Wyższa Szkoła Informatyki i Umiejętności

CHEMISTRY IS ALL AROUND NETWORK

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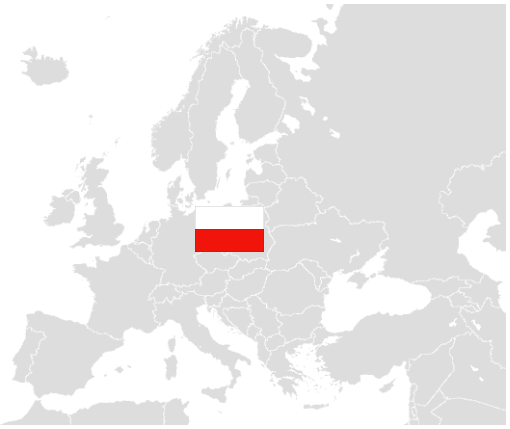
Students' Motivation to Learn Chemistry in Poland



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Students' Motivation to Learn Chemistry in Poland

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Abstract

The paper is going to present the Polish national scene on Students' Motivation according to Chemistry is All Around Network project requirements (WP4.1).The paper will briefly introduce Polish national trends in teaching science subjects, chemistry in particular. It will also consolidate the information about the project in Poland; the involvement of schools, teachers and experts and describe their role in the project and their field of expertise. Space will be devoted to presenting the main obstacles to students' motivation to learn chemistry with reference to teachers and experts' comments as well as analysis of the main teaching and learning resources available online. Comments will be made to the most innovative online solutions available on the Polish educational scene supporting teachers in the classroom and motivating learners at different levels of education to explore chemistry deeper and further on their own. Some references will be made to the teachers and experts' workshop organized at WSIU premises on the above topic.

Introduction

With the rapid development of our civilisation and the constant ageing of society there has been a great demand for new medicines, surgeries or alternative, economical sources of energy. Without any doubts contemporary world is in a desperate need for well-educated and creative scientists, thanks to whom the world of science could develop further, that is why, the sooner the governments, Polish government including, start to promote initiatives of raising society's awareness of science-oriented disciplines, the better. It has been proved that first fascinations with science can be created and developed already in the early childhood e.g. Albert Einstein was inspired by a magnet which he saw as a child. This leads us to inspiring children; to such a powerful influencing of young kid's imagination, and making them interested to so such extent, that they are motivated enough, at the later stages of their education, to come back to their childhood passions. They are willing to learn chemistry or physics as they associate them with something they experienced in the early age.

1. Introduction to the National Situation

Over the last two centuries, chemistry has changed our daily lives more than any other of the sciences. Chemistry has made our world more colourful, more efficient, more reliable and safer. Pharmaceuticals, cosmetics, toiletries and body care products, airbags and brake fluid – they are all chemical products. Of all the natural sciences, this is the only one to have given rise to an entire industry – more and more people are currently employed in the chemical industry. At the same time, however, no other science is connected with more bad emotions, refusal and anxiety across wide sectors of society. No wonder that chemistry has always been the struggle for some students in Poland. Students either love the subject or hate it, but according to research carried out, the latter group is far in majority. Perhaps we can begin to understand student disaffection with science in general and with chemistry in particular if we examine briefly the questions: What motivates students

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to want to learn? What are the barriers to their wanting to learn chemistry? What intellectual talents enable students to learn advanced level concepts? What are the barriers that prevent students from learning chemistry? Although definitive answers to questions such as these are at present beyond the knowledge and understanding of even the most advanced thinkers in educational psychology it is possible to gain some insight into the areas responsible for changing the situation. As all instructors know, students will learn what they want to learn, and if they really wanted to learn chemistry teachers will not be able to keep them out of our classes and laboratories. If students felt; for example, that learning chemistry would give them enough additional understanding of and control the forces that affect their lives, if they believed it would make their lives more exciting and fulfilling, if they thought it would develop their talents and abilities or if they were reasonably certain it would result in not only good grades but a feeling of accomplishment, they would learn it--and most would enjoy doing so. Unfortunately, for large numbers of young people the rewards in learning chemistry are perceived as simply not worth the effort. For many, chemistry is seen as a difficult, remote subject, one that requires special intellectual talents to learn and one that neither they nor the vast majority of the public needs to comprehend in order to live a happy productive life. They often are reinforced in this belief by guidance counsellors and teachers in non-science disciplines. Even many of those planning careers in professions requiring chemistry doubt that the effort they exert to learn it will pay off. Contemporary schooling in Poland faces many obstacles with regards to teaching scientific subjects. Despite undergoing a few educational reforms Polish students are still quite reluctant to study subjects like Chemistry and Physics and object to learning anything more than the required minimum. The majority of young people find science difficult, boring and useless – young people clearly call chemistry, biology and physics their least favourite subjects, and they do not have any motivation to explore them further. Within this, teachers struggle in the classroom trying to work both in compatibility with the core curriculum requirements, which after the reforms contains a reduced number of chemistry lessons in all the educational stages, and with the agreement with their own consciousness. Schools are poorly financed and chemistry or physics laboratories badly equipped. Many of teachers are forced to change their teaching and adapt it to the existing situation i.e. poor infrastructure, students' little expectations and changes in the curriculum. One kind of motivation influencing the process of learning new things is the motivation to learn in general. It is based on the concept that a student treats learning as a way of self-developing; improving competences and gaining significant knowledge of a certain subject. As it was mentioned earlier intrinsic motivation plays a crucial role in the didactic process. Of course, it can be shaped and developed by external factors e.g. by choosing specific teaching methods and defining forms of teacher-student interaction. However, it must not be forgotten that each student is an individual and it is worth pointing out each requires a set of different motivating strategies. That is why, motivating students to learn any subject, and chemistry in particular, requires from the teacher a great deal of flexibility, observation, consequence, patience and effort. Managing students motivation is undoubtedly a long, time-consuming and responsible process, which should be realised in practice after first diagnosing students needs, capabilities, getting to know their learning styles and ways of motivation. In the whole learning process there is a great need to shape enquiry-oriented interests students might have and it is logical that the way a chemistry lesson is conducted can either positively encourage students for further learning or discourage them permanently. One of the methods applied, can be directing students attention and the whole learning process towards practical knowledge, by showing them the usefulness and usability of the taught concepts in real life. Once the knowledge is relevant to students interests it will be automatically more digestible. The fact that chemistry has such an impact on present life and society works as a facilitator as it should be much easier to visualise chemical processes around us in the chemistry lesson. According to the new Core Curriculum (compliant with regulations of the Educational Reform in Poland) Chemistry is an obligatory school subject in Junior-Secondary Schools (3 years of study) and Senior Secondary Schools (2-3 years of study), i.e. for students aged 13-19. Primary schools in Poland treat chemistry as one of the natural sciences and do not distinguish it as a single, separate subject. As seen above the reform has brought many formal changes. Currently chemistry is taught only in lower-secondary schools (gimnazjum) and secondary schools (liceum). Primary schools have been devoid of a separate chemistry subject. They cover chemistry-oriented issues within one subject area called Science, which includes elements of

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physics, biology, chemistry, geography etc. It mostly centres on environmental issues and health protection. Gimnazjum level is the first one officially introducing chemistry to students in the full. During three years long education in Gimnazjum chemistry is taught within 130 hours of Chemistry - 114 hours of Chemistry education in Upper Secondary School – Basic Level (age 16-19) and 152 hours of Chemistry education in Upper Secondary School – Extended Level (age 16-19)

1.1. Teacher's work on developing student's creativity

According to the educational reform and its main objectives teachers should help their pupils to gradually pass from a specific to formal way of thinking – young people should be encouraged to creative, independent thinking, analysing, deducting, assuming, evaluating and assessing. All the tasks teachers face their students with should be compatible with their intellectual potential – tasks adapted for the students' capabilities are a synonym of success and do not demotivate teenagers unnecessarily. At the same time, science-oriented students with special abilities should be fully involved in the class and teachers must not allow them to get bored. Their special talent should be promoted and facilitated in all kinds of additional initiatives such as contests, competitions and knowledge quizzes. It is them who are involved in academic and institutional cooperation with universities or technical universities, as well as chemical companies and plants. Talents are revealed and developed with special and careful care to let the most apt students blossom. This leads us to development of individual treatment of each pupil and with his or her special skills in mind, driving , steering or gearing their science oriented-education even at the earliest stages of scientific education. This could be realised with the help of applying various tasks which need to employ logical thinking skills and analysis skills e.g. posing questions, making assumptions and giving logical justifications to solutions. Students ability to think creatively, working on hypothetical cases, linking potential relationships between various issues could be confirmed by experimenting and observation. Teaching students creative thinking means the tasks become more digestible to them. Simple, real-life examples such as stating differences between kinds of petrol, ingredients of cosmetics or cooking procedures – whether to put salt to cold or hot water, whether to pour raw meat with cold or hot water first or why we cover icy roads with salt in winter – all this facilitates students interaction with a teacher and engages creative, independent thinking. The changes in the educational reform were conducted in order to allow Polish science and chemistry students to develop student-centred learning processes based on inquiry-based learning. Students are to design the experimental procedure themselves, and this seems to help them gain a better understanding of the process of scientific inquiry. This is in marked contrast to the 'normal' situation for teaching chemical kinetics in Poland, which more often simply involves following laboratory instruction or watching teacher demonstrations. The use of small group discussions also seems to reinforce the socially negotiated nature of scientific knowledge; more consistent with more holistic views of the nature of science and genuine inquiry-based learning.
A key feature needed to move students from passive to active learning is the use of the POE strategy (Prediction-Observation-Explanation), along with small group discussions. Most students are able to explain changes to the rate of a chemical reaction based on kinetic theory, and drew upon energy and particle theory to explain changes in rates of reaction. They understand how to conduct experiments, and the notion of investigating variables by changing each separately, while maintaining the others constant. They also have a better understanding of chemical kinetics, and are able to explain the changes in the rate of a chemical reaction, and also developed a better conceptual understanding of chemical kinetics. One intention of this new type of experiment is to relate the laboratory classes to daily life, since the chemicals used in the experiments are, sometimes, not purchased from a chemical company. This also introduced an element of student choice, with respect to research design and the conduct of the experiment.
To facilitate learning students should be involved in more 'open-ended-type' activities. It is intended that this approach allows the students to construct their knowledge by actually conducting authentic scientific work. This includes the following:

- Asking relevant problems concerning the phenomena that students have observed;

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- Formulating a hypothesis that is in alignment with the suggested problems;
- Choosing an appropriate problem for further investigation;
- Conducting a suitable experiment in order to investigate this problem (including prediction, observations, and explanation);
- Analyzing the findings and arriving at conclusions;
- Sharing the ideas between their classmates.

All the material presented above seeks to help students learn chemistry better and to enjoy their learning but fostering an active-learning environment. The driving force behind the interventions was a desire to develop learner-centred instruction that is consistent with the aims of the Polish science curriculum. As such the interventions consisted on hands on activities, such as laboratory work, collaborative group learning, argumentation and analogy. As a result of the reform specific pedagogies are going to be applied in classrooms or laboratories (at any level of schooling), and the research findings point to some gains in terms of learning. There is reasonable evidence that learning outcomes are enhanced.
And the final touch, at some point Polish authorities will need to consider the match between the desire for more active learning in the classroom or laboratory, and the nature of the assessment regime. As it is observed, assessment drives teacher and student behaviour and if there is miss-match between the assessment processes and pedagogies, the assessment regime wins every time.

2. Setting up of the Network

WSIU – Wyższa Szkoła Informatyki I Umiejętności in Łódź, one of the partners in the Chemistry is All Around Network initiative, has decided to join the project as it found its main objectives very much compatible with the University's profile and educational offer. Its academic staff had been researching the topic of e-learning and new technologies applied to science teaching long before the Chemistry is All Around Network project. Our interest in the previous edition of the project called, Chemistry is All Around Us was in tune with our involvement and research. At present WSIU among its educational offers has been researching e-learning solutions teaching and learning scientific subjects. Our scientific and academic staff, when joining the project, expected to deepen their knowledge about e-learning with reference to Chemistry teaching in general and in more detail. Chemistry teachers, who are cooperating with our institution are not very technically minded, would like to broaden their horizons and gain extra qualifications in the new technologies application in the teaching and e-learning in particular. WSIU has a huge infrastructural potential and having well-equipped classrooms at its disposal, it can take full advantage of new technologies. Our role in the project as a partner is of two kinds. On one hand we are the project coordinator and manager, as far as the activities are concerned in Poland. And on the other hand, our staff members are actively involved in the activities fulfillment and progress trying to encourage Chemistry industry, teachers and experts to share their knowledge and experience about the topic. 10 Chemistry teachers, 7 experts were finally employed to do the activities of the project. As it was said above, they were asked to share their knowledge and experience to evaluate e-learning based products and publications with reference to chemistry teaching and learning. Later on, their comments were uploaded to the portal website. Also, being the coordinator of the activities at local and national level we are responsible for managing other teachers and trainers' work. We monitor communication between institutions and organize events to familiarize the public with the project's objectives, progress and results.
After a thorough analysis of the project's objectives WSIU staff members decided to select target group members. Many schools and educational institutions were contacted in the Łódź region in order to comply with the project's needs. Initially contacted schools were substituted with new ones due to various reasons. Some schools gave up in the middle of the first year, one school was closed and some did not actively involve in the project. At the end of the first year our institution decided to widen the scope of our potential partners in Poland and we started contacting schools and institutions outside of Lodz region. We ended up with recruiting one school from the north of Poland.

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To recruit 10 teachers and 5 experts WSIU contacted the schools and institutions by letters, fax and e-mail, as well as in person. Letters inviting to potential cooperation where sent in both Polish and English to enable a wider response of directors, principals and teachers. They contained basic project objectives and concepts and listed roles the institution or school could play in the project activities. School and institutions were carefully selected, previous years of experiences were taken into consideration and finally WSIU managed to recruit the required amount of teachers and experts. Later on two new experts joined our team and their involvement was included in this report. At this stage representatives of all educational sectors were needed and we did not want to limit ourselves to Higher educational levels only. As a result we ended up with a wide scope of representatives of all levels of education. Primary level was represented by 1 teacher, Junior Secondary by 3 teachers, Upper secondary by 6 teachers and University education by 7 experts who are both academic teachers, researchers and trainers. From previous years it has been learnt that teachers usually quit initiatives like these due to different, usually personal reasons that is why more participants were involved at the initial stage of the project. The teachers mentioned above represent different kinds of institutions. Within the project's first year a few teachers resigned and new teachers substituted them. Similarly, new schools were searched for, first to expand the network of active participants in Poland and, secondly, to maintain the standards and requirements of the formal regulations of the project.

Below there is a more detailed list of teachers representing different institutions at various levels of education. Primary level was represented by mgr Joanna Błaszczykiewicz – School4Child Primary School. Mrs Błaszczykiewicz is an experienced teacher of science. Her lessons include elements of chemistry, physics, geography and biology. Due to the core curriculum specifications in Poland the lessons are mainly based on experimentations made either by the teacher, or students themselves and their objective is to activate young learners' imagination and desire to learn science. Officially, children are not taught a separate subject called chemistry. Primary school School4Child was selected mainly due to the years' long cooperation in other projects and the school authorities to promote learners' autonomy in learning science.Lower-Secondary school (age 13-16) is the first introducing chemistry to students in the form of a separate subject. Representatives of this school type are ABiS Lower Secondary School with the teachers Monika Pawluś and Ewa Marczewska. Hanna Spisacka is a teacher with 16 years of teaching experience in Gimnazjum no1 in Gdańsk. Upper-Secondary Schools were represented by experienced teachers of chemistry Agnieszka Pilich from Zespół Szkół Ogólnokształcących nr 7 in Lodz, mgr Luiza Wężyk and mgr Małgorzata Urbanowicz from 33 LO in Lodz, mgr Anna Panek and mgr Małgorzata Kozieł from 8 LO in Lodz. The latter is also a regional representative and teacher trainer of Chimistry in Lodz. Ewa Marczewska and Jan Stawiany from the Private Upper Scoendary School AbiS complement the team of teachers recruited for the project activities.

Experts involvement was marked by three major higher education institutions in Lodz. University of Lodz, the Technical University of Lodz and Medical University of Lodz. WSIU's University of Third Age was also represented with its retired members Helena Kaniewska, an experienced teacher of chemistry and Jadwiga Skowrońska expert in Biochemistry and also a teacher trainer - methodology of teaching chemistry. Dr n. Farm. I inż. Chem. Elzbieta Zurek is a specialist in Chemistry for Pharmaceuticals - molecular modelling both development and implementation. She is the University professor and researcher at the Faculty of Pharmacy - Chair of Pharmaceutical Chemistry and BioChemistry at the Medical University of Lodz. Prof. dr hab. n. med. Elżbieta Czarnecka specialises in Chemistry for Pharmaceutical Dynamics; she is employed at the Chair of Pharmaceutical Chemistry and Biochemistry at the medical University of Lodz and she also holds the position of an Academic at the Wyższa Szkoła Informatyki i Umiejętności w Łodzi. Dr Iwona Krawczyk-Kłys from both the Technical University of Lodz and Institute of Leather Industry where she holds the position of a researcher, and adjunct, she is also the Head of Department of Innovative Polymer Technology. At the Technical Univerity of Lodz she is employed at the Faculty of Process and Environmental Engineering - Ph D Study Academic teacher of chemistry. She has also wide experience of teaching chemistry at Higher Vocational School LKO in Lodz where she works as an academic teacher of chemistry. Dr. Eng. Aleksandra Smejda-Krzewicka is another representative of Lodz university of Technology - Faculty of Polymer and Dye technology. She holds the position of a researcher on modification of

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polymer, recycling of rubber waste and polymer crosslinking). She holds a Ph.D Study form Lodz technical University - Faculty of Chemistry where she is also an academic teacher of chemistry and polymer technology. Dr Eng. Edyta Grzesiak an expert from the Institute of Leather Industry in Lodz - Researcher and Adjunct in the Institute of Leather Industry - Head of the Optical Spectroscopy Department. Currently she works at the Institute of Engineering of Polymer Materials and Dyes where she holds the position of a Director of the Branch office in Zgierz. At the Institute of Dyes and Organic Products she is also a researcher and adjunct - Head of the colorimetric analysis labolatory. At the Technical university of Lodz - faculty of chemistry - Institute of Applied Radiation Chemistry - Ph. D Study she is an academic teacher of chemistry.

3. Main obstacles to Students' Motivation to learn Chemistry

Motivating students is not an easy task but undoubtedly worth trying as there is not a better feeling for the teacher as seeing a young person fully content and satisfied, involved in a scientific task. Teacher's role today focuses not only on teaching but also on opening students eyes to the world around them, on making them sensitive to critical scientific issues. He or she should be aware of a few tricks how to make science more digestible and student-friendly to a young, curious mind. So the question arises "How to share with young people our passion to learn scientific subjects?" Many educators in Poland struggle hard trying to find a logical answer to this simple question. Without any doubt it is the school and the student's own home which should be motivating teenagers to learn any subject, and scientific subjects in particular. There is nothing more precious than supportive, encouraging parents and eager, passionate teachers who are able to inspire and awaken even the most critical and reluctant minds to discover passion and pleasure in learning in general, and learning science in particular. According to Monika Pawluś, an educator and an advocate chemistry teacher from a lower-secondary school in Łódź – it is the teacher himself or herself who is responsible for building up and developing students' eagerness to learn the world and about the world around them. Interesting facts supported by examples form real life make pupils think and analyse. It is the teacher who is responsible for familiarising teenagers with the beauty of scientific subjects. It is him or her who should share his or her passion with young people and undoubtedly, only then pupils' reaction to such a teacher's attitude is more than positive one. Teenagers appreciate teacher's efforts to prepare and conduct an interesting, interactive lesson and they cooperate learning effectively and efficiently. Dr Stefania Elbanowska-Ciemuchowska from the Chair of Didactics of the University of Warsaw pinpoints her University's initiative to help teachers from secondary and lower secondary schools to motivate their students to learn. She concentrates on a little gap between the science and scientific world and the real, everyday life. Presenting knowledge in a tangible, non-abstract context and showing its feasible applications in practice are the key targets of the successful chemistry or physics lesson. That is why, hands-on activities, experimenting, practical labs and logical tasks are more than appreciated by young people due to the arousal of their imagination and use of creativity.

3.1 Research In Junior Secondary Schools

For the purpose of the Project Chemistry is All Around Network a sample research was carried out among students of 1 school at the Junior-Secondary Level. 48 students of class I (16 students), class II (15 students), and class III (17 students) - more or less equally girls and boys- were asked about their opinions about chemistry in general and the motivating factors which help them learn the subject. Their questionnaires tackled three thematic questions:

- Individual motivation to learn chemistry
- Teacher's role (if any) in motivating students to learn chemistry
- Ways of rewarding their efforts in chemistry

The results were the following: for 75% of all questioned students the most important motivating factor to learn chemistry was to get good grades. For two thirds of students of the first class this is the most

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key issue. Class II students were less motivated in this issue and they mainly learn chemistry because they have to and because they are forced by their parents to do so. Generally speaking, it occurred that only 8% of students 'feel internal need' to learn, and only 7% like learning in general. However, despite the lack of intrinsic motivation, 36% of interviewed students want to 'learn more' and broaden their horizons. According to research, students of class I are really interested in learning chemistry because they are curious of the chemical processes, whereas more than a half Class III students are aware of the importance of chemistry in their life in the future. A lot of them justified their opinions by saying that knowledge of chemistry might be useful in Senior Secondary School, University or if they decide to become a doctor, vet or pharmacist.

As far as the teacher's role in motivating students is concerned, the majority of students (65%) claim that the teacher plays a crucial role in acquiring knowledge of the subject. Students pinpointed such issues as experimenting, explaining difficult concepts, visualising and showing demonstrations as well as adding additional material supporting a regular coursebook with online materials, presentations or visits to chemical plants. According to majority of students, it is mainly teacher's responsibility to interest students with the subject and his or her personality is master factor, too. Patience, smile and a good sense of humour were among a few characteristics students mentioned, when interviewed. However, more than a half of class I students claimed they 'learn for themselves, not for the teacher or because of the teacher' and that it does not matter what the teacher does in the class.

For the majority of the students the motivating factor is the possibility of correcting and improving any mark, even a good grade for the better one; and the teacher's ability to explain even complicated concepts in an easy, digestible way. Many students pinpointed defining and setting learning objectives in the lesson as crucial, as well as explaining usability of chemistry in real/ future life. For Class I students spoken or written appraisals and teacher's assistance in general are of great importance, whereas for older students they do not play any role at all. Class II students learn mainly because the teacher gives them frequent tests and quizzes. When students were asked what reward they obtain for good results at school, more than a half of them mentioned parents' approval; "pocket money" is distributed only to 10% of respondents. Nice holidays, a new bike or a computer game can be treated as a form of 'money rewards' and 14% of students admit to that kind of reward type. 13% of students do not get any rewards for their learning. Self-assurance, satisfaction and the awareness of the gained knowledge are for sure true examples of intrinsic motivation and they have been identified with almost 27% of students of junior secondary schools.

3.2 Conclusions of the research

According to the research carried out in this school, intrinsic motivation related to sheer will to learn something, broadening horizons and deepening knowledge is less important for students than external motivation full of approval from the teacher or parents and the possibility of receiving good or better grades. The role of the teacher in students' learning chemistry is restricted rather to making students aware of the significant role of the chemistry in life, by showing this branch of science in context and explaining its usability in society.

3.3 Teacher's work on developing student's motivation

Nothing is more interesting to us if we are fascinated with it. What is meant by that is fascination and interest in something work as triggers to get actively engaged in any task. Think of a story for kids read in the early childhood – a mother reading it, modulates her voice, she becomes an actress and all this to have a greater impact of the story on her child. A good teacher of chemistry or physics should become an actor on the stage influencing students' emotions, too. Chemical experiments with tricks, unexpected, interesting solutions always stay in memory despite students' age, abilities or attitude. What is more, a teacher should be able to tell students the story of a famous scientist and his career as a chemist, the same way a mother reads a bedtime story to a kid. Boring facts and figures from the scientist's life and work are easily forgotten, whereas something original and funny could inspire students or at least arouse some interest in the covered topic or chemical issue. It all depends on the

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teacher's will and devotion to make the lesson interesting and understandable. Good preparation, research and planning of an interactive, engaging, preferably technology-based lesson is more than required. A good, motivating teacher's role in the classroom is also the one of a lesson's director. He/she should be ready to offer and allow experiments and observations performed in the classroom, by students, too. It is not the teacher who should actively involve, but the students. Theory is needed but cannot fully substitute practice – hands-on activities and 'classroom action' help students to understand laws of science and nature better, faster and more efficiently. It is true for all students, even those who have not reached the level of independent, abstract thinking. Without any doubt, an eager, motivating teacher should cooperate with various specialised scientific institutions, organisations, universities, polytechnics, chemical plants and business initiatives in order to support his or her classroom teaching in a more practical context. Trips to chemical plants, visits to production lines of chemical factories, lectures and classes with experts and scientists would undoubtedly facilitate traditional teaching and learning process. All this could reveal the secrets of science and link the most difficult and problematic fields with easy to understand, everyday applications, digestible enough for a young, curious mind. Polish students love participating in lessons organised by Orlen or Organika companies for example. These companies are very much involved in developing students' passions and supporting teachers' initiatives in the classroom. Experiments online, lessons on demand in particular schools, visits to factories all this promotes understanding chemistry as a more friendly subject. Academic institutions such as University of Adam Mickiewicz in Poznan, University of Marie Curie Sklodowska in Lublin, University of Lodz, University of Warsaw as well as Technical Universities organise contests, lectures, 'chemistry nights', chemistry shows and experiments even for the youngest kids. When motivation in the classroom is concerned one must not forget about a motivating, interesting course book. With its layout, structure and visual, interactive content it could make learning a more enjoyable process. And here a question arises what makes a coursebook a good one. Undoubtedly, it should be inspiring enough to allure students to think creatively and independently and should be able to, at least attempt to, teach them scientific thinking i.e. planning, performing and analysing experiments. Of course it should be well illustrated, 3D models of elements and processes and photos explaining various experiments step by step are certainly supporting the visualisation process. It would definitely need interesting facts and stories from chemistry, sometimes even widening requirements of the core curriculum. Real examples, tables and diagrams substitute lists of difficult facts and figures. All this to develop students interests and passion with the subject. Contemporary chemistry coursebook should be interactive in content, too. Electronic materials, both for students (e-book) and teachers, would make the coursebook more interesting and easy to use. For students they would allow further practice and revision and for teachers they would be a useful source of extra material to be used in the classroom, during progress tests or just to consolidate students knowledge before exams. From the teacher's perspective a good coursebook should also be flexible, accompanied with an interactive syllabus compliant with the core curriculum requirements, which could be easily updated, altered and adapted to the students' special needs. An accompanying e-book or e-activity book would facilitate students' systematic learning and help them visualise chemical concepts further. E-materials are also various sets of diagnostic and evaluative tools which would make teachers work much easier and pleasurable.

3.4 Work on teacher training

To educate someone to become a valuable teacher of chemistry or physics is a long process. Potential teachers must not only be well prepared theoretically but also trained how to pass their knowledge to students in a clear, easy to understand way. A lot depends on the teachers themselves, their personality, attitude, sense of humour and enthusiasm. Being enthusiastic about their subject, teachers share their eagerness, zest and passion for nature and science with their students. Only then students are able to see and appreciate both ordinary and extraordinary achievements of mankind and science can be an interesting and alluring subject for them. To achieve this teachers should be supported from above levels. Their education should be more practical and methodology courses are specially tailored to meet this demand. Both students of chemistry, and then graduates, teachers and

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educators should have a wider and easier access to various forms of trainings, workshops and conferences in order to keep them updated with latest trends in chemistry and the methodology of a 21 century, modern classroom. Initiatives, like teacher manuals and magazines dedicated to developing their skills and comply with novelties of the science world are more than appreciated and welcome. Polish teachers, students of chemistry and scientists have a chance to contribute to development of a magazine 'Chemia w szkole'. Apart from practical teaching tips and methodology-oriented context, the magazine contains information about chemistry events, reports from conferences, overview of novelties and trends in contemporary teaching, as well as interesting lesson plans to be implemented in the classroom. International projects like Chemistry is All Around Network add more ideas to chemistry teaching. Didactical resources and materials available online, free of charge are very much appreciated by both students and teachers. Teachers use them as a point of reference or core material for lesson preparation. Ready-to-use tools facilitate teachers work and allow students to practise on their own both in school labs and at home.

3.5 Parents' role in creating and shaping children's interest in science and nature

As it was mentioned earlier, from the early childhood parents should encourage their offspring to explore nature. Simple experiments with water and colour can be performed at every household even with nursery or pre-school children. Floating objects at bath time, mixing ingredients when preparing a meal or watching lightening and thunders during the storm are some of the experiments or observations even an inexperienced chemist-parent can interest his or her children with. At later stages of mental and intellectual development children should be encouraged and supported to participate in various kinds of scientific initiatives addressed at whole families e.g. science and nature picnics, trips, scientific festivals and of course last, but not least, chemistry knowledge quizzes, competitions and contests organized by universities or technical universities in various places in Poland. Family events are more than enjoyable; appreciation of parents can be seen and passion for science can be shared. All this might have a really powerful effect on the young, creative minds and it might not only make students choose science subjects to study and explore further because they are useful and needed in everyday life, but also because they are fascinating and spellbinding.
Polish educational system has been reformed. Teaching and learning have become more practical, developing creativity of a student's young mind and allowing teachers, at the same time to implement new technologies in their classroom. Educational films, activities available online, meetings with external experts both in factories, universities or other businesses force teenagers' imagination to rapid action and teach them chemistry in a more interesting way; not as a subject full of boring facts, figures, numbers and special characters but as a useful knowledge of the world they gain for lifetime.

4. Analysis of Teaching Resources

According to the project requirements all the recruited teachers and experts were asked to identify, review and evaluate the teaching resources available online or in digital form at the national level. The task was set to the Polish team members via e-mail first and each teacher/ expert was responsible for identifying 2-3 resources. Some teachers were more reluctant to complete the task and others had to do their job to fulfil project's requirements at the national level. Finally 22 resources were selected and reviewed. The initial reviews made by the Polish teachers had to be updated as they were not fully compliant with the project objectives – some were too short in descriptions and comments sections. The resources represent different typologies of materials. Some are websites or portals run by official chemical organizations (POCZUJCHEMIE by ORLEN), some by higher education institutions (Virtual Campus at the Faculty of Chemistry at UMCS, Chemia.waw.pl or www.e-chemia.pl - Portal Chemiczny Politechniki Rzeszowskiej) or some by chemistry enthusiasts, teachers or experts (Baza Narzędzi Dydaktycznych - Database of Teaching Tools, CHEM-ŁEB czyli Chemiczne strony Witka, EDUDU.pl - E-Learning Educational Portal). A group of resources is a database of interactive materials and others are less interactive, just being a database of quizzes, tests and chemistry-oriented tasks for self-study on the individual basis mostly before the examinations or tests at school. It has been noticed that

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some resources are constantly updated and reliable sources of information whereas some were created some time ago and are not frequently updated both in terms of contents and usability. What has been greatly praised in the teachers' comments was the interactivity and visual stimulation contents. All resources accompanied by videos, animations and 3d modelling ranked automatically higher in the teachers and experts comments. Plain quizzes and explanatory descriptions of processes or chemical concepts were criticized for their monotonous nature and lack of explanatory tutorials in some cases. On the bright side, as it was mentioned above, some teachers found them useful as a from of revision before exams but only for the most motivated students. Majority of Polish team members agreed that for the classroom use the resources have to be packed with interactive, visual material presenting simulations and explaining more difficult, theoretical concepts in an 'easily digestible' way, so that the young minds can enjoy and understand the content rather than find it difficult and boring.

4.1 POCZUJ CHEMIE by ORLEN (http://poczujchemie.pl)

This resource has been ranked really high in Polish teachers' comments. It is not only a website but interactive portal created and run by the Orlen group to support chemistry teaching and learning in Poland. It has been created in order to stimulate young students' creativity and interest in science. Its main goal is to visualise chemistry in simple, funny way and sometimes even explain it in a non-technical way. Orlen group also organises interactive chemistry lessons at schools, which can be use as an advantage. The portal is divided into a few sections. More practical one, with NERD TV and Laboratory as main representatives. Both sections concentrate on visualizing chemistry in a hilarious way. Students can either 'experiment' on their own or watch a visualisation of some experiment with a teacher in the classroom. Some sections of the portal are less practical and become more theoretical but still are loaded with interesting facts and supported by down-to-earth explanatory solutions to tasks. The main objective is to present chemistry as the science all around us, constantly present in our life. A very interesting section of the portal is the Lesson of Chemistry whose main motto is centred around the statement that 'Chemistry does not have to be boring'. Experienced and well-prepared trainers visit schools to support the material covered in the lessons. They are accompanied by lesson plans, lesson materials and handouts to be distributed among the students. The whole portal contains downloadable materials section and a section were greatest fans and enthusiasts of chemistry are given a chance to share knowledge, participate in online chemistry quizzes and exchange opinions. Teachers of chemistry will also find it useful as the portal content can facilitate their teaching and arouse interest, or at least reduce boredom on their students' faces.

4.2 Baza Narzędzi Dydaktycznych: Database of Teaching Tools

Another resource identified by the Polish team and worth pointing out, as a reliable source of information and interesting content is Baza Narzędzi Dydaktycznych - Database of Teaching Tools (http://bnd.ibe.edu.pl/subject-page/9). In a nutshell it should be characterised as a collection of teaching tools available for teachers of lower-secondary schools in different subjects at lower secondary and upper secondary levels. The portal presents results of a project to support classroom learning and individual study. The portal offers opportunities of an interesting, innovative and unconventional way of presenting Chemistry to all students. All the available material facilitates students thinking, helps faster memorization of concepts and improves understanding of various chemical processes. All tasks are supported by explanations and comments of experts and present different ways of visualization of various experiments. They can be studied by students at home as well as used in the classroom even with students of not extended chemistry profile. Tasks are provided with answers and a thorough descriptions of how to perform the experiment in safe and effective way. They are carefully graded and without any doubt motivate students to experiment on their own. The portal also gives teachers an opportunity to play with various chemical concepts visualising chemistry in a daily use. Polish teachers and experts were quite positive in comments on this resource finding it worth recommending as a useful tools for chemistry education both in the

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classroom and self study at home. It has been noticed that all the descriptions of the experiments are provided to allow young people to visualise them and understand chemical concepts much better. Some experiments are encouraging students imagination and help them experiment on their own. Daily use of chemistry is pointed out. How to make a green scrambled eggs - can inspire even the most reluctant or bored students. The rest of the resources are rather packed with theory but also contain practical side. The ones created and run by individual authors have more of a revision value for individual study rather than contain interactivity-oriented simulations or experiments as Orlen produced.

5. Workshop on Students' Motivation

According to the project requirements WSIU as a partner had to organise the teachers and experts' workshop on students' motivation. Below there are details concerning organization of the event, its participants and results.

5.1Participants

The workshop was participated by 11participants. 4 of them were project Chemistry experts and 5 Chemistry teachers involved in the project. 2 other participants were WSIU representatives Magdalena Gałaj and Magdalena Bujak. The following experts were present in the event: Dr n. Farm. I inż. Chem. Elzbieta Zurek – Medical University of Lodz; Dr Iwona Krawczyk – Technical University of Lodz; Mgr Helena Kaniewska – 3 Age University; Dr Jadwiga Skowrońska – Technical University of Lodz/Among the teachers present during the workshop were: mgr Ewa Marczewska – ABiS Lower and Upper Secondary Schools; mgr Jan Stawiany – retired Chemistry teacher, mgr Joanna Błaszczykiewicz – School4Child Primary School, mgr Anna Panek – VIII LO in Lodz and mgr Luiza Wężyk – XXXIII LO in Łódź.

5.2 Objectives of the workshop

The main objective of the workshop was to introduce Polish teachers and experts to the contents of the Project Portal and resources available there.
The workshop was also intended to involve teachers into further project activities related to planning, designing and implementing new resources on the portal and prepare them for further stages of the project (teacher training and best practices).

5.3 Workshop Organization

The workshop was organized on 13 December 2012 at 12:30 – 15:00. It was quite short due to many teachers and experts' suggestions. It has been agreed that the needed cooperation and exchange of information will be done by e-mail. However, despite the convenient timing the workshop was participated by quite a small number of teacher of teachers. Most of them when contacted on the phone excused themselves with being busy at the end of the year. Unfortunately some also quit the project in the meantime due to various reasons.
The workshop was moderated by Magdalena Gałaj WSInf Project Expert at the premises of the Foreign Languages Department. During the workshop teachers received all the necessary materials about the project requirements to facilitate project work.

5.4 Delivery of the contents

During the workshop teachers and experts were briefly reminded about the project activities and once again were reminded about the deadlines. Teachers were introduced to the contents of the course briefly and asked to study it on their own back home.
The main part of the meeting was occupied by presenting the portal resources and assigning roles for further roles. Participants were also able to discuss the Polish situation with reference to teaching and learning chemistry and motivating young people to study the subject further on their own. Teachers and experts were also presented briefly with the outcomes of the 2 Transnational project conference in Prague.

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5.5 The reaction of teachers and experts

Teachers and experts were generally quite positive about the contents of the workshop – those who were generally positive about the project and the portal resources available online on the Chemistry is All around Network platform found it useful and for those, so far quite reluctant to cooperate fully, some bits of the workshop were difficult and the portal not user-friendly. Technology mattered here a lot as some teachers complained about poor internet connection at home when they wanted to upload their comments. It was observed that some teachers really needed support in understanding contents of the portal due to the language barrier as only a few are able to speak English. In the last part of the workshop teachers were distributed .doc files evaluating the portal and asked to complete the forms. Some teachers admitted a few bits of the portal were difficult for them mainly due to the language barrier and had a technical nature. For some who were more technologically minded some sections of the portal were very easy to follow and clearly presented. Everybody liked the graphical layout which made the content much more interesting and easy to follow.

6. Conclusions

Without any doubt Polish national scene with regards to science teaching and learning required and still requires some initiatives which would facilitate learning and exploring scientific subjects. Despite local or regional problems Polish authorities and educators are aware of the problems and are doing their best to eliminate them or at least reduce their side effect. Schools lacking money opt for solutions free of charge but still of a good quality. That is why initiatives like the one in the project, to establish a network of institutions and partners around Europe and maybe even outside, are more than welcomed on the educational market. A database of materials, resources, articles and activities online grouped together according to different topologies creates great opportunities for young learners to involve in the world of science.

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