

# Students' Motivation to Learn Chemistry in Slovak Republic



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### Abstract

*Slovak National Report contains basic information about the situation of teaching chemistry in Slovak primary and secondary schools. Mentioned are the main problems in the actual teaching of chemistry with respect to the student motivation. They are based on two major surveys conducted by experts in 2007 and 2008 in primary and secondary schools. These surveys reflect the overall situation in the teaching of science in Slovakia nowadays. The situation is partly the result of a complete change of structure in the vocational education after 1989, partly the consequence of liberalization and destruction or re-orientation of many professional schools focusing on teaching chemistry. The report provides background information on the system of teaching chemistry at Slovak schools of all levels. The results of the above surveys are given in Section 4 as well as at the end of the national report. The report names the main challenges and obstacles to students' motivation for learning chemistry, teacher approaches and possible solutions. At the same time, the report presents current most innovative resources and materials for teachers of chemistry, which, in the last three years developed in Slovakia. It includes particularly the Ministry of Education's project supported by the EU- new innovative curriculum and chemistry textbooks for teachers and students in the process of education modernization for primary and secondary schools, as well as other major foreign sources. The report also contains basic information on schools, teachers and experts in Slovakia involved in the project as well as their collaboration on the development of new curricula and approaches. The report also lists the results of a joint workshop of teachers and experts, their views on the current state of teaching chemistry in Slovakia in terms of student motivation as well as other problems in teaching of chemistry in Slovakia.*

### 1. Basic information about the situation in Slovakia

The current system of teaching chemistry in Slovak primary and secondary schools is the result of development and changes in the economy and society over the last twenty years i.e. changes of the system in 1989. Under the socialism Slovakia had a very strong chemical industry focused virtually on all sectors of chemistry with large chemical companies with thousands of employees. Each such company also had a vocational school focused on teaching chemistry and/or chemical professions that the company needed. Training usually ended with graduation and has always been a combination of theoretical and practical experience. Most of these schools were at that time very well equipped, from student dormitories all the way to the chemical laboratories. There was a significant interest in specialized study at universities with a chemical focus. The best students were admitted only after intensive testing. At the moment, the situation is completely different, 80% of the chemical industry does not exist any more. Only a few companies with foreign participation remained and they did not keep the schools. There are only four schools left with chemical specialisation but also here the chemistry teaching is only to a very limited extent. Extent of teaching in elementary and secondary schools decreased at the expense of other subjects, the interest in chemistry and science declined significantly. This trend is dramatically reflected in the universities, which in contrast to the past have a big problem to admit enough students to the Faculty of Chemical Technology. The knowledge



level of incoming students has been also significantly reduced. Many excellent students study abroad and those who finish their studies often do not work in the study field.

In the Slovak school system teaching chemistry begins in elementary school, which is in Slovakia compulsory for nine years. In the 6th and 7th grade it is 16 teaching hours, in the last two years, in the 8th and 9th grade it is 33 and 66 hours. These hours include five hours of laboratory work where students are divided into groups with a maximum of 15 or 18 students. In the ninth grade it is 99 hours of theory and 23 hours of chemistry laboratory work. For primary schools with extended teaching of mathematics and science is 99 hours of chemistry compulsory in both years including 33 hours of laboratory work in the 8th grade and 23 in the 9th grade. Chemistry is also being taught on the 4 and 8 year long high schools with 99 and 66 hours, as well as on specialized secondary schools with a focus on chemistry and secondary vocational schools with an apprenticeship in chemistry. Current trends in teaching chemistry in Slovakia are the same as in other European countries. The difference is the speed and possibility of their application at individual schools.

Key trends in teaching of chemistry and its upgrading include the use of ICT technologies- computers, internet, interactive boards, integrated learning, experiments in groups etc. It must be emphasized that all of the above mentioned depend on several key factors. The most powerful of them is the teacher himself with his or her professionalism, personality, creativity and taking on new challenges. Particularly older teachers have problems with accepting and using new approaches. The facilities of the school itself are only secondary. In this area, there are still big differences in various regions of Slovakia. Despite the fact that more than 300 teachers of chemistry participated in the project of Modernization of teaching at primary and secondary schools, the number is still not big enough and many teachers still teach the traditional way with little or no use of ICT technology. The curriculum is of little interest for the students and therefore little encouraging.

## 2. Creating the national network

The project Chemistry involved five schools, of which there are three high schools, one elementary and one vocational high school. Two schools are located in Bratislava and three are from a countryside region of central Slovakia- Krupina. This sample is very representative, because it includes all levels of schools and also several country regions. The two high schools in Bratislava belong with their level to the best in Slovakia. It is also interesting to mention that one is a public school and one is fully private with a relatively long history - it was the first private 8 year long high school established in Slovakia after 1989. Teaching chemistry at these high schools is very interesting and innovative, teachers also use the latest ITC methods. Prof. Lisá of the high school of L.Sáru participates in the methodical commissions for the preparation of new curricula and textbooks of chemistry for the secondary schools, as well as in the projects of modernization of teaching in secondary schools. Last school year forty of her students graduated from chemistry and then went on to continue with their studies in different types of higher education with a focus on chemistry. Similar situation is also on the 1st Private High School Bajkalská where chemistry professors teach using three very modern and progressive ways using ITC technology for practical experiments and trying to further motivate the students on the subject. On the other hand, other schools from outside of Bratislava still teach traditionally. Partly because of the technical equipment, partly because the overall level of students is lower with a lower average marks in all subjects which places much greater demands on their motivation to learn.

Ten teachers participated in the project, seven of them were from high schools, two from primary schools, one teacher from a vocational school. They are usually older and more experienced teachers. A total of 200 students participated in the project, 110 students from three high schools, 50 from a primary school level and 40 students from a vocational high school. It is expected that the project will gradually involve more schools. The plan is to involve a vocational high school with a focus on chemistry from Bratislava as well as other schools.

At the expert level, the project involved five experts of which our are of the Department of Didactics in Science, Psychology and Pedagogy, Faculty of Natural Sciences, Comenius University in Bratislava. One expert comes from the Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava. The first



four are the experts of the department which trains teachers of chemistry and of other science subjects. They are specialists in didactics of chemistry, and they have been working with this issue for a long time. The department is specifically focused on teaching science and thus preparing the future science teachers especially for the secondary schools. These experts are also involved in a number of international projects and national projects aiming at the modernization of teaching science in Slovakia. These experts will work on the project of Chemistry preparing lectures for conferences as well as the National Reports from various areas of the project. There is an assumption that the number of such experts will extend according to their time availability and their focus.

### 3. Main obstacles in chemistry learning motivation of the students

In this section are presented two surveys of motivation of pupils and students to the subject of chemistry. They were conducted by the members of the Department of Didactics in Natural Sciences. Surveys clearly show all, both objective and subjective obstacles to students' motivation in learning natural science in Slovak schools.

PISA Research 2006 was focusing on the evaluation of natural science literacy, including related competences and skills among students finishing elementary school level in OECD countries. In the research, part of which was student testing, the term scientific literacy is defined as " the ability to use scientific knowledge, to identify questions and to draw evidence-based conclusions for understanding and decision making about the natural world and the changes that occurred in it as a result of human activity (PISA 2006, 2007, p 29). It is significant for the concept of this research that the quiz questions were not based on the curricula of education systems of individual countries, but on the skills to obtain information independently, exploit it, communicate, solve problems and apply creativity in the field. Slovak students achieved below-average results in this study when in science literacy they occupied 22nd place within the OECD countries. Up to 22.2% of the examined students showed insufficient knowledge of scientific literacy and was included, as it is stated in the research report, into a risk group with potential problems with application in society and the labor market. Worrying is also the fact that while in Slovakia science creates 21% of the content of education, in countries as Hong Kong and Finland, which are on the highest ranking positions within PISA results, the part of these subjects in compulsory education is less (Koršňakova, 2007). Paradox is that Finland, for example, was very successful in all researched areas among the PISA tested 15 year olds within the OECD countries, and at the same time it is a country with minimal total time of education between the ages 7-14. More experts in the field of natural science didactics point out the possible causes of this condition.

- Besides the fact that students' interest in science and scientific issues can be seen as part of scientific literacy, another fact influenced the research focus on the issue. It was the fact that students' interest in science is very low or decreasing. In this context, the results of the international project ROSE are surprising. The project aimed at the investigation of the relationship of students to natural science and technology. It was found out that fifteen year old students from technologically less advanced countries had higher level of interest in science and science teaching in schools than their peers in the developed Western countries. In a similar way they more notably associated their future and the future of the development of society with the development of natural science and society. Moreover, compared with the students from the developed Western countries, they would have willingly chosen professions where they would have worked with technologies. Particularly girls from Western countries would prefer to elect a profession in which they would work with people. Neither boys nor girls have desires of becoming scientists.
- Moreover, the research is based on the assumption that knowledge of attitudes, opinions, and also motifs students relate to learning subjects, as well as the conditions and methods of teaching, through which the teacher influences students' interest in learning subjects and their motivation to learn, can make an important contribution to more effective teaching and the teacher efforts of its humanization.

When there is a source of cognitive needs, interests, values and positive attitudes towards education, a student is willing on his or her own accord, based on arousing curiosity, a desire to learn something new or master this, perform various cognitive activities, receive and search information, think about them, solve tasks and problems, and overcome obstacles. Cognition stimulated by the interest and related activities may become a source of joy and feelings of competence of the successful management of cognitive tasks. The condition of such oriented interest is satisfying cognitive needs. Students with intrinsic motivation and autonomous regulation will further and better process information, they will better understand textbook concepts as well as be more active in school work and also be happier and more successful. They will also choose more challenging and long-term academic career with a higher likelihood to finish the studies.

The research was attended by 223 first year students (93 boys and 130 girls) of high schools from Bratislava, Banská Bystrica (big town), Banská Štiavnica, Martin (medium towns), Skalica and Moldava nad Bodvou (small towns). Respondents rated natural science subjects and teaching at the primary school level. The questionnaire contained 21 items and a sheet for recording answers. Selected demographic information (gender and school location) were also noted in the answer sheet. All items of the questionnaire have a five-point verbal scale form with the mean value of neutral, emotionally indifferent evaluation answer. The used questionnaire was created based on a sample questionnaire by adding another ten items to the original or slightly changed eleven original items. However, the changes did not substantially alter the scaling technique or intended use of the questionnaires. Administering of the questionnaires with the help of participating co-students took place at the time of teaching. Data obtained through the questionnaires were subjected to statistical analysis using a computer program Statgraphics 5 Plus.

Analysis of the data using the LSD Fisher test revealed that the students expressed highest degree of interest in mathematics and natural science-biology. At the middle level of interest is located geography and chemistry. Relatively lowest interest students put on physics and natural history-geology. Test has shown that students' interest among subject pairs of: mathematics and natural science-biology, geography and chemistry, physics and natural history-geology did not differ significantly. Similar results were obtained ten years ago (Veselsky, 1998) when mathematics that has current position with the best interest of the subjects was replaced by the subject of natural science-biology. Chemistry was found, as in the current research, on the mid-level interest position, while geography and mathematics were more popular. The lower level of interest in physics-geology and natural history were in line with the current research. Ramsden (1998) refers to lower attractiveness of physics and chemistry for students in comparison with biology. Prokop and Komorníková (2007) recently found that students' interest in natural history and chemistry and their importance for the Slovak primary school students is with increasing grades decreasing. The authors explain this by saying that students' attitudes to natural history varies depending on the content of the curriculum in each grade. Natural science was relatively the most popular for students in the 6th grade (zoology) and least popular in the 8th grade (Geology and Mineralogy). These findings are mutual with our results. A more detailed analysis revealed that the most interesting natural science classes are according to the students those where they can examine and explore the live material or learn more from nature documentaries.

Comparing these results with the results of research that was conducted ten years ago, when interest in the chemistry declared 66.7% of respondents and disinterest 14.4%, enables, even in the absence of statistical analysis, note some decline in interest in the teaching subject of chemistry. Pronounced decline of interest in chemistry was found among the high school students at the end of the 2nd year of study, which commented on the learning subjects and teaching at the high school. In the latest study only 38.1% of respondents declared interest in the subject of chemistry compared to 42.7% of respondents who declared a lack of interest in chemistry. Even those who chose an alternative of the answer "it is very interesting for me" was only 8.3%, while for boys and girls of the reported research the number was approximately 15%. However, similarly as in the current research, girls showed higher interest in the subject of chemistry than boys. In both cases this finding is to some extent surprising because based on the results of the project ROSE rather the opposite might have been expected. This project demonstrated, at least as far as the developed countries such as Japan, England, Norway and Denmark, priority interest of boys in science learning subjects.



The importance of chemistry for every day life preparation declared 43.1% of boys and 46.9% girls. In terms of the above 43% of boys and 39.2% girls found the subject of chemistry little important or unimportant. Boys and girls, however, did not differ significantly in their evaluating. Compared to the results of previous research in which chemistry was evaluated from this point of view 47.3% of respondents saw it as an important subject and 34.7% of respondents as less important or unimportant subject. It is again possible to state a definite shift in the assessment of students to the detriment of chemistry. The least favorable results were obtained in the group of high school students who assessed this level of study. Only a minor part of them (28.1%) proclaimed the importance of the subject of chemistry from the above mentioned point of view, while more than double the respondents (58%) were convinced that it is of little importance or unimportance.

Chemistry in terms of developing own knowledge is evaluated as important or very important by 64.6% boys and 66.1% girls. Conversely, as less important or unimportant in this sense it is for 18.3% boys and 14.6% girls. However, in this assessment student gender was of no significant difference. Comparing these results with previous analysis in which the importance of the subject of chemistry declared 74.3% of students and as unimportant 13.5% of asked students points out again to determining rating of the importance of chemistry. High school students evaluated chemistry in terms of the above more critically. As important or very important found it 43.7% and as unimportant or little important only 38.4% of the respondents.

- Chemistry was appreciated in terms of using the acquired knowledge and skills in the future profession by 36.6% boys and 37.7% girls. For less important or unimportant it was considered by 51.6% boys and 40.8% girls. Comparing the average marks of the boys and girls showed no significant difference. Significant differences did not show even when comparing the current results with previous research in which the importance of chemistry in terms of the above appreciated 41% and vice versa regarded it as unimportant 43.7% of the respondents. The least favorable was the evaluation of chemistry at high school where 65% of the respondents do not put chemistry from that point of view as important, compared with 22.2% of the respondents who admit its importance. Found data, in particular evaluation of teaching chemistry at the high school level, are not favorable and reflect the relatively low interest in chemistry by adolescents in their studies.
- According to our findings students evaluate chemistry to the highest degree for enriching own knowledge (with an average value of 2.30), following was the aspect - the total preparation for life (with an average of 2.92) and the end point of view - use of the acquired knowledge and skills in the future career (with average value 3.01). Statistical analysis confirmed the significance of differences between the first and second factors, respectively, but not between the second and the third one. It means that students appreciate the most chemistry studies for enriching their understanding and less for its significance for the life and future career. It is expressed by a relative undervaluation of chemistry in terms of the last of the considerations. It could be also explained by considering the respondents' age when they do not yet focus in future life issues and their professional orientation in details. To mutually connect these aspects is however a considerable challenge for the teachers. There is reasonable prospect that emphasizing practical questions, using subject matter of chemistry in real life, in the student hobbies or broadening and deepening their knowledge can significantly stimulate students' interest in learning chemistry and ultimately their interest in the study of chemistry in the future.
- We found a strong relationship of students' interest in chemistry and their understanding of the curriculum. This finding confirms that meaningful learning is closely linked to the students' interest in learning subjects. Meaningful learning is an active process of thinking, in which the learning individual uses past experience with adopting, understanding and processing of the input information. Information adopted by meaningful learning adoption students take more likely into activities of thought and apply it to different practical activities and interests than the information they have acquired in a way of mechanical learning. It also explains the observed medium-high correlation between students' interest in chemistry and how the study of chemistry requires and stimulates their intellectual activity.



Our research confirmed the expected relationship between students' interest in chemistry and the possibilities for discovering teaching knowledge, procedures and finding the explanations of phenomena and relationships, as well as opportunities for students to express and satisfy their own curiosity. Both relations can be considered as moderately high. Neither surprising nor detected is relatively high relationship between students' interest in chemistry and chemistry evaluation because studying chemistry develops their creative thinking, creativity and the sense of new. However, it was not expected that no significant relationship will be shown between students' interest in chemistry and asking questions, asking about what they do not understand or what interests them. Asking questions in the classroom is not only an opportunity for students to deepen their understanding of the subject matter, but also an opportunity to satisfy their curiosity and interest. It is therefore a mean to influence teaching, and meet the needs, interests or curiosity. The reason for these findings may be the lack of opportunity for students to ask the teachers and classmates questions in the classroom and/or also the experience that they did not get a satisfactory answer to their questions. Based on the feedback from the teacher the students might be convinced that asking questions is more likely to be understood as their ignorance or misunderstanding rather than their interest.

Similarly, for unexpectedly low, even though a significant relationship, can be considered the relationship between the opportunities for the students to perform experiments and their interest in chemistry. Since there is no other relevant data from the students it is again possible to believe that one of the causes of the poor relationship is the lack of opportunities for students to perform these activities in the classroom and/or their unsatisfactory progress. Low but significant relationship was also found between the teacher's use of the visual didactic tools in the classroom and/or display experiments lining with the curriculum, and students' interest in chemistry. The analysed relationship can be justified on the grounds that the visual aids in teaching contribute to meaningful learning for the students, encourage their attention and stimulate their imagination.

- However, two of the other expectations did not prove. The assumption was that the ability of students to work together in solving tasks and problems will have a positive effect on students' interest in learning subjects, which could not be confirmed. Neither the other expectation that the opportunity to use computers in the classroom for collecting, processing or recording information will be linked to the students' interest in chemistry was not confirmed. Assuming that computing is for the current generation of children and youth appealing did not prove. For the users it provides lively graphics, color and big amount of detail with surprising changes in a short time etc. Computers allow personal communication, gaming, but also provide the ability to search, transform and communicate or share information, for example by project teaching. In terms of its use in teaching conditions, it is particularly significant that it can place students into the virtual environment in which they deal with tasks and problems in the form of interactive communication with the computer.

According to our research up to 80% of students of the 3rd year of high schools, expressed a belief that internet can be used in teaching and nearly two thirds of them (62%) would prefer to be taught with the use of internet over traditional teaching. Regarding our current data, we believe that in both cases there may be a lack of opportunity for the students. In the first case we assume that students had rarely a real opportunity to work together in group forms of teaching to address common tasks, which was also reflected in their evaluations. In the latter case, as confirmed by our research at Slovak schools, it is still not a common practice, except teaching IT, to use computers and internet in the classroom. It is also possible to consider the possibilities that the use of computers in teaching science at the elementary school is still not methodically developed enough to become an integral part of the teaching process. At the same time it is not possible to ignore that the students' interest in the computer use is decreasing compared with the past.

#### 4. Analyses of the teaching sources

In Slovakia, we were unable to find twenty original national ICT resources for teaching chemistry in schools of all types, simply because there are not so many. After much discussion with teachers and experts who work with ICT in schools and in their work, we found sixteen national web sites. Other four websites for learning chemistry are international. Slovak national web sites dedicated to teaching and learning chemistry are focused on different areas - there are articles on the utilization of information technology in teaching chemistry, sites about environment, medicaments and drugs, modernization of teaching chemistry in secondary and primary schools, a new educational approaches in teaching chemistry such as AJM. A number of international web pages focuses on the chemistry in forms of databases, libraries, and various chemical portals in the field. The main problem of Slovak web pages is that most of them, and these are the ones related to the modernization of teaching chemistry in secondary and primary schools, are not publically available. They are only for teachers and tutors who are directly involved in these projects. Administrators of these sites are computer companies with licences not allowing an entry to the public. These sites do not include only chemistry but all subjects that are being upgraded. In the field of chemistry it is the development of new textbooks, curriculum, equipment for the use of ICT in teaching chemistry, seminars and workshops for teachers of chemistry etc. These web pages are: [www.modernizaciavzdelvania.sk](http://www.modernizaciavzdelvania.sk) or [www.mpv.elfa.sk](http://www.mpv.elfa.sk) Another important Slovak web page is the Multimedia in teaching chemistry - it is a web page with many other teaching resources and other specialised sites with chemistry teaching curriculum. The next important Slovak web page is [www.naucteviac.sk](http://www.naucteviac.sk). It is a new and very usefull slovak education web portal for modern teachers .Another very important slovak web page is [www.infovek.sk](http://www.infovek.sk). The aim of the Infovek Project ( in English the Info Age Project) is to prepare the young generation in Slovakia for life in the information society of 21st century in order to prove competent in the knowledge economy and to create the preconditions for the young generation to be competitive on the forming global labor market, especially in comparison with the young people of the same age from the European Union. Last but not least is the Czech chemical education web portal <http://chemie.gfxs.cz/index.php?pg=main>.

#### 5. Workshop

The first of the three planned project workshops was held with the participation of experts and teachers both from Bratislava and from Central Slovakia. Workshop was attended by a total of ten participants including three experts and seven teachers of which were three teachers from Bratislava and four from Central Slovakia. The atmosphere was a little tense at first and not very relaxed. It was necessary repeatedly familiarize all participants with goals and objectives of the project, and in particular the benefits for them as teachers and the schools where they operate. It must be emphasized that it is currently very difficult to get teachers and experts in Slovakia to cooperate in such type of activities. They are very busy with office work and are also involved in plenty of various national and international projects and mobility. The financial motivation is minimal so the professional benefits must be clear in order to gain their cooperation. Another problem is that the teachers do not understand English so some of the information on the project website is poorly available for them. In case of the experts this is not true. Experts have rather bigger problem with the time availability as they are mostly involved in international projects.

The workshop was attended by seven teachers and three experts. Participation of the teachers from outside of Bratislava was also managed. They took the time to come and discuss the problems of teaching chemistry in secondary and primary schools in terms of student motivation.

The talk about motivating students to learn chemistry was essentially based on a single basic fundamental starting point: how is the chemistry actually being taught in all types of schools (including universities) and for that matter what, in what way and why should be attractive and interesting about it for the students.

The first topic discussed mostly by the teachers of primary and secondary schools was the system of teaching chemistry at Slovak schools, number of teaching hours, number of students in classes with laboratory practice, equipment of individual schools with the chemical laboratories and ITC technolog, as well as the latest educational technology. Teachers of secondary schools emphasized that the fundamental problems of



secondary school chemistry teaching are the attractiveness of the facilities and especially, as with other subjects, the key factor is the teacher figure. This was evident not only in the teaching but mainly in the number of students who continue to study chemistry at university level taking it as a major or as one of the majors. For these students the main motivation is not to get a good grade (which is the motivation of most natural science students), but to learn more. Chemistry is essentially a very attractive subject even though most teachers are not able to motivate students for its study. Where there are such teachers e.g. Prof. Lisá of the High School of L. Sáru or Prof. Smreková from the 1st Private High School in Bratislava, the number of students who go on to study chemistry is high. The motivating factor is not so much linked to a graduate's good position in the labor market of applied chemistry or related fields but more to the personality of the teacher. Prof. Lisá of the High School of L. Sáru had 37 students graduating from chemistry in 2012. They all continued studying chemistry on different types of colleges. Similar figures were presented also by Prof. Smreková.

Since the main theme of the workshop was the use of the ITC technology for teaching chemistry, teachers better understood that in the present times when computers are ordinarily used by the students, teaching chemistry this way is a necessity. Specific examples in the discussion were reported by the teachers from high schools, especially Prof. Lisá who is one of the authors of model textbooks for chemistry teachers. Along with other workshop participants from different high schools including Prof. Smreková, Fedešová and Fabiánová, they clearly agreed that chemistry must be definitely be taught principally on examples from life, and then practical experiments (within the limits of each school). ITC technology is a tool that can make the teaching more attractive and better motivate students but should not be a mean standing by itself. In addition, practical activities and experiments are crucial for chemistry, therefore laboratories and school facilities are the key. ITC can help a lot and can simulate a lot of but direct practical experiments can not be replaced by anything. Participants noted there are several problems with the laboratory experiments. The list starts with a ban of the European Union to use direct gas which has not been a problem previously. The second issue is the facilities. Paradoxically older schools built under socialism are now better equipped than the new schools (if some were built in the last twenty years). In the last ten years the experiment costs rose dramatically. Schools often do not have money to cover these costs so they improvise. All participants stated that the key issue is the large number of students in the laboratory classes without the option to better motivate and work individually with those students who have an interest in chemistry. This is thereafter replaced by individual consultations.

Another topic of the workshop was the differences of the school facilities in different Slovak regions. Schools in Bratislava as the capital city are doing the best. The workshop was also attended by the teachers from Krupina, a typical small Slovak town in a provincial region of Central Slovakia with three types of schools (high school, vocational school and elementary school). It provided great confrontation in terms of facilities, approaches to teaching, student knowledge levels and their motivation for natural science disciplines. Teachers of Krupina stated that the first difference is the level of students who do not have foundation and systematic learning habits from home. This results in much greater demand on the teacher, a different approach and different ways of motivating students to learn. More emphasis is placed on practical illustration and practical mastering of the topic. Schools are not so well equipped and have to look for other solutions. Even though the situation has greatly improved by the teachers' involvement in the National Project of the Ministry of Education EFTA, in which were created entirely new textbooks and teaching aids for teachers of chemistry with an ongoing training and exchange of experience through the project web site. The project includes more than 3000 teachers.

Another discussed topic was the current training of the future chemistry teachers at the Faculty of Natural Sciences.

A relatively big part of this faculty is the Department of Science Didactics. The workshop was attended by two people from this department, Prof. Prokša and Associate Prof. Brestenská who lecture didactics of chemistry at the faculty. Both of them deal in a long-term with the problem of didactics of science and motivating of the students through the use of ITC. Associate Prof. Brestenská is involved in several European projects, as well



as the above mentioned national teacher training project. According to her, the biggest problem in motivating the students includes a complex of several factors:

- School laboratory facilities
- Experience and didactic training of the teacher- New textbooks- Private motivation of the student

Prof. Prokša said that the generation of teachers studying didactics at the universities has learned the traditional didactic approach to the students (tasks, assignments, grades and penalties, explanation of the topic) and until the end of the 90s did not have classes such as communication and social skills. These are nowadays considered essential for new approaches of managing group dynamics in the classroom as well as individual approach to each student. Today, these approaches allow motivating students in a more effective way as well as resolving conflicts and problems in the classroom.

At the end of the workshop project manager Juraj Dúbrava thanked to all involved for a very stimulating discussion and mentioned looking forward to further cooperation within the project.

## 6. Conclusions

The fact that the interest and popularity of science subjects, including chemistry among primary and secondary school students is relatively low in recent years, a downward trend should lead teachers to planning and implementing of such forms of teaching and communication styles which would reverse this unfavorable situation. Low interest and students' negative evaluation of the subjects and teaching are often the result of teaching style itself. The teachers are convinced that they can give the most when they present the information, which they consider to be important, directly without respecting the students' individual interests. Students do not have enough opportunity to discuss in the classroom with other students, with the teacher, ask questions, show interest, alone or with classmates conclude their findings, examine problems and explanations. Their knowledge is often passive, partial, based on the requirements of the teacher to mechanically reproduce the learnt knowledge and skills. Students in the classroom often feel as passive recipients of the information and skills which for them have no cognitive or practical sense. The solution is teaching focused on students with a significant constructivist approach in learning the students. It stresses the active nature of cognition, in which the cognizing subject organizes, manages and interprets information alone by using his or her previous insight and skills. In this sense, the goal of the teacher should be a rich learning environment in content and communication, which respects the subjective experience of the students and supports their creative manifestations. The modern teacher should be in a role of manager and facilitator. Students should not only impart good quality information, but should be encouraged by the teacher to activities in which they develop their thinking, problem solving skills and take the structure of knowledge and skills, which will be functional enough in their further learning and practical activities. Part of the science education should also be development of the student competences to measure, compare, sort, examine, interpret, and formalize. For the teachers it is recommended applying, to a significant extent, the model of teaching/learning through discovery, putting an emphasis on group-forms of teaching and encouraging students to learn by the means of intrinsic motivation. Important place in the intrinsic motivation of students to learn belongs to the interests and attitudes that emerge in the understanding of the importance and functionality of the shaped knowledge and skills. Therefore, it is necessary that the contents and methods of teaching science subjects reflect the interests and needs of the students, including cultural and gender specifications. Given the importance of the emotional component of the motivation the teachers can perhaps be recommend to create conditions for positive emotional experience of the students, for the manifestation of their aesthetic and ethical feelings. For instance Prokša (1997) recommends including spectacular chemical experiments accompanied by engaging classical music. Emotionalisation of the teaching brings a process of the task solutions or discovery, particularly when it comes to tasks or problems which induce curiosity in students and are presented in group forms of teaching such as discussions or project teaching. Students' interest in subject of chemistry and attitude to its usefulness can be positively influenced by the integration of its contents with the



contents of other subjects, especially other science subjects, emphasising the topics and contexts, which are for students attractive and/or affect their hobby or hobbies or are a part of everyday life chemistry.

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