

## Chemistry Education in Polish Schools

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### Abstract

*In the paper the chemistry education in Polish schools (including lower secondary school, upper secondary school and higher education) was described. The Ordinance of the Minister of Science and Higher Education from 17 January 2012, which was also signed by the Minister of Education [2] is currently in force in Poland. In this regulation standards of training to work as a teacher have been determined. According to them one should pay attention to: the effects of education (learning outcomes) on the expertise and methodology, pedagogy and psychology, preparation for the application of technology information and foreign language proficiency, the duration of studies and postgraduate studies and the dimension and organization of training programmes for teachers. Universities provide the education to prepare for the teaching profession in college and postgraduate studies in the relevant training modules. In the chemistry education it is extremely important that the teacher could present the student with practical aspects of chemistry, while meeting the educational and tutorial purposes. The awakening of students' natural curiosity for the world is not without significance, too. Therefore the purpose of proper training and education in schools is to transfer knowledge in a clear and understandable manner, to present the importance of chemical knowledge in everyday life, to shape the attitudes of research and logical thinking and drawing conclusions from observations. Properly carried out monitoring and assessment of performance has a significant impact on the course and the final effects of the learning process. It is the continuous professional development of chemistry teachers which guarantees the highest quality of students' learning. This is possible thanks to the numerous courses, including language courses.*

### 1. Introduction

Chemistry knowledge acquisition should be an important element of the education of every high school graduate. However, largely it depends on the objectives and implementation of the curriculum of chemistry. The main result of chemical education should be to equip pupils with the knowledge to help them properly assess the phenomena in the world and use them in everyday life. How to achieve this? Such objective can be achieved especially when the pupils receive a solid, reliable, specific and systematic knowledge of the basics of chemistry. To achieve this purpose, the teacher should have the opportunity to construct assessment and evaluation tools, make adjustments of their own work with the pupil and appropriately motivate pupils to work [1].

### 2. Chemistry teacher – how to become one?

The Ordinance of the Minister of Science and Higher Education from 17 January 2012, which was also signed by the Minister of Education [2] is currently in force. The standards of training leading to the teaching profession are defined in this ordinance. The ordinance regulations specify:

- the learning outcomes across the range of expertise and methodology (cross curricular), pedagogy and psychology, application of information technology and foreign language proficiency,
- the duration of studies and postgraduate studies,
- the size and organization of practical training for teachers.

In the new standards the two-specialization education, obligatory until now in the first degree, was rejected. The process of preparing teachers for their work is modular and its implementation will depend on the course of study and graduate and postgraduate studies. Pathways to education of a teacher will be conducted in three compulsory modules, including the substantive, psycho-pedagogical and didactic preparation for teaching (preparation to conduct the course). This education will be



expanded to optional modules including preparation for teaching another subject (preparation to conduct the course), and the background in special education.

Teacher training relies mainly on getting practical skills needed to work as a teacher. In turn, theoretical knowledge supports the acquisition of these skills and gives a scientific synthesis of obtained experience. Thus, the discussed Regulation leads to increase of the role of practical training, in particular in the areas of competence of the care, education and diagnose of individual student's needs.

## 2.1. Teacher training – process and organization

Universities provide courses which prepare students for the teaching profession in academic education and post-graduate studies in the relevant training modules. Chemistry teacher education takes place during the second-cycle of studies and includes mandatory training in the following areas:

- 1) substantive education for teaching of first subject (preparation to conduct the course) – first module;
- 2) psychological and pedagogical education – second module;
- 3) didactic education – third module.

The preparation to work as a teacher during the academic education can be extended to optional preparation for teaching of another subject (to conduct the course) – fourth module.

However, the preparation to work as a chemistry teacher at postgraduate studies may be conducted in the following areas:

- 1) preparation for teaching of another subject (to conduct the course) – fourth module;
- 2) psycho-pedagogical and didactic preparation for graduates with substantial preparation for teaching (to conduct the course) and without psycho-pedagogical and didactic preparation – second and third module;

The implementation of each module, both in academic education and post-graduate studies, should lead to the attainment of the same learning outcomes. The implementation of module 2 and 3 should take a total no less than three semesters. The third module is implemented after the second module. The training in the range of the fourth module is taken by students or graduates preparing for the teaching profession, who intend to prepare to teach more than one subject. The fourth module may be implemented parallel to the third module or on completion of the third module. The implementation of the training modules according to [2] is presented in Tab. 1.

Table 1. Implementation of the training modules

Module	Module components	Hours	ECTS credits
1. substantive preparation for teaching of the first subject (of course)	Substantive preparation according to description of training results for implemented field of study	*	**
2. psycho-pedagogical preparation	general psycho-pedagogical preparation	90	10
	psycho-pedagogical preparation for teaching in the education stage	60	
	practise	30	
3. didactic preparation	didactics basics	30	15
	teaching of subject in the education stage	90	
	practise	120	
4. preparation to teaching of another subject (of course)	substantive preparation	*	**
	teaching of subject in the education stage	60	10-15
	practise	60	

5. preparation for special didactics	psycho-pedagogical preparation	140	25
	special didactics	90	
	practise	120	

\* dimension that provides academic preparation for teaching

\*\* the number assigned to the objective course of study

Postgraduate studies are designed for teachers who wish to improve their qualifications by updating of their knowledge and practical skills necessary for chemistry teaching in lower secondary and upper secondary schools. Recruitment for the study includes people who have completed their master's degree in chemistry or engineering or related fields of chemistry (among others biology, physics). A graduate of postgraduate studies can obtain the most up-to date knowledge of general chemistry and inorganic, organic and physical chemistry necessary for teaching in lower- and upper-secondary schools and implement the information technology resources to support the teaching of the subject.

### 3. Chemistry education

Natural curiosity of the world is the potential which should be exploited among students.

Among the objectives of training and education in lower secondary schools we have to mention [3]:

- a) presentation of the importance of chemical knowledge in everyday life;
- b) the relationship of chemistry with other sciences;
- c) knowledge of the properties of chemical substances present in the environment and the possibility of their conversion;
- d) shaping the research attitudes;
- e) development of appropriate attitudes in caring for the health and protection of the natural environment;
- f) the ability to use the chemical language;
- g) the ability to draw conclusions from the observations;
- h) the ability to perform simple chemical calculations;
- i) the ability to acquire and process information from various sources, such as the periodic table of elements, tables, charts.

The main objectives of training and education in the upper secondary schools we can mention the extension of knowledge acquired in lower secondary school, and especially [4]:

- a) observation of the world around us;
- b) the ability to describe the phenomena under observation;
- c) logical thinking and associating facts;
- d) the ability to use available information from many sources and properly selecting them;
- e) acquisition of the belief that success is a source of systematic work.

The new core curriculum pertains to a combination (not structural) of a first-grade of upper secondary school and the lower secondary school. At primary level, in the upper secondary school the curriculum, of the lower secondary school cannot be repeated, but it can be continued in upper secondary school. Therefore, pupils graduating from lower secondary schools should best learn chemistry content provided in the core curriculum to complete the third stage of education and to acquire the necessary skills. The teacher of the first grade of secondary school has to discuss topics related to the chemistry of everyday life, which is possible only in case of a good mastery of basic knowledge of chemistry at the lower secondary level. Pupils in lower secondary schools need to learn at least the basics of chemistry and to acquire such skills that will allow them to use safely different materials, and therefore they will enable them to live in a safe environment. The scope of the curriculum offers many opportunities for work by educational project (especially about the nature of research) experiment using chemical or other methods of activating, which will enable pupils to acquire and process information in different ways and from different sources. Self-observation is the basis of the student's experience, reasoning, analysis and generalization of phenomena, so experiment a very large role in the implementation of the above content. According to the provisions of the new core curriculum, teaching content cannot be repeated in different subjects.

### 3. 1. Evaluation of chemistry knowledge among students

Properly carried out monitoring and evaluation of performance has a significant impact on the course and the final effects of the learning process. It is important for both the pupil and the teacher. Among the forms and methods of assessment we can include:

- verbal response,
- homework,
- quiz (takes up to 15 minutes),
- test (takes 1 hour lesson),
- activity in the classroom,
- extra-curricular work (competitions, the Olympics, the wheels of interest).

In this way, the student receives information about the state of his or her knowledge and potential drawbacks and deficiencies, and the teacher can assess the extent in which education has achieved its objectives; conclusions about improvement are drawn on that basis. It is important that the teacher can check the knowledge, which will have importance for students in the future. Students' achievement should be monitored regularly, because this encourages them to study systematically. It is important for students to receive the reports on the results of their learning, with an appropriate commentary of the teacher, as soon as possible. Certainly, this fact translates into better motivated students and more effective learning outcomes.

### 3.2. Training standards of chemistry students

#### 3.2.1. I cycle programme Undergraduate education

Bachelor's studies last at least 6 semesters, and the number of hours should not be less than 2200 ( $\geq$  180 ECTS points). The graduate of these studies should have knowledge and skills in general chemistry topics, based on mathematical and natural sciences. Engineering studies last at least 7 semesters, and the number of hours should not be less than 2500 ( $\geq$  210 ECTS points). Engineering graduate should have the ability to use the basic knowledge of chemistry and chemical technology, based on the broad-based mathematics, natural sciences and engineering.

#### 3.2.2. II cycle programme Graduate education

Graduate education takes not less than 4 semesters, involving undergraduate alumni. Number of hours should not be less than 1000 ( $\geq$  120 ECTS points). However, in the case of engineering graduates in postgraduate courses last not less than three semesters, involving engineering graduates and the number of hours should not be less than 900 ( $\geq$  90 ECTS points). Graduates should have an extended (according to first degree) knowledge of chemistry and demonstrate a proficiency in the chosen specialization. He should have the knowledge and skills leading to solve chemical problems in non-standard situations.

## 4. Future perspectives for enhancing attractiveness and effectiveness of chemistry teaching at school

Certainly, the primary research tool of each chemist should be an experiment, e.g. experience, chemical test, proof [5]. The chemistry teaching with the selected experiment will be more impressive. The experiment is not only a tool of research, but also educational value. Experiment promotes thorough understanding of chemical phenomena and teaches how to experimentally obtain answers to the posed questions. [6].

Conducting of interdisciplinary activities is also very important, because it gives teachers freedom to choose how to implement these activities. This could be, for example, the organization of activities outside school, designed to observe nature in the field, or to complete projects to raise social awareness and active citizenship. Chemical education in school can be carried out in different ways, depending on the capabilities of the school, teacher preferences and needs of the students.

It is worth noting that the technology development affects also the educational sector. It is necessary for each school to meet the challenges it has to face, each school has to be a modern school. In a nutshell, it is impossible to provide effective learning without the knowledge based on the latest



educational solutions. Nowadays, electronic media complement books. Computers, tablets and interactive whiteboards are tools whose applications in the classroom are increasingly required by both students and their parents. This is not surprising. Learning through multimedia is not only interesting, but also more effective.

Moreover, a good teacher of chemistry:

- has a knowledge of chemistry in accordance with curriculum content of these subjects,
- is able to independently deepen this knowledge, update, and integrate with other fields of knowledge and transfer properly to students,
- knows the correct development of students and can be a good guardian and tutor through knowledge based on psychology and pedagogy,
- supports the intellectual development of students through appropriate teaching methods and educational measures,
- knows how to use information technology in the classroom,
- knows the foreign languages,
- wants to continue to develop professionally.

More than 90 per cent of Polish teachers have higher education diploma, but only about 25 per cent of them speak foreign languages fluently [7]. English is known only by teachers with the short-term (up to five years) of teaching experience. Teachers with work experience of above 20 years have the lowest English language skills. This makes it difficult for chemistry teachers as they are expected to attend language courses very often free of charge. Undoubtedly, a good knowledge of foreign languages will help teachers to be able to participate in international mobility programmes, exchange their experience, establish contacts with teachers from around the world and benefit from foreign sources, preparing for lessons.

#### 4. Conclusion

In the course of the chemistry teaching it is extremely important that the teacher could acquaint the student with practical aspects of chemistry and implement and complete educational and tutorial objectives at the same time. Not without significance is the awakening of students' natural curiosity to substances and phenomena that surround us. It seems that crucial teacher skills and information useful in everyday life should be one of the main objectives of the chemistry science. It is certain, that is not enough to complete the chemical studies to be a good teacher of chemistry. The continuous improvement and training are equally important. The teacher should do this to share his passion of science with his or her students.

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