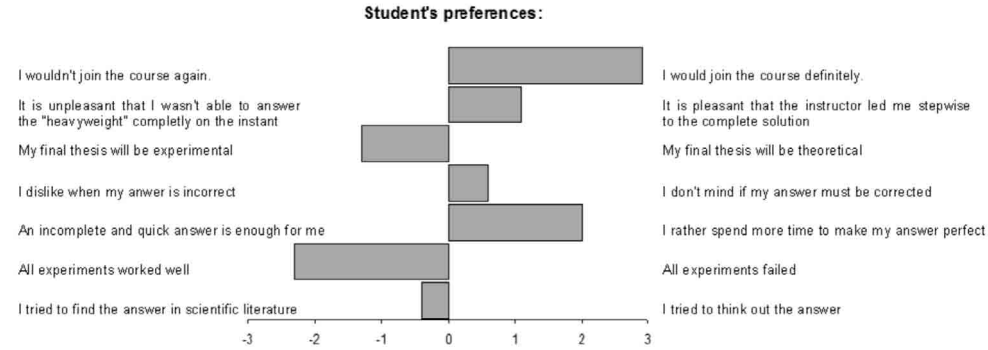


The starting experiment brings an important motivation for the further work in the course that is quite time-consuming. All the three parts of the lessons were neither excessively difficult nor too easy for the students and the dialogue with the instructor was found helpful. Therefore the same educational forms and methods will be used in the continuing of the course.



The students are very satisfied with the course and would join it again. They accept the corrections from the instructor and the stepwise process of completing the solution in a dialogue. The results agree with the instructors' observations through the communication with the students. Some individual preferences will be taken into account in the spring block.

Conclusions

The on-line chemistry course "Biochemistry and Natural Compounds" became a good learning opportunity for at least nine talented high-school students from Czech and Slovak Republic. The individual approach, practical activities, intellectual challenges and the possibility of expert consultations is an evident benefit for these talented children who are by far not optimally engaged with their school work. Other forms of cooperation between the instructors and the students arose from the course: scientific and technical consultation, deepening the school chemistry topics or work for the national Contest of Young Scientists. The course will continue in years to come, modified according to the students' feedback.

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