

CHARLES UNIVERSITY IN PRAGUE, Faculty of Science

Department of Teaching and Didactics of Chemistry



**Hypermedia educational program Halogen chemistry
and its application in the education of gifted pupils in
chemistry**

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Summary of Ph.D. Thesis

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This Ph.D. thesis was worked out during a regular doctoral study at the Department of Teaching and Didactics of Chemistry, Faculty of Science, Charles University in Prague.

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KEY WORDS

Hypermedia; education software; interactive and flexible program; XHTML; halogen chemistry; videorecording of chemical experiments; education of gifted pupils; distance education; e-learning.

Introduction

The education of gifted pupils reflects problems dealt by the current chemistry education. There is a lack of presentation chemistry as an experimental subject and scientific discipline (by chemical experiments demonstrations or pupils experimental work), too little examples of chemistry as a science useful for humankind and its application in different fields of industry as well as in everyday life. This all, together with underestimation of gifted pupils (pupils interested in chemistry) special educational needs, can lead to the loss of motivation and interest in chemistry as a subject.

I believe that the key the solution is to improve the individual attitude to gifted pupils (pupils interested in chemistry) education. This effort became the main aim of the presented thesis. It consisted of several partial aims:

- Reconnaissance of the gifted pupils education legislation support in the Czech Republic.
- Comparison of gifted pupils education in the Czech Republic and abroad.
- To run a questionnaire among grammar school chemistry teachers, dealing with their attitudes and opinions of gifted pupils education in the Czech Republic
- To find out a percentage of pupils interested in chemistry in Czech grammar schools.
- To suggest and create a solution to the problems found in gifted pupils education.
- To process the topic “Halogen Chemistry” into a teaching aid suitable for gifted pupils (pupils interested in chemistry) education in chemistry.
- To test the created teaching aid and its influence on gifted pupils (pupils interested in chemistry) education in chemistry.
- To find out the rate of didactic effectiveness of the created teaching aid by means of didactic tests (in relation to the education process results and the interest in the subject).
- To gain a feedback to the created teaching aid from pupils and teachers by means of a questionnaire.
- To suggest an utilisation of the teaching aid in distant learning of gifted pupils, eventually to apply it.

Theoretical part

In the theoretical part, I dealt with theoretical models of giftedness as well as identification and education of gifted pupils particularly in chemistry. I focused on gifted

pupils (pupils interested in chemistry) education process problems and on their needs, which often are different from teachers' possibilities and conceptions.

Nowadays we most frequently use complex models to describe giftedness (Renzulli, 1978; Sternberg, 1985; Mönks, 1987; Gagné, 1991). I concerned particularly to intellectually gifted pupils, who according to Hříbková (2009) are divided into two types: solvers (who are very good at quick solution of a task) and researchers (who like to get to the root of a problem).

Identification of gifted pupils is a long-term and very complex process involving testing, observation and pupils portfolio assessment. Giftedness is highly difficult to scientifically prove and it is not usually limited to one field but exceeds to several (sometimes not related) fields. However, giftedness is insignificantly accompanied with specific learning disabilities or even other problems, and these pupils are generally called "twice-exceptional" pupils (Jurášková, 2006).

Most authors dealing with giftedness agreed on the necessity of individual approach to gifted pupils education and curriculum differentiation (Jurášková, 2006):

- Necessity to accept specific displays of gifted pupils as well as their character and emotional unusualness.
- Modification of curriculum (including the content and form of the education process), so that it affects effectively the gifted pupils progress.

Experimental part

Program creating

Following the thesis of Dvořák (2009), I decided to create a teaching aid suitable for an easier curriculum differentiation as well as for home preparation of pupils interested in chemistry. (I focused at pupils interested in chemistry instead of gifted pupils, because of difficult process of their identification. I assumed that the bigger group involves gifted pupils). This teaching aid resulted from demands and remarks of gifted pupils (in the project Talnet), teachers and other specialists in giftedness.

I created the teaching aid as a XHTML program on the theme "Halogen chemistry". The program is based on 80 videorecordings (Fig. 1) of chemical experiments (in flv format), referring not only to chemical characteristics of elements and their compounds but also to their preparation, production and practical utilization. A great deal of the program is devoted particularly to a practical utilization of halogens and their significant compounds as well as safety and risk assessment (Shakhashiri, 1992; Greenwood, Earnshaw, 1993; Čtrnáctová et al., 2000; Atkins et al., 2006).



Fig. 1 - A printscreen of one of the interhalogen videorecording in the program "Halogen chemistry"

According to the used technologies, the program could be classified as hypermedia. It is flexible (easily editable, as for its structure and content, unlike commercial programs), interactive and multimedia. Despite a great number of videorecordings, pictures and photos, the data do not exceed the CD data capacity (Bílek, 2005; Čipera et al., 2007).

Research

I tested the created program by the means of didactic tests, and gained a feedback from questionnaires at seven grammar schools in the Czech Republic. Seven teachers and 201 pupils participated in the research.

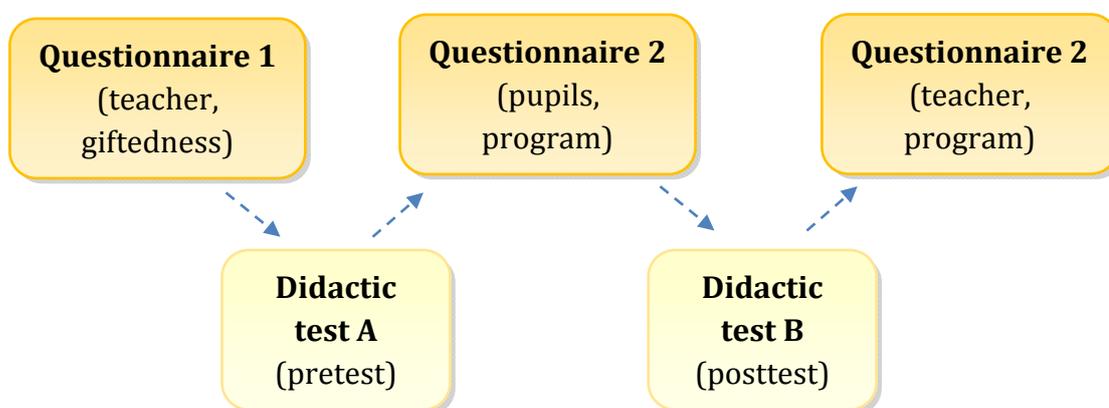


Fig. 2 - A scheme of the research run

The research problem could be summarized as the following question: Is there a difference among the groups of teachers, pupils interested in chemistry and other pupils in the program "Halogen chemistry" evaluation and in the contribution of the program for individual groups? Pupils expressed their interest in chemistry in the Questionnaire 2 (Fig. 2). I formulated eight hypotheses and verified them by instruments of statistical analysis at the significance level $\alpha = 0.05$ (Meloun, Militký, 2006):

H₁: The raw score of the pretest (Didactic test A) will be higher in the group of pupils interested in chemistry than in the group of other pupils.

H₂: The raw score of the posttest (Didactic test B) will be higher in the group of pupils interested in chemistry than in the group of other pupils.

H₃: The difference in the pretest and the posttest results (Didactic tests A and B), representing a didactic effectiveness of the program “Halogen chemistry”, will be higher in the group of pupils interested in chemistry than in the group of other pupils.

H₄: The capability of the program “Halogen chemistry” to induce an effort to search for additional information, expressed as a raw scores difference of some of the pretest and the posttest items results (Didactic tests A and B), will be higher in the group of pupils interested in chemistry than in the group of other pupils.

H₅: The motivation asset of the program “Halogen chemistry”, expressed as a centre value of the points gained in particular questionnaire items, will be higher in the group of pupils interested in chemistry than in the group of other pupils.

H₆: The evaluation of the program “Halogen chemistry” as a whole, expressed as a centre value of the points gained in particular questionnaire items, will not differ between the tested groups : pupils interested in chemistry, other pupils and teachers.

H₇: The evaluation of the graphical interface of the “Halogen chemistry” program, expressed as a centre value of the points gained in particular questionnaire items, will not differ between the tested groups: pupils interested in chemistry, other pupils and teachers.

H₈: The evaluation of the text part of the “Halogen chemistry” program, expressed as a centre value of the points gained in particular questionnaire items, will not differ between groups: pupils interested in chemistry, other pupils and teachers.

E-learning

Two topics of the program “Halogen chemistry” were used in the modification of an e-learning course “Chemistry 3” for gifted pupils. The course is a part of the project Talnet and it took place in the school year 2009/2010. Both new topics, “Halogen bulb” (Fig. 3) and “Freons”, got a very positive feedback from participants. This reaction was apparent not only from the final evaluation of the course, but also from quicker and more frequent sending the tasks back. There was a richer discussion regarding these topics, too.

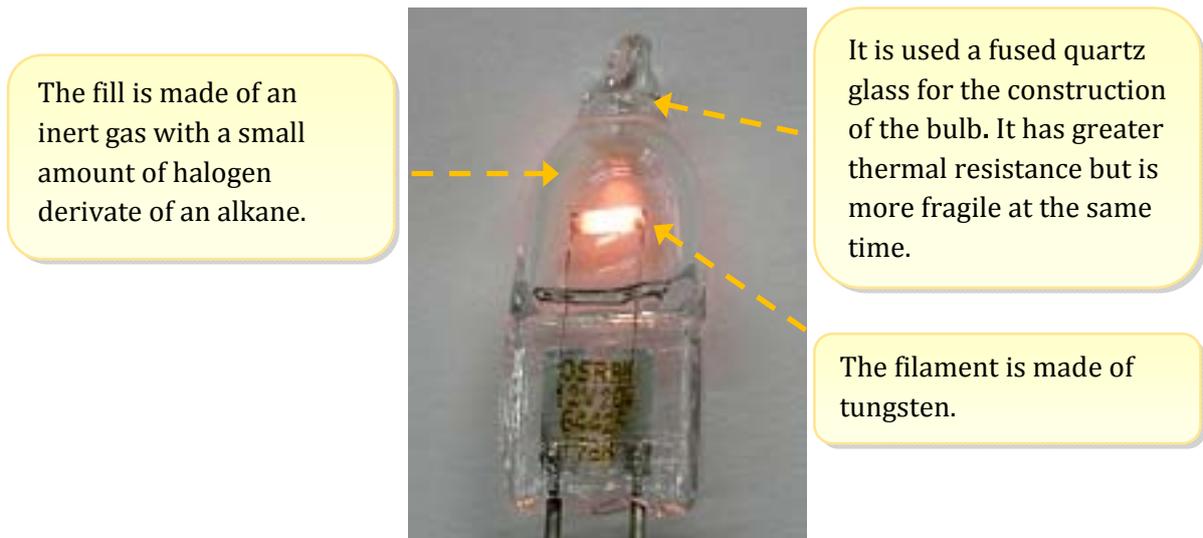


Fig. 3 - An extract of the study text for the topic "Halogen bulb", used in the e-learning course "Chemistry 3"

Summary

In my dissertation, I dealt with the problem of education of gifted pupils in chemistry. I particularly focused at a detailed search in this scientific field, problems identification and suggesting as well as realisation of possible solutions. All the particular aims specified in the introduction were gradually accomplished.

A survey among high school chemistry teachers (in the form of questionnaires) showed that there neither is a sufficient attention paid to the gifted pupils education in the Czech Republic, nor the prospective teachers are systematically prepared for this role. There are also consequent problems with gifted pupils curriculum differentiation, which most teachers consider to be more suitable for the gifted pupils education than a (lepší asi their?) segregation and separate education. Teachers lack a sufficient amount of enough information about curriculum differentiation (individual approach) and educational software, suitable and available for the education of gifted pupils.

On the basis of this survey, reserch results and my own experience in this field, I designed and created a hypermedia teaching aid as a XHTML program. The main theme was "Halogen chemistry", because of its universal relevance. The main purpose of this program was to facilitate differentiation of curriculum for pupils interested in chemistry (gifted pupils) at school or during a self-study. I tested the created program "Halogen chemistry" in several grammar schools of different parts of the Czech Republic. I was particularly interested in the influence of the program upon pupils interested in chemistry (in comparison with the other pupils) as well as in the feedback from pupils and teachers.

It was statistically proven that the program "Halogen chemistry" had a bigger influence on the effectivity of the education process in pupils interested in chemistry than in the other pupils. On the other hand, the ability of the program to induce a pupils

effort to search for additional information was not proven to be higher in the group of pupils interested in chemistry than in the others. It was confirmed that teachers have a very strong influence on the formation and developing of pupils interest in chemistry. In general, the program was very well evaluated by all the groups involved in the research (pupils interested in chemistry, other pupils, teachers). The best evaluation was given by teachers, but their research sample was not representative.

I also used two topics of the program "Halogen chemistry" ("Freons", "Halogen bulb") in an e-learning course, designated for gifted pupils as a part of the project Talnet. These topics were better assessed by the pupils compared to the other topics. I assume this was thanks to the closer connection with everyday life that resulted in greater interestingness of these topics.

I have also used two topics of the program („Freons“, „Halogen bulb“) in the e-learning course designated for gifted pupils as a part of the project Talnet. These topics were better assessed by the pupils compared to the other topics. I assume this was thanks to the closer connection with everyday life that resulted in greater interestingness of these topics.

References

- ATKINS, P. ET AL., 2006. *Shriver&Atkins Inorganic chemistry*. 4th edition. Oxford University Press, Oxford. 822 pp. ISBN 978-0-19-926463-6
- BÍLEK, M., 2005. *ICT ve výuce chemie*. Gaudeamus, Hradec Králové. ISBN 80-7041-631-9
- ČIPERA, J. ET AL. Chemistry education – Computers – ICT. In *2nd European Variety in Chemistry Education*, Prague: Charles University Faculty of Science, 2007a, ISBN 978-80-86561-85-1
- ČTRNÁCTOVÁ, H. ET AL. *Chemické pokusy pro školu a zájmovou činnost*. Praha: Prospektrum, 2000, ISBN 80-7175-071-9
- GAGNÉ, F. Toward a Differentiated Model of Giftedness and Talent. In Colangelo, N., Davis, G.A. (Eds.) *Handbook of Gifted Education*, Needham Hights, Allyn and Bacon, 1991, s. 65-80
- GAGNÉ, F., 1991. Toward a Differentiated Model of Giftedness and Talent. In: Colangelo, N., Davis, G.A. (eds), *Handbook of Gifted Education*. Allyn and Bacon, Needham Hights: 65-80.
- GREENWOOD, N. N., EARNSHAW, A. *Chemie prvků I, II*. Praha: Informatorium, 1993, ISBN 80-85427-38-9
- HŘÍBKOVÁ, L. *NADÁNÍ A NADANÍ*. PRAHA: GRADA, 2009, 256 s., ISBN 978-80-247-1998-6
- JURÁŠKOVÁ, J. *Základy pedagogiky nadaných*. Praha: IPPP ČR, 2006, ISBN 80-86856-19-4
- MÖNKS, F. J. *Beratung und Förderung besonders begabter Schüler*. Psychol. Erz. Unterr., 1987, 34, s. 214-222
- RENZULLI, J. S. *What makes giftedness? Re-examination a definition*. Phi Delta Kappan, 1978, 60, s. 180-184
- SHAKHASHIRI, B. Z. *Chemical Demonstrations: A Handbook for Teachers of Chemistry*, Volume 4, Wisconsin, USA: The University of Wisconsin Press, 1992
- STERNBERG, R. J. *Beyond IQ: A triarchic theory of human intelligence*. New York: Cambridge University Press, 1985

Curriculum vitae

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Selected publications

Čípera, J.; Klímová, H.; Chlubna, P.; Dvořák, M.; Kamlar, M.; Roštejnská, M.; Teplý, P. *Chemistry education – Computers – ICT*. In 2nd European Variety in Chemistry Education, Charles University – Faculty of Science, Prague 27.-30.6. 2007, ISBN 978-80-86561-85-1

Čípera, J.; Klímová, H.; Dvořák, M.; Kamlar, M.; Chlubna, P.; Roštejnská, M.; Teplý, P. *Použití flexibilních programů v procesu osvojování chemického učiva*. In: Aktuálne trendy vo vyučovaní prírodovedných predmetov, Univerzita Komenského v Bratislave (28.-30. 5. 2007): 389-392, ISBN 978-80-88707-90-5

Teplý, P.; Čípera, J. *Využití DiV při práci s talentovanými žáky v chemii*. In: Alternativní metody výuky, PŘF UK Praha (26.4. 2007), ISBN 978-80-7041-129-2

Čípera, J.; Dvořák M.; Kamlar M.; Teplý P.: *Multimediální programy v chemii*. In: Inovačné trendy v prírodovednom vzdelávaní, Trnava: Trnavská Univerzita, 2007:12-14, ISBN 978-80-8082-130-2

Teplý, P.; Čípera, J.: *Flexibilní program „Chemie železa“*. In: Soudobé trendy v chemickém vzdělávání (sborník z mezinárodního semináře Aktuální otázky výuky chemie XVI.) Gaudeamus 2006, Univerzita Hradec Králové, ISBN 80-7041-560-6

Čípera, J.; Dvořák, M.; Chlubna, P.; Teplý, P.; Kamlar, M.; Ševčík, J.: *Multimediální prostředky ve vzdělávání v chemii*. Sborník příspěvků Alternativní metody výuky, PŘF UK, Praha 27.4. 2006

Čípera, J. a kol. *Gifted pupils education in Chemistry via e-learning*. *Chemia bliżej życia. Kształcenie chemiczne w swietle nowej podstawy programowej*, Poznań, Poland, 2009, s. 69-73, ISBN 978-83-89723-77-8