

RESEARCH ON USING THE INTERNET IN CHEMISTRY TEACHING

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Abstract

This article describes some of the results of a research that is mapping the use of the Internet and electronic materials in Chemistry teaching at grammar schools in the Czech Republic. The research was made in 2008 – 2009 at the Faculty of Science of Palacky University in Olomouc. The main aim was to answer the question “What is the extent of the use of the Internet and electronic materials available on it in activities related to teaching Chemistry at grammar schools in the Czech Republic?” and, through this research, to acquire necessary information for preparation own chemical educational portal. It was a quantitative descriptive research; the research method was a questionnaire. The random sample included 50 Chemistry teachers from 50 different grammar schools in the Czech Republic (from total number of 368 grammar schools). Most of the teachers used in connection with teaching Chemistry the Internet and many different electronic materials; they used mostly free materials rather than paid and visited some web pages at least once a week. The vast majority used programs and services enabling basic work with the materials, chemical graphic programs were used just by a half of the respondents.

Key words: chemistry, electronic material, Internet, questionnaire, teaching.

Introduction

The actual growing importance of information and communication technologies is reflected in many areas, including the Chemistry teaching. A powerful tool for obtaining a lot of information is the Internet, which offers a variety of electronic teaching materials: videos, electronic presentations, educational programs, animations, simulations of processes, learning texts, discussion forums, lists of links, etc. These materials, respectively references to them can be grouped in specialized chemical teaching portals.

The research mapping the use of the Internet in Chemistry teaching at grammar schools in the Czech Republic was made in 2008 – 2009 at the Faculty of Science of Palacky University in Olomouc.

The main purpose of this research was to answer the basic research question “*What is the extent of the use of the Internet and electronic materials available on it in activities related to teaching Chemistry at grammar schools in the Czech Republic?*” The work was focused on a basic research – the description of the contemporary state of the use of the Internet and electronic materials available on it in activities related to teaching Chemistry at grammar schools in the Czech Republic. The aim was to describe the situation just in the Czech Republic (because this type of a research was missing in the Czech Republic) and, through this research, to acquire necessary basic information for future potential comparative researches and mainly information for preparation of own chemical educational portal, which would suit the wide teachers’ public.

The basic research question was further divided into 5 sub-questions that can be formu-

lated as follows:

- RQ1: How often and to what extent do teachers use the Internet and electronic materials in connection with teaching Chemistry?
- RQ2: Do the Chemistry teachers create their own electronic teaching materials?
- RQ3: If the Chemistry teachers create their own electronic teaching materials, how do they provide it to students respectively to the public?
- RQ4: Would the Chemistry teachers appreciate a new complex chemical teaching portal dedicated just to them?
- RQ5: What is the support of Chemistry teachers in the use of the Internet and electronic materials from the school management?

A wide range of authors in the Czech Republic are interested in the theme of the Internet or, more generally, information and communication technologies – e.g. Bílek and Zemanová (2007), Šmejkal (2005), or Frýzková (2009). From the Slovak Republic can be mentioned these authors: Ganajová (1999 and 2008) and Haláková (2005).

The authors Škoda and Doulik (2003) did a research on the use of ICT in Chemistry teaching in the year 2002 (and also in 2000). A questionnaire method was used in the research in 2002 and it was focused on chemical educational programs – their use in tuition in primary schools and at the first stage of grammar schools in the regions of Usti nad Labem and Liberec. In this research only a small part was directly devoted to the Internet and electronic materials (frequency of Internet and its applications usage by teachers of Chemistry, teachers' attitude to the importance of the Internet). According to the authors, the effective use of hypermedia in tuition is limited by four basic factors: the technical equipment, the appropriate applications, the readiness of pupils and students and finally the readiness of teachers. According to this point of view our research (at the Palacky University) covered three of them: the readiness of teachers, the appropriate applications and the technical equipment needed to effective use of the Internet and its applications (readiness of students wasn't enquired).

Roštejnská (2008) describes in her dissertation a research called "Teaching biochemistry at secondary schools" in which a questionnaire was given to teachers of Chemistry. Its purpose was to describe the current state of teaching biochemistry and use of computer technology at secondary schools in the Czech Republic. The part dealing with computer technology included computer literacy of teachers, next the purposes for which computers are used, providing materials to students and technical facilities of schools.

The article of authors Zákostelná and Šulcová (2008) refers to the dissertation of RNDr. Renata Šulcová, Ph.D., which is, among others, dealing with a comparison of the same schools in electronics and ICT equipment for teaching Chemistry (in years 2000/01 and 2005/06).

It can be seen (from the similar researches of the other authors described above) that our research was really original – several reasons are formulated below. The character of the target group was special (we worked with Chemistry teachers at grammar schools in the Czech Republic), but many other researches didn't work exactly with the same target group – they worked e.g. with all secondary-school teachers (such as Roštejnská (2008)) or with teachers of primary schools and the first stage of grammar schools (such as Škoda and Doulik (2003)). The main topic of other researches was often very similar, but different – e.g. it generally concentrated on ICT (such as Škoda and Doulik (2003)), but our research specialized mainly on the Internet. Therefore the comparison with other researches would be complicated and it wasn't the aim of this research.

Methodology of Research

General Characteristics of the Research

A quantitative descriptive research was chosen as a type of research. The main purpose was to acquire necessary basic information describing the contemporary situation of using the Internet and electronic materials available on it in connection with teaching Chemistry at grammar schools in the Czech Republic (the comparison with other researches wasn't the aim). The acquired information was also important for preparation of chemical educational portal. This portal started to be planned for secondary-school Chemistry teachers in keeping with the results of the research.

At the end of March 2009 a pilot study was done among 15 grammar-school teachers. The main research started in April 2009.

Sample Selection

As a target group were chosen Chemistry teachers at grammar schools in the Czech Republic. The extent of the population was 368 grammar schools according to register of Czech schools (MŠMT, 2010) and a representative sample, in accordance with statistical theory of the experiment, included 50 Czech grammar schools. Then one Chemistry teacher was randomly chosen at each of the selected schools (a respondent representing the school). Finally, the random sample included 50 Chemistry teachers from 50 different grammar schools in the Czech Republic. This procedure is called "two-stage cluster sampling".

Instrument

The chosen research method was a questionnaire. The questionnaire contained nine questions, which sometimes contained other sub-questions.

Open-ended (for respondent's own formulation of an answer) and closed-ended questions (dichotomous and multiple choice questions) occurred in the questionnaire. The questions inquired mainly nominal and ordinal data, but occasionally tested also interval data (the Likert items).

With regard to constitution of the inquired data (including the work with computers and the Internet) classical distribution of printed questionnaires was used, but teachers could also fill out electronic version of the questionnaire (directly in MS Word and then send it completed back by the e-mail). According to the pilot study the content and graphic optimization of the questionnaire was done before posting (in April 2009) the final version of the questionnaire to 50 Chemistry teachers.

The entire questionnaire can be divided into 5 parts (see Table 1) – each part deals with an individual research question (RQ1 – RQ5).

Table 1. The structure of the questionnaire.

Questionnaire part	Research question	Questions in the questionnaire
1	RQ1	1, 2, 3, 4, 6, 6A
2	RQ2	2, 4, 5
3	RQ3	5
4	RQ4	6B, 6C, 6D, 2
5	RQ5	7, 8, 9

The questionnaire was sent together with a covering letter, which besides instructions for its completion, contained demographic questions (sex and a number of years of practice of the respondents) followed by an area for teachers' comments and organizers' acknowledgement. The instructions also included a definition of a basic term which was repeatedly occurring throughout the questionnaire. This term was an *electronic material* which for the purpose of this research meant: "whichever (educational) document, file or program created using a computer that can be given on the Internet or downloaded from it (a web site, an electronic presentation, an educational program, etc.)". Teachers were also informed that all questionnaire data concern the teaching of Chemistry (and no other subject).

Return of the Questionnaires

45 (90.00 %) completed questionnaires returned back – a relatively high number.

Characteristics of the Sample

50 grammar-school Chemistry teachers were contacted in the survey (37 women and 13 men), a completed questionnaire returned (and thus participated on the research) 45 teachers (32 women and 13 men), i.e. all of the men, but only 86.49 % of the women.

Teachers working at pedagogical practice in the range of 2 –10 years (33.33 % of the sample), 10 – 20 years (28.89 %) and more than 20 years (31.11 %) were relatively equally represented in the sample (15, 13 and 14 respondents), a smaller part of the sample were beginning teachers (2, i.e. 4.44 %). One respondent didn't specify the length of his teaching practice.

Data Analysis

The program ABBYY FlexiCapture 8.0 Professional was used for OCR (optical character recognition of printed questionnaires) and for export of the obtained data to MS Office Excel 2007. Excel was used for first data analysis (computing absolute and relative frequencies of the answers). Next, program PASW Statistics 18 (formerly know as SPSS Statistics 18) was used. Firstly, it was used to control possible mistakes in former data analysis (absolute and relative frequencies) and then it has been used for deeper statistical analysis. This article describes the first results.

Results of Research

The text below is dealing with a technical description of some of the results of the research. The first results, only from the first part of the questionnaire (because of the extent of this article) are presented (but other parts of the questionnaire were processed on equal level).

Results of the 1st Part of the Questionnaire – the Extent of Usage of the Internet

The first part of the questionnaire should have answered the first research question RQ1: "How often and to what extent do teachers use the Internet and electronic materials in connection with teaching Chemistry?" As for the extent of usage of the Internet, this part tested whether the teachers used the Internet or not (questions 1 and 6) and eventually for what purposes connected with teaching they used it (question 1), next which electronic materials, programs and services enabling basic work with these materials teachers used (questions 2, 3 and 4). The frequency of visiting web pages in connection with teaching Chemistry was tested in the question 6A.

The 1st question found out *for which purposes connected with teaching Chemistry the respondents used the Internet or materials downloaded from it.*

The vast majority (42 respondents, 93.33 % of the sample) said that they used the Internet during their preparation for Chemistry tuition. A relatively large proportion of respondents (26 respondents, 57.78 %) said that they used the Internet right in the lessons, 5 respondents (11.11 %) specified that they used the Internet to evaluate the teaching. It is interesting that no respondent chose the option that he didn't use the Internet in connection with teaching Chemistry.

The aim of **the 2nd question** was to determine *which electronic materials in connection with teaching Chemistry the teachers used or created, and next if teachers understood basic terms related to electronic materials or not.*

The respondents should have marked out whether statements about each electronic material (sub-questions 2A through 2H) related to teaching Chemistry, preparations for it and its evaluation was valid for them or not. An overview of frequencies related to this question is in the table below (Table 2).

Table 2. The summary of answers on question 2 – absolute frequencies (percentage [%]).

Electronic material (100 % = 45)	I use and create	I use, but I don't create and it is bought (by school, by me)	I use, but I don't create and it is free of charge	I don't use but I would like to	I don't understand the term	Respondent didn't answer
2A	4 (8.89)	35 (77.78)	15 (33.33)	3 (6.67)	0 (0)	3 (6.67)
2B	30 (66.67)	5 (11.11)	6 (13.33)	11 (24.44)	0 (0)	3 (6.67)
2C	1 (2.22)	17 (40)	10 (22.22)	20 (44.44)	0 (0)	4 (8.89)
2D	1 (2.22)	2 (2.22)	19 (42.22)	13 (31.11)	0 (0)	12 (26.67)
2E	1 (2.22)	0 (0)	21 (46.67)	13 (28.89)	0 (0)	10 (22.22)
2F	3 (6.67)	9 (20)	15 (33.33)	18 (40)	0 (0)	7 (15.56)
2G	0 (0)	3 (6.67)	3 (6.67)	13 (28.89)	1 (2.22)	25 (55.56)
2H	2 (4.44)	4 (8.89)	10 (22.22)	22 (48.89)	0 (0)	9 (20)

Legend to question 2:

2A – a video,

2B – an electronic presentation (e.g. a presentation in the PowerPoint),

2C – a program for teaching Chemistry on a CD or on the Internet (not presentations, not graphic programs for creation of pictures),

2D – a chemical teaching portal or a web page,

2E – an expert chemical web page not dealing with teaching,

2F – an animation or a simulation of a process,

2G – a mailing list or a discussion forum,

2H – an electronic test of knowledge.

Which of these materials teacher used or didn't use (options "don't use, but they would

like to” and “don’t understand the corresponding term” or when the respondent didn’t answer the question) can be deduced from the responses to the question 2 – see a chart below (Figure 1). Most of the teachers (86.67 % of the sample) used videos, then a lot of respondents used electronic presentations (68.89 %) and almost half of the sample used chemical educational programs (46.67 %), visited chemical educational websites (44.44 %) or expert sites (48.89 %) and used various animations and simulations of processes (44.44 %). The least used materials were discussion forums and mailing lists (13.33 %) and electronic tests (31.11 %)

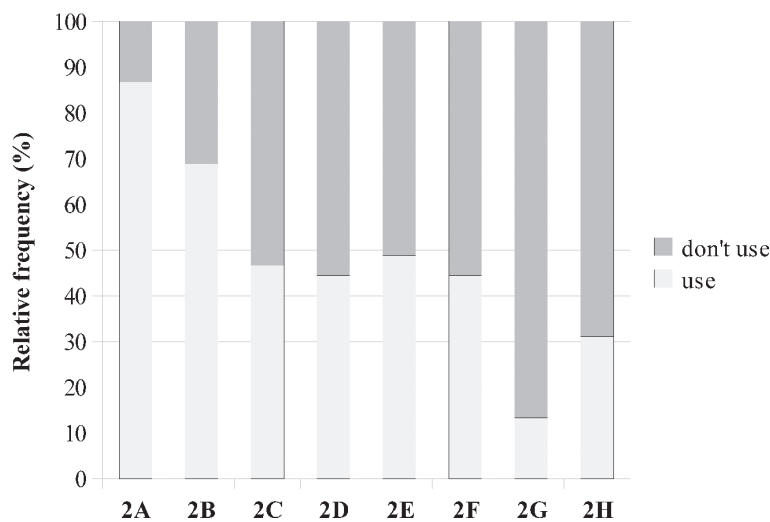


Figure 1. The use of electronic materials (100 % = 45).

The Table 3 below shows 95% confidence intervals of the proportions. For example we can be 95% sure (with confidence level 95%) that the proportion of Czech grammar-school whose Chemistry teachers use electronic presentations in connection with teaching Chemistry, falls into the range from 55.36% to 82.42%.

Table 3. 95% confidence intervals of the proportions (expressed in percentages).

Electronic material	Use	Relative frequency (%)	95% confidence interval (%)
2A	yes	86.67	[76.73; 96.60]
	no	13.33	[3.40; 23.27]
2B	yes	68.89	[55.36; 82.42]
	no	31.11	[17.58; 44.64]
2C	yes	46.67	[32.09; 61.24]
	no	53.33	[38.76; 67.91]
2D	yes	44.44	[29.93; 58.96]
	no	55.56	[41.04; 70.07]
2E	yes	48.89	[34.28; 63.49]
	no	51.11	[36.51; 65.72]
2F	yes	44.44	[29.93; 58.96]
	no	55.56	[41.04; 70.07]

	no	55.56	[41.04; 70.07]
2G	yes	13.33	[3.40; 23.27]
	no	86.67	[76.73; 96.60]
2H	yes	31.11	[17.58; 44.64]
	no	68.89	[55.36; 82.42]

From the responses to the 2nd question can be also deduced how many respondents used the free of charge materials (i.e. their own materials or materials from the others which are free of charge) and how many respondents used paid materials (bought by someone). The Table 4 shows that the most used materials for free were electronic presentations (31 respondents, 68.89 % of the sample), almost half of the respondents used in connection with teaching free websites (20 respondents, 44.44 % of the sample used teaching web pages; 22 respondents, 48.89 % of the sample used expert sites). It can be also said that respondents used most of the tested materials for free rather than paid. Exceptions are videos and educational programs which they used rather paid (videos – 35 respondents, 77.78 % and educational programs 17 respondents, 37.78 %).

Table 4. Free of charge vs. paid materials – absolute frequency (percentage [%]).

Electronic materials (100 % = 45)	Materials for free	Paid materials
Videos	17 (37.78)	35 (77.78)
Electronic presentations	31 (68.89)	5 (11.11)
Programs for teaching Chemistry on a CD or on the Internet	10 (22.22)	17 (37.78)
Chemical teaching portals or web pages	20 (44.44)	2 (4.44)
Expert chemical web pages not dealing with teaching	22 (48.89)	0 (0)
Animations or simulations of processes	15 (33.33)	9 (20)
Mailing lists or discussion forums	3 (6.67)	3 (6.67)
Electronic tests of knowledge	12 (26.67)	4 (8.89)

In the 3rd question of the questionnaire respondents should have expressed *whether they used programs or services* (listed below the question) *in activities related to teaching Chemistry* (see Table 5).

Table 5. The use of programs and services – absolute frequency (percentage [%]).

Program or service	Yes	No	No answer	Total
3A	19 (42.22)	23 (51.11)	3 (6.67)	45 (100)
3B	44 (97.78)	0 (0)	1 (2.22)	45 (100)
3C	37 (82.22)	7 (15.56)	1 (2.22)	45 (100)
3D	14 (31.11)	30 (66.67)	1 (2.22)	45 (100)
3E	45 (100)	0 (0)	0 (0)	45 (100)

Legend to question 3:

- 3A – chemical graphic programs (e.g. ChemSketch, ISIS/Draw, ChemDraw, ChemWindow, etc.),
- 3B – web search engines (Google, Yahoo, AltaVista, Seznam, Atlas, Centrum, etc.),
- 3C – e-mail (electronic mail),
- 3D – online gradebooks,
- 3E – text editor (e.g. Microsoft Word, OpenOffice Writer, etc.).

The vast majority of respondents used (in connection with teaching Chemistry) text editors, web search engines and e-mails (100 %, 97.78 % and 82.22 %). The least used program is an online gradebook – its use depends largely on the school and not on the choice of the respondent. About a half of the respondents didn't use chemical graphic programs and nearly a half of them did.

The use of other electronic materials, educational programs or services not mentioned in questions 2 and 3 investigated **the 4th question**. If a respondent used some, he should have written which material it was and its type (his own, paid or free of charge).

The vast majority of respondents (82.22 % of the sample) wrote that they didn't use other electronic materials, programs or services than those mentioned in questions 2 and 3. Therefore it can be assumed that questions 2 and 3 covered almost the entire field of the use of the Internet and electronic materials by Chemistry teachers. An accurate example of material was given only in one case – a spreadsheet.

The 6th question was only for those *respondents who had ever visited in connection with teaching Chemistry some web page*. 41 respondents (91.11 % of the sample) answered this question – so many respondents used web pages (according to the 6th question) in connection with teaching Chemistry. 3 respondents, who according to the 6th question didn't visit any web page in connection with teaching Chemistry, used the Internet in other way (according to the 1st question).

The sub-question 6A found out the frequency of Internet usage related to the teaching Chemistry. The respondents should have stated *how many times a week they visited some website during preparation for teaching Chemistry or right in the lessons (in average)*. For an overview of responses see Figure 2.

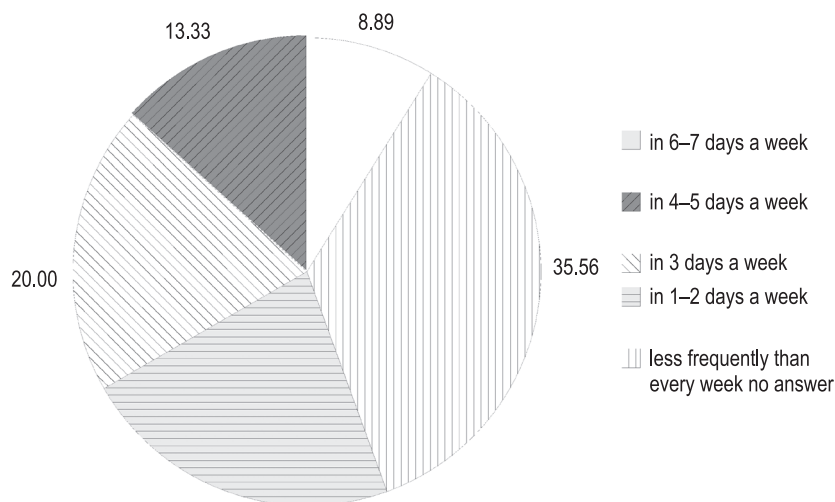


Figure 2. The frequency of visiting web pages by the teachers in connection with teaching Chemistry [%] (100 % = 45).

The most teachers chose the response that they went on the Internet less frequently than every week (16, 35.56 % of the sample). However, the majority of teachers visited some web page in connection with teaching Chemistry at least once a week (25, 60.98% of the 41 respondents went on the Internet in 1, 2, 3, 4, 5, 6 or 7 days a week).

Discussion

The vast majority of the grammar-school Chemistry teachers (93.33 % of the sample) used in connection with teaching Chemistry the Internet (in the year 2009). It's close to the research of Roštejnská (2008) who found that 87% of secondary-school Chemistry teachers could use the Internet without problems. Nevertheless there are differences between the researches (the research of Roštejnská is older, the target group is not exactly the same and the content of the question is a little bit different – Roštejnská asked if teachers could use the Internet without problems, in our research was tested if they just used the Internet), an important information for preparation of the new educational portal was, that the majority of the teachers used the Internet in connection with teaching Chemistry and that indicates possible usage of the portal.

Other important results for planning the portal were the next ones. Many different electronic materials were used by the respondents; they used mostly free materials rather than paid. The vast majority of respondents used (in connection with teaching Chemistry) text editors, web search engines and e-mails, chemical graphic programs were used just by a half of the respondents, the least used program was an online gradebook. It can be assumed that the questionnaire had covered almost the entire field of the use of the Internet and electronic materials by Chemistry teachers.

In the research of Škoda and Doulík (2003) respondents should have described the frequency of Internet usage in Chemistry lessons on a scale of „every lesson“ (mark 1) to „never“ (mark 5). The average mark was 5.92 – very close to never. According to our research the majority of Chemistry teachers visited some web page in connection with teaching Chemistry at least once a week. There is a big difference between the results – it could be caused by the time of realization of the researches (from the year 2003 of the research of Škoda and Doulík to the year 2009 of realization of our research) teachers' attitude to frequency of the Internet

usage in the lessons could positively change. For the portal it meant that it would be probably good to provide some electronic materials on it, which teachers would possibly use in their lessons. The same reason (time of researches) could explicate why in our research programs for teaching Chemistry on a CD or on the Internet were used by nearly a half of the respondents, whereas in the research of Škoda and Doulík multimedia CDs were used almost never (average mark 5,79).

Conclusions

There are several conclusions from the results of the 1st part of the research, which was dealing with the extent of usage of the Internet. The results were taken for further statistical analysis. Most of the teachers used in connection with teaching Chemistry the Internet. The respondents used many different electronic materials and it was mostly free materials rather than paid. The vast majority of respondents used in connection with teaching Chemistry these programs or services: text editors, web search engines and e-mails, chemical graphic programs were used just by a half of the respondents, the least used program was an online gradebook. It can be assumed that the questionnaire had covered almost the entire field of the use of the Internet and electronic materials by Chemistry teachers. The majority of teachers visited some web page in connection with teaching Chemistry at least once a week.

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