

Successful Experiences in Chemistry Teaching in Poland



SUCCESSFUL EXPERIENCES IN CHEMISTRY TEACHING IN POLAND

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Abstract

The main objective of this report is to present the examples of best practices and experiences in Poland with references to national sources such as websites and journals where teachers can find suggestions and guidance about successful experiences dealing with teaching and learning Chemistry in Poland and abroad. The report also describes the fundamental competences that students should have in order to face the study of chemistry in Poland. Furthermore, the author will present examples of successful experiences with reference to reviewed national publications and will describe the criteria to assess the improvement of learning of Chemistry thanks to the above experiences. In the last part of the report the author will make reference to the Chemistry is all Around Network Project outcomes (workshops with teachers and testing of ICTs applied in Chemistry education) and will describe its role in the improvement of teaching and learning chemistry in Poland.

1. Introduction

Please describe the national sources (sites, journals...) to which teachers can access in order to get suggestions about successful experiences

The Chemistry is All Around Network project among other tasks had to create a meaningful and useful database of resources for teachers and students of Chemistry. Each partner had a wide choice of sources to choose from. The most common ones were available online in the form of websites of other project initiatives and research, some were interactive portals for teachers of chemistry, others just paper or online journals in which teachers could both find reference and suggestions about their teaching and new methodologies, as well as publish and share their experiences with others. Of course the most recent database created was the one created through this project i.e. <http://chemistrynetwork.pixel-online.org/>, where teachers can read conference papers, identify national and international publications and read the comments and reviews of their quality and role in the field of teaching chemistry. The portal collected all the necessary materials for teachers in one place and in that term is a very up-to-date and robust teaching tool. Below there are some examples of websites and journals for teachers identified by the Polish project team.

Let us start with 2 Chemistry Journals. Jagiellonian University promotes scientific development of its lecturers, students and graduates. *Niedziółki* magazine, edited by the staff of the Department of Chemistry Teaching, is designed for teachers of science, especially chemistry, as well as for students interested in these subjects. The aim of this quarterly journal is to promote chemistry and its achievements, information and discussion about the problems of teaching science, information about the activities of the Department of Chemistry Teaching at Jagiellonian University. In 1998, the magazine received the recommendation of the Polish Chemical Society and has been recognized as the publication recommended for school use. The authors of the articles in *Niedziółki* are primarily researchers and teachers, but also students of chemical departments. The magazine publishes popular articles devoted to teaching science, particularly teaching chemistry, history of chemistry etc. Furthermore, it contains updates on the activities of the Department of Teaching Chemistry - information on teaching sessions for teachers, competitions for students of secondary schools, open days of the Faculty of Chemistry, Department of Chemistry studies, including postgraduate studies.

Chemia w Szkole is a bimonthly journal for teachers of chemistry in all types of schools and teachers and students of chemistry pedagogy. It includes materials on a variety of topics to help teachers improve the teaching of chemistry. It has been available on the publishing market since 1954. The journal publishes: methodological proposals to facilitate the proper implementation of the new curriculum and prepare students

for final examinations in chemistry and tests at the secondary school; practical tips on chemistry experiments and safety in the classroom chemistry; information about the most important achievements of chemistry in the last century; tasks along with solutions from Polish and international Olympiads chemical and national competitions chemicals for lower secondary and secondary schools; conference reports by chemistry educators, highlighting new educational initiatives; news in the publishing sector: popular books and publications appearing in international journals. *Chemia w Szkole* is both available in printed and online form.

As far online materials and publications are concerned, the best example is "*Baza Narzędzi Dydaktycznych*" - the most tangible example of an online database of resources for both teaching and learning chemistry in Poland. It offers a variety of tasks within the subject of chemistry, physics, mathematics and humanities with comments and answer keys. The intention of this initiative was to support teachers who endeavor to make teaching and learning chemistry at school more interesting. The authors of the portal were encouraged and inspired by the results of recent studies indicating that young people are more likely to go to school today than five years ago. New core curriculum of general education tends to go from memory learning, „learning for the test”, the repetition of algorithms and „chaining dates.” The initiative wants to promote the new systematic approach towards teaching critical thinking, reasoning, and logical thinking skills. The whole portal offers proven ideas and sets of tasks in chemistry and physics which can be useful for conducting interesting classes in these subjects. The portal authors invite educators, teachers, and teacher trainers to add to the tasks discussed. The portal's main objective is to serve as a source of inspiration not only for teachers but also for students across disciplines and parents who want better education for their children; education which is more attractive for them, awakening their imagination and ability to think independently. The authors of the portal invite all enthusiasts of education to enrich comments, add suggestions, as well as ideas for new tasks, lesson plans and other teaching tools. Currently, the portal's content focuses on the lower-secondary school level core curriculum. In the future, it will be expanded for upper-secondary school students and vocational school students. As it was mentioned above, all the presented ideas and tasks have been created by teachers and scientists involved in the work on the new core curriculum. The collection of tasks, assignments and experiments can help teachers in the development of pupils' skills defined in the general and specific requirements of the core curriculum for the third stage of education. All the materials in this database in terms of content and form are based on the printed version of the booklet, and are fully compatible with all the requirements prepared by the Polish Central Examination Commission. The new core curriculum includes both general and specific requirements for teaching and learning. Specific requirements apply to the content of education, including mastering certain kinds of information and knowledge, and general requirements apply generally to complex skills, often within the cross-curricular framework. These refer to reasoning and argumentation, exploration, exploitation and creation of information, knowledge of research methods of the natural sciences development. It should be emphasized that the general requirements shall take precedence in relation to specific, and some complex skills, such as those concerning research methodologies which are stored only in the general requirements. All the suggested material and tasks relate to the requirements of both types, and comments posted facilitate their interpretation. The authors of the tasks are teachers and researchers, working with the Institute for Educational Research. The database of the material is gradually enriched and updated.

Another example of online portals where teachers can find examples of best practices and successful experiences is a portal of the educational programme "*Poczuj chemie*", whose aim was to educate and stimulate a new generation of young chemists, who want to build their future on chemistry, the future in both educational and professional aspects. Based on previous experiences of ORLEN - which has pursued educational programs such as "*Lekcja chemii*" - it creates a new quality educational system, which is expected to attract students to chemistry after hours spent in school. The foundation of the project was a new language of communication, developed on the base of a previous project supported by PKN ORLEN "*Lekcja chemii*". It was attended by 40,000 students whose interaction with that project allowed its authors to gather experiences for the new initiative. The authors emphasize that feedback between producers and consumers of the teaching content had a key role in the creation of a new quality. They also used popular media and technologies. The keynote of the project was a spectacular side of chemistry, with not-dominant

formal description. The chemical portal www.poczujchemie.pl the main result of the project, as interactive, dynamic, with a modern graphic design, stands out from the other solutions of this type. Of course, there are also presentations of experiences and interactive learning tools. The novelty consists in competitions with prizes (including non-virtual), often organized by the exchange of multimedia records of chemical experiences. The pioneer feature is also a formula for direct contact of schools with 'mobile' experts, 'experts on the road' who promote not only the chemistry as it is, but also through loosely related activities available through the portal [WPC]. The portal gathered many experts who interact with users on blogs and forums. Many of these experts are PKN ORLEN scholars who stand out not only due to their knowledge, but also due to pro-social attitudes. The portal has an additional interface for mobile devices. In this version of the site the authors abandon a typical professional hierarchy, known from other information portals for a loose convention of the computer game. Experiences with this form of knowledge transfer seem very interesting, but lack any evaluation of the type of learning, beyond the clearly positive assessment of users in terms of providing entertainment, does not allow to formulate any conclusions, yet. After a year and a half in operation, the portal has gathered more than 110,000 unique users, and 4500 of fully registered, who fulfilled all the authentication procedures. Among them we can find students from Polish partner schools of the project *Chemistry Is All Around Us - Network*. One of the measures of popularity of this web service is the submission of several hundred movies to two competitions on the presentation of the movie about pupils' own chemical experiments.

2. Key competences and their development in chemistry education

Please describe the fundamental competences that students should have in order to face the study of chemistry

Chemistry education in Poland has been facing constant changes as it has been challenged many times throughout the last few years. Without no doubt, chemistry is an important subject in the curriculum that fulfills a variety of tasks, but first of all shows us that chemical substances and phenomena are everywhere around. It is the science, which requires demonstrations and experiments. And here the questions arise. Is it possible to reverse the traditional teaching schemes in Polish education? Why should you get to know them and use at school?

What is interesting for students is usually what is unknown to them, different, something which is amazing, and unusual. One should apply a concept of "reversed lesson" or "reverse education", however they are understood differently, but above all it is associated with innovation, which changes the style of students' learning and breaks the established patterns in teaching and patterns of traditional didactics. "Reverse lesson" is the Polish translation of the English term appearing in many publications and papers (flipped learning). Automatically questions arise: What is the reversed lesson and what are its advantages? How to organize a reverse chemistry lesson? How to teach the subject to achieve a higher quality of learning? How to reorganize traditional school teaching and learning of chemistry? How to take advantage of "reverse lesson" in chemical education?

Why should you get to know and use the principle of "reverse lesson" in the classroom? The need to organize school teaching and learning in an innovative way, unconventional way has been mentioned for years. The problem also applies to teaching not only learning chemistry. Much attention is centered today around the need to break the teaching paradigms and educational paradoxes to make school teaching and learning more interesting for the learners themselves. This creates quite an interesting innovation. Even if it is the best innovation up to date, it still does not produce the expected effects without the high activity of learners. "Reverse lesson" is an innovative lesson, which dominates activity of students. It requires implementation of some crucial aspects focused around the growth of students' independence and responsibility for their learning. Another aspect is changing roles in education, where the students have an important role; students' partnership in conversation and discussion with the teacher. Another is total independence of learning content that is recorded and always available on the network. Tolerance to an individual style and pace of learning, because materials can be yourself reproduce themselves many times as the student needs to understand the content. Last but not least, respect for individualization, because nobody here urges or reminds that something needs to be repeated, because the student can review the

material as many times as he/ she wants or needs. And the final most important aspect of innovation accentuates classroom experimentation; discussions, posing questions, argumentations and sharing views with colleagues. Curiosity leads to knowledge and in the "reverse lesson" it becomes a much more active initiative based on self-reliance and responsibility for their learning. The curiosity of pupils is quite widely recognized as one of the strongest motivators for exploring, learning, experimentation. Because of the need to achieve greater curiosity students at the beginning of the lesson, it boldly breaks didactic diagrams and educational paradoxes to learning to be interesting, motivating and above all effective for students. But it is true that the subject can tighten-Self-reliance and responsibility of students. Moving away from the traditional scheme will definitely promote students active participation in the class. The feature of modern education is based on highly-independent learners. It is a fundamental and indispensable issue needed for appropriate performance and high quality learning outcomes. To achieve this it is necessary to raise the level of students' activity and commitment. You have to make use of their personal qualities to show them the meaning of high activity (activism), i.e. doing various activities and engage involvement in the matter of learning of chemical content. Particularly important in this respect it is to speak, present and discuss things which builds and improves the quality of learning and teaching in the way which is interesting for learners, of course, in an effective and creative way that is, one that allows students to invent, combine, try, experiment, break clichés and schemes and at the same time make errors, but primarily one which leads to the understanding of the content, because "(...) one should be afraid of nothing in life, one should only understand it." (M. Skłodowska-Curie).

Another feature of modern school education should focus on efficient organization of the learning process. Hence it is evident that to achieve the better the effects of school work, teachers should focus their efforts on improving the organization of students' learning. i.e. to create essential, basic and necessary conditions that would resolve the issue. Teachers should analyze the reasons for the unsatisfactory level of students' activity and develop concrete ways to inspire and stimulate learners. A mere activism is a feature of modern a teacher and a human of the twenty-first century. It is worth promoting among students and teachers. The objectives and the main approach of "reverse lesson" quite nicely correspond to the tasks of democratic school, which are increasingly a very hot subject of discussion and consideration of scientists and experts. This concept seems to be rather utopian in Polish conditions. The most doubts appear when one considers ways of how to motivate students to acquire skills and verify the usability of the acquired knowledge.

More and more often on the Polish educational market appear different materials related to connectivism. What is interesting in this thesis indicates that human knowledge is not necessarily all stored in the head. This proves that to do a specific task a student may use available devices and information collected in the external resources. The modern learner simply needs to obtain information, accumulate, and then parse, use and apply - and here is the key to the most important human competence of a digital era. It is high time probably to change "knowledge based" school for the school of thought and development of critical thinking skills and not accepting and praising everything around us, whether it is white or the black. Thinking is a necessary component of all the key competences of the student and the teacher. It determines the knowledge, understanding and handling of the human language. Deliberate and conscious decisions shall be based on the specified resource information, but this is constantly changing. The theory of connectivism assumes that the most important aspect of a modern school is to know where to find information. The key skill of critical thinking is to teach students how to distinguish which information is relevant and which is not. Otherwise the saying, "know how" (know-How) or "know what" (know-what) is replaced by "know where" (know-where). This is the key leading resource for your search of knowledge.

Chemistry, being the subject of laboratory, requires a well-equipped and functional laboratory to perform experiments, demonstrations and tasks. In this area the teacher must boldly organize lessons and their own innovations of teaching, which strongly engages students in the implementation of new tasks, in particular emotionally. But the idea of "Inverted education" itself is based on putting greater store by self-reliance, activity students in the classroom and their responsibility for tasks. Digital school and availability of open educational resources on the Internet opened up new opportunities for school and work on raising effectiveness, and what is more has become friendlier for students learning. This education suggests the organization of four lessons stages: activation, processing, systematization, evaluation. The teacher's main

task is to introduce initial activity of students and introduce them to the concept of self-learning. In this method the teacher is no longer the person who tells students what and how they should learn. His or her main task is to indicate the range of material and sources of information to look for.

3. Examples of successful experiences

3.1 Experience description

Please make reference to reviewed national publications

This section of the report will present a short overview of the Polish national publications on how to teach Chemistry and science effectively. Let us start with a web article entitled **E-NAUCZANIE CHEMII NA WYDZIALE CHEMICZNYM POLITECHNIKI WROCŁAWSKIEJ**. It is a publication by Piotr WOjciechowski, published in E-mentor nr 3 (35) / 2010. The main objectives of the publication are: to present the idea of e-learning courses (70) available through Moodle at the Faculty of Wrocław Technical University with a great store set by the faster access- nor time and place limitation, better testing and wide access to resources online. Another perfect example is **E-NAUCZYCIEL PRZYRODY** by a group of scientists from the University of Adam Mickiewicz in Poznań and Boulder Language Technologies. Although available in Polish, this publication is a project outcome, whose main objectives were to facilitate teacher education and raise its quality. The E - Teacher of Science Subjects is an Integrated learning environment for the development of scientific thinking , information literacy and language skills of students by modelling technique based on the dialogue in the classroom; Questioning the Author and e-learning platform BLT VHT contained multimedia teaching materials made in Flash. A virtual teacher MONICA allows students to safely review and evaluate the learnt material. Third national publication worth mentioning here is **TEACHING OF ANALYTICAL CHEMISTRY IN POLISH UNIVERSITIES** by M. Biziuka& J. Namiesnika published in English by Taylor & Francis Online in 2010. The main objectives of the publication focus on: dealing with the issue of analytical chemistry – how it is taught and why it is important for the industry; great store set by the cooperation of the students with the researches and experts during their studies with the need for environmental monitoring, food quality control, human health, industrial production quality control, nanotechnologies, material science; these are only some of the areas where analysts are indispensable. Last, but not least, it is worth mentioning what the Jagiellonian University produced. **A FILM BANK, a conference article** by Małgorzata Świątek presented International Conference ICT for language Learning - conference proceedings in 2011. The objectives of this initiative was to help Chemistry students to develop their knowledge of English (ESP) via a set of films and listening to comprehension exercises aided by vocabulary bank available in the form of an online course.

3.2 Experience assessment

Please describe the criteria to assess the improvement of learning thanks to the above experiences

All the mentioned above examples of publications on successful experiences have had a great impact on the improvement of learning in Polish schools at all levels of education. All the four publications enable prospective teachers of Chemistry to develop their critical skills and later apply more open-minded teaching strategies in the classroom. Language development allows young teachers to communicate freely and use a great amount of teaching materials available online on international websites in order to prepare interesting lessons for learners in the classroom; lessons, which develop learners' critical thinking skills and allow them to select and verify the usability and efficiency of the collected materials and teaching resources. All this should enable students to make their own assumptions on the chemistry-oriented world.

4. The Impact of the Project on Successful Experiences

4.1 Workshop

Please describe the main observations and proposals emerged during the discussion with teachers

Among many project tasks, each project partner was to complete in the third year of the project, was organization of the teachers' workshop on Successful Experiences.

The main objective of the workshop on Successful experiences organized by the Polish partner was to discuss the issues and activities already realized and to be achieved in the third year of the Chemistry is All Around Network project.

The workshop was also intended to involve teachers and experts into further project activities related to planning, designing, implementing and disseminating resources and materials collected on the portal by the project's consortium. What is more, the objective of the workshop was to introduce teachers and experts to final activities of the project i.e. two international conferences (Braganza and Genoa), as well as to discuss final outcomes of the project and its sustainability.

Workshop Organization

The workshop was organized on 1 April 2014 at 8:00-12:00. It was quite short due to many teachers and experts' suggestions. It was agreed that the needed cooperation and exchange of information will be done by e-mail prior to the workshop. However, despite the convenient timing the workshop was participated by quite a small number of experts and teachers. Unfortunately some experts and teachers quit the project in the meantime due to various reasons; either stopped cooperating with the University of Computer Sciences and Skills (one expert) or changed their place of work (3 teachers). WSIU partner was forced to search for new teachers and experts. We managed to invite and introduce a few new teachers to the project who agreed to join us and help us evaluate final products.

The workshop was moderated by Magdalena Gałaj WSIU and the main expert conducting the workshop was dr Mariusz Jarocki. The workshop took place at the premises of the Foreign Languages Department, in the classroom equipped with a whiteboard for better visualization of the portal contents. Each participant had his or her own laptop for more convenient and effective workflow. During the workshop teachers and experts received all the necessary materials about the project requirements to facilitate project work.

Delivery of the contents

The workshop started with a brief introduction by Magdalena Gałaj, where teachers and experts were quickly reminded about the project activities and once again reminded about the deadlines. Teachers were introduced to the contents of the portal briefly and asked to study it on their own back home in order to complete the evaluation questionnaire.

The main part of the workshop was occupied by presenting the portal resources with reference to materials, papers and articles with reference to Successful Experiences in teaching and learning chemistry. Participants were also able to discuss the Polish situation with reference to teaching and educating prospective teachers of chemistry and motivating young people to study the subject further on their own.

Prior to the workshop each teacher and expert was asked to think of their most successful best practices implemented in their classrooms.

Then dr Mariusz Jarocki took over with a presentation of a few most interesting resources collected on the portal. Dr Jarocki started with a short presentation of the Polish situation to let everybody realize the availability of the resources online. He briefly reminded websites and objectives of all of the collected resources and initiatives in Poland. Dr Jarocki referred to the resources described in his paper, which is going to be presented during the 5th International project conference in Braganza, Portugal.

Examples of good practices discussed during the workshop:

1. Initiatives of Universities and Polytechnics

- a) Jagiellonian University – A language course for chemistry students and teachers - <http://www.efch.jci.uj.edu.pl>

English for Chemistry: Film Bank is a non-profit project, aiming to provide materials for teaching English for Specific Purposes at B2 level in accordance with the Common European Framework of Reference to the students of the Faculty of Chemistry at the Jagiellonian University in Kraków. The project was conducted in the academic year 2010/11 by third year students of this faculty under the supervision of Dorota Klimek, a teacher of English at the Jagiellonian Language Centre. The film bank includes a set of listening comprehension exercises based on films concerning a variety of chemistry subjects, carefully selected from the multitude of materials available on the Internet. The films are accompanied by a follow-up section, consisting of complementary reading and vocabulary exercises.

The materials can be used in the classroom and for self-study purposes alike. The files are also available as printable pdfs.

The course aims to bridge the gap in the Polish Chemistry Teacher's education and qualifications with reference to language training so needed in order to use materials available in English language versions.

- b) Higher education institutions in Poland are quite active in promoting learning and teaching chemistry in an interesting and innovative way. In the current academic year, Jagiellonian University in Cracow Department of Chemistry invites pupils and students of secondary schools to participate in *Meetings with interesting chemistry, Cryogenic Demonstrations, Workshops for high school graduates - "Last call before Matura exam"* ; *Lectures on "Chemistry has many names"*. The above listed are only a few among many exciting initiatives for young people, whose main objective is to increase awareness of the society and promote better comprehension of science oriented subjects. Similar initiatives are promoted by University of Lodz, University of Warsaw, Technical University of Lodz and many others.

2. Initiatives of Chemical businesses and industry

- a) The chemical portal www.poczujchemie.pl, the main result of the project by PKN ORLEN Chmical Plant, as interactive, dynamic, with a modern graphic design, stands out from the other solutions suggested by chemical business. The portal included presentations of experiences and interactive learning tools. The novelty consists of competitions with prizes (including non-virtual), often organized by the exchange of multimedia records of chemical experiences. The pioneer feature is also a formula for direct contact of schools with 'mobile' experts, 'experts on the road' who promote not only the chemistry as it is, but also through loosely related activities available through the portal. The portal gathered many experts who interact with users on blogs and forums. Many of these experts are PKN ORLEN scholars who stand out not only due to their knowledge, but also due to pro-social attitudes. The portal has an additional interface for mobile devices. In this version of the site the authors abandon a typical professional hierarchy, known from other information portals for a loose convention of the computer game.
- b) Chemical Plant "Police" co-operates with schools and universities from the West Pomeranian region, which include: University of Szczecin, West Pomeranian University of Technology, Maritime Academy, and West Pomeranian Business School. Among many partner universities are also Poznan University of Technology, Warsaw University and Warsaw School of Economics. Cooperation with schools and universities is based on long-term contracts on the basis of organized programs and internships in the company in order to prepare students and prospective teachers for their work either in the chemical or educational sector.

3. Initiatives collected and available online

- a) "Baza Narzędzi Dydaktycznych" <https://bnd.ibe.edu.pl/subject-page/9> is the best example of an online database of resources for both teaching and learning chemistry in Poland. It offers a variety of tasks within the subject of chemistry, physics, mathematics and humanities with comments and answer keys. The intention of this initiative was to support teachers who endeavor to make teaching and learning chemistry at school more interesting. The authors of the portal were encouraged and inspired by the results of recent studies indicating that young people are more likely to go to school today than five years ago. New core curriculum of general education tends to go from memory learning, „learning for the test”, the repetition of algorithms and „chaining dates." The initiative wants to promote the new systematic approach towards teaching critical thinking, reasoning, and logical thinking skills. The whole portal offers proven ideas and sets of tasks in chemistry and physics which can be useful for conducting interesting classes in these subjects. The portal authors invite educators, teachers, and teacher trainers to add to the tasks discussed. The portal's main objective is to serve as a source of inspiration not only for teachers but also for students across disciplines and parents who want better education for their children ; education which is more attractive for them, awakening their imagination and ability to think independently.

- b) “Projekt Gimnazjalny Akademii Uczniowskiej” <http://www.ceo.org.pl/pl/au> an online database full of lesson plans and ready-to-implement solutions based on the conduct of experiments, observations, learning games and activities with the problematic question. Various scenarios of projects equipped with tailored lesson plans were developed by teachers and students and validated by experts as a good practice of science teaching in the modern Polish classroom. Teachers, actively involved in the project, participated in the *Akademia uczniowska* course on "experimentation and mutual learning". All lesson plans collected in the database include the following issues formulated by the students: needs analysis, research questions, hypotheses, description of the students' experiences, planned and carried out projects designed Mutual Learning, educational games and evaluation. Teachers and experts were generally quite positive about the contents of the workshop – those who were generally positive about the project and the portal recourse 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. Teachers appreciated the Polish language version of the portal. Dr Jarocki pointed out the functionality of the resources but also stressed the fact there is a huge demand for young teachers and experts to be able to create their own interactive materials. This would of course have to involve a change in the training of prospective teachers so that on completion of their training or university course they will be able to design and create their own materials with the least effort and time. Such materials would give teacher freedom to select the most interesting content to be introduced to his or her students, as well as will allow them to adapt it to the learners needs – from the most talented to the weakest ones. The teachers pointed out poor chemistry lab infrastructure. Access to latest technologies during the lesson is possible only in schools with computer-equipped or white-board-equipped classrooms. Another problem was, which was discussed during previous workshops was the language barrier. Interactive resources could only be implemented fully when the teacher and his or her students are able to understand and explain the chemical processes fully. In Polish reality students may have fewer problems to understand the technical concepts. This could be both a disadvantage and advantage. Mainly due to the fact that thanks to materials available in the foreign language versions both students and teachers can develop linguistically. Of course for a busy teacher of chemistry is mean more preparation and work prior to the lesson. Further discussion during the workshop also tackled the issues related to chemical industry involvement into the learning and teaching processes both in lower-secondary and secondary schools, as well as universities. For example the organization of internship programs for most talented students at university level or conducting interesting lessons in the chemical plant labs in order to facilitate young learners' interest in chemical phenomena in everyday life.

5.2 Testing of ICTs

Polish educational market has been so far overloaded with teaching theoretical concepts and not much impact has been made on experimenting and hands-on activities. The practical experiments were neglected and not very much favored by the teachers in the classroom due to the lack of financial resources. The project Chemistry is All Around Network enabled Polish teachers to access a huge database of materials and teaching resources free of charge. They welcomed the portal content with great interest and enthusiasm. Thanks to the resources collected on the portal Polish teacher have a chance to make use of a huge variety of teaching tools and especially those oriented for visualization of experiments and chemical phenomena. Especially teachers of young learners appreciated this form of presenting chemical content mainly due to safety reasons. Other resources are very successful in the Polish classroom due to their ideas and simplicity of use. Teachers appreciate readymade tools and solutions to be used in the classroom. “Baza Narzedzi dydaktycznych” is one of the examples of a collection of materials “by teachers- for teachers”. Simple, cheap and safe solutions of how to perform an experiment or a demonstration in the, usually overcrowded classroom are the most favoured by Polish teachers.

6. Conclusions

Please write the conclusions to your report, also emphasizing the need to stimulate a proper scientific approach since the early years.

The case studies of implementation of comprehensive programs to support teaching chemistry presented in this document provide a view of the trend in the use of modern and innovative solutions in the context of the Polish education system. The main conclusion seems to be the assertion that the period in which the focus was on developing new, innovative methods slowly evolves into the consumption of these innovations, with the particular emphasis on the creation of the basis of already implemented prototypes of new teaching resources in other areas of chemistry, ICT support for virtualization experiments and e-learning. The great emphasis is placed on companies and industry cooperation, which in addition to the natural profit in the form of exchange of experiences has also a marketing aspect. It proves the fact that chemistry, as a branch of science and a field of study, is a good choice in terms of further education and work careers. The role of the Project Chemistry Is All Around Us - Network is undeniably useful in this regard. Providing solutions to support the education process remains the main task of the project, but it seems that in the future the strongest accents will be moved to the cooperation between the partners from industry and raising the qualifications of the teachers through the use of the collected tools and materials within the project's operation.

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