US-China Education Review B 1 (2012) 31-40
Earlier title: US-China Education Review, ISSN 1548-6613

A Conceptual Approach to Learning Chemistry in Professional Secondary School in Latvia

Daina Priede, Aira Krumina
University of Latvia, Riga, Latvia

After the year 1991, great structural reforms were launched in Latvia at all levels of education, including secondary education. Still, there are many reforms that must be implemented in secondary professional education. The objective of our research was to develop a contemporary didactic coverage for teaching chemistry in professional secondary education. New teaching/learning material in chemistry for professional secondary schools was elaborated as a result of this study. It consists of the following units: basic (invariable) theory a unit based on the curriculum of the "State Educational Standard" in chemistry. Variable theory, a unit, includes various and specific information about environmental chemical processes that are vital to ensure definite students' professional competences in future. A unit that develops students' self-dependent skills and activity this unit includes exercises of different difficulty based on the implementation of the didactic approach: knowledge understanding application. A unit that promotes students' experimental skills and activity this unit contains descriptions of environmentally "friendly" laboratory exercises.

Keywords: chemistry education, professional secondary education, teaching/learning materials

Introduction

Before re-establishment of independent republics, the government organized the economy in the Soviet Union as a planned economy. Natural sciences in the educational system had indubitable advantages compared with social sciences and economics. Natural sciences had a high rating not only in schools, but also among parents and in overall society. Pupils had to show extensive knowledge in concrete fields of natural sciences and these expectations had to be fulfilled by teachers. However, usually knowledge obtained was limited by information available in textbooks that were etiologically compromised of soviet ideology. Government controlled subject content. The mastery of natural sciences (chemistry, physics and biology) was planned and organized as an education for training "modest" scientists.

After regaining its independency in 1991, Latvia and other post-soviet countries faced a serious dilemma. A new democratic country with an open market economy was starting to emerge. Therefore, the goal of economic policy was to reach the level of development of Western countries. This process was hastened when Latvia joined EU (European Union). Therefore, economic development was intensively accelerated. However, soon Latvia and similar countries arrived at the conclusion that alongside economic development, it is necessary to change the educational system, so that students would gain the knowledge necessary in an open

Daina Priede, Ph.D., the Center of Chemistry Education of Faculty of Chemistry, University of Latvia.
Aira Krumina, assistant professor, the Center of Chemistry Education of Faculty of Chemistry, University of Latvia.

market economy. The level of academic knowledge among students of different levels of the educational system was sufficient, whereas practical skills were decreasing due to insufficient resources (Holbrook, 2008). Significant structural reforms were performed at every level of the educational system, including secondary education. The aim of the reform was to prepare graduates of secondary schools that would be ready to study in universities Latvia and abroad, as well as to participate in a worldwide labor market. Today, the long-term aim of the in Latvian educational system is to move forward with a knowledge-based society where cultural, social and economic development is driven by a high intellectual level of the inhabitants. Nowadays, in order to secure substantial development, the quality of education has to correspond to the increasing demands of society and economy. The Latvian national plan of development for 2007-2013 noted that knowledge of growth resources is relevant. The plan declares that our key resource to achieve the level of development of Western countries is the proficient and determined use of inhabitants' knowledge and wisdom (Ministry of Education and Science of the Republic of Latvia, 2009).

The Necessity of an Accent Shift in the Content of Secondary Professional Chemistry Education

The adjustment of the professional educational system in general can be characterized as an acquisition of professional education that corresponds to state and labor market interests. This means that the population has a lifelong opportunity to receive the comprehensive and professional knowledge and skills that are appropriate to their endowment and interests. This opportunity has been ensured by optimization of professional educational establishments, adjustment of subject content and reorganization of the financing model (Ministry of Education and Science of the Republic of Latvia, 2009). Today, Latvia is struggling with a serious shortage of engineering personnel. Therefore, the implementation of progressive changes in the contents of natural sciences is one of the directions driven by educational system reform.

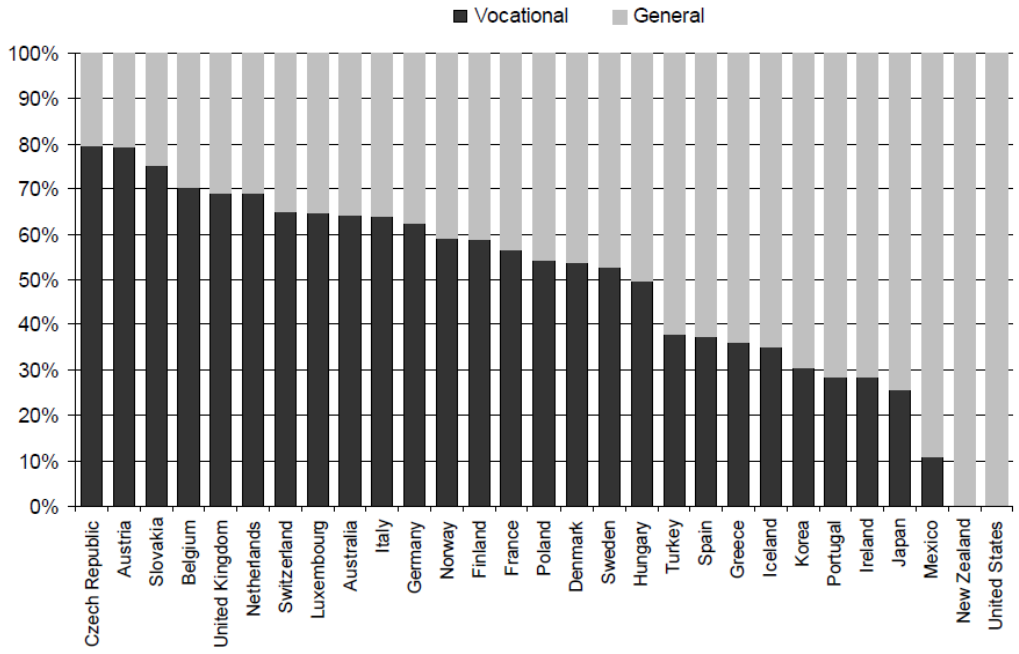

Figure 1. Percentage of students attending vocational and general upper secondary programs in OECD (Organization for Economic Co-operation and Development) countries in 2004. Source: OECD (2006).

Secondary education in Latvia can be obtained in two kinds of educational establishments: general and vocational secondary schools. The graduates of general secondary schools are oriented toward continuation of studies in universities, while vocational secondary schools prepare specialists that, after receiving a secondary school diploma, are ready for the labor market. Of course, graduates of vocational secondary schools still retain opportunities to continue studies in universities. In the 2010/2011 academic year, 35.8 thousand students (Actualities of educational statistics in academic year 2010/2011) were obtaining secondary education in vocational secondary schools. However, still more than 50% of primary school graduates chose to study in general secondary schools. This fact is in contradiction with the practice of many world countries (see Figure 1), where vocational secondary education has been obtained by more than 80% (Czech Republic, Austria) of teenagers (Sahlberg, 2007).

In many world countries, an interdisciplinary approach is used in learning natural sciences in general and vocational secondary schools (Anon, 2008). Integrated teaching of natural sciences means that different elements of the curriculum are united in a sequential program. Thereby, students obtain systematic and qualitative knowledge that cannot be obtained, if every subject is taught separately. In 1994, Norwegians implemented an obligatory course of natural sciences in 11th grade of general secondary and vocational school programs (Van Marion, 2003). Here, we must note that different countries have a different approach to vocational secondary education. They often do not anticipate teaching general educational subjects (int. al. chemistry) or they use an analog approach that has been created for general secondary education.

In Latvia, mastery of the natural sciences is still realized by a disciplinary approach. Already, in 2008, Latvia implemented new educational standards in physics, chemistry, biology and geography that were referable to both general secondary and professional secondary education. The aim of our research was to develop a contemporary didactical approach to teaching chemistry in professional secondary education that would improve students' competence and understanding of sustainable development. One of the results of this work is a study aid in chemistry for vocational school students.

Didactic Principles of the Developed Approach

Diverse literature and different auxiliary materials are necessary to develop a contemporary process of learning. Educational literature must promote independent actions of students and stimulate creation of learning skills. Nowadays, teaching aids are developed not only based on content, but also on form, for example, developed materials that can be processed using computer technologies. Today, teaching aids are developed taking into consideration basic principles of humanitarian pedagogy:

(1) To help students learn independently, at the same time developing their skills;

(2) To create a personal culture and understanding of partnership (Anthology of Human Pedagogy, 1996; Ding, 2005).

When developing any teaching aid, it is obligatory to take into consideration general didactic principles, such as purposefulness, regularity, systematic actions, consistency, succession, objectivity, obviousness and the connection of teaching aids with everyday life, etc. (Van der Stoep & Louw, 2007). Realizing our approach in the mastery of chemistry in vocational schools, we proposed some specific didactic principles as follows.

The Principle of Complement

Complementary improves and makes perfect (Dictionary of Foreign Words, 2003). Vocational schools, in

different countries including Latvia, offer pupils the opportunity to obtain dozens and even hundreds of different professions. The adaptation of educational program content to concrete professional demands indisputably increases its total amount. Every vocational school student must know that the fundamental laws of chemistry, most important classes of compounds, are able to characterize properties of substances and construct equations of chemical reactions. But still, the most required knowledge about chemical substances processes and phenomena is that which vocational school students meet already working in their future professions.

Implementation of the principle of complement in the contents of chemistry in professional education means that a definite amount of material has been replaced by others that are more suitable for professional studies. This allows emphasis of concrete questions and specialized knowledge and skills, at the same time not extending the subject contents.

Special information that is necessary for specific professions can be textual, included in worksheets, tasks or laboratory exercises. This kind of approach increases future specialists' opportunities and competitiveness in the labor market and society. Principle of complement in practice relates to the so-called principle of cultural level significance (Amonashvili, 1989).

The Principle of Variable Choice

Students start to learn in secondary professional and vocational schools after obtaining primary education in urban and rural pre-gymnasiums and primary schools. The level of knowledge among these students differs in and geography proportion with their self-estimation. If their self-estimation is low, it is possible that the students will be afraid of or even will not try to complete exercises unassisted. Students with high self-estimation usually start their activities with exercises of the highest difficulty level.

The approach of variable choice foresees that tasks for acquisition of concrete skills are completed based on already obtained knowledge. The approach allows variable content of curriculum and teaching methods (Ackerman, 1992). According to the principle of variable choice, the student himself chooses the exercises from different difficulty levels based on his/her own self-estimation. Thus, the exercises chosen comply with the student's interests and abilities.

The Principle of Professional Evolution and Motivation

Professional evolution is based on recognition of one's "ego" (Craig & Baucum, 1999). It is the aspiration to realize one's own potential. The teacher must stimulate the student to get acquainted with a new subject and perceive its importance in the creation of a future career. Motivation to do and improve unaided in the long run is created in the student himself/herself. It is not created and developed, if the subject content does not comply with the student's aims, interests and expectations. This principle can be successfully realized in practice, if the student learns with examples connected with his/her chosen profession, meets with professionals connected with his/her specialty and visits work places. Using this approach secures, both students with weaker knowledge at the start and those whose level of knowledge is above average are interested in the learning process.

Conceptual Characteristics of the Developed Approach

The Latvian educational system defines that chemistry in professional education has approximately three times fewer contact hours than in general secondary schools. However, contents of chemistry in general and professional secondary schools are of the same amount.

Since the target audience for the developed teaching aid is students of professional secondary schools and vocational schools, the following are proposed as essential aspects in developing the teaching aid: evaluation of educational content, comparison of themes, selection of significant material, revision of amount, merging of themes, evaluation of succession and elaboration of the new teaching aid that is based on understanding of chemical processes in the environment and raising human professional competence. The content of chemistry in general secondary education has been divided into 20 themes according to the State Educational Standard. Grounded in the developed approach in professional education, we advise concentrating content of chemistry in 14 themes (see Table 1).

Table 1

The Structural Changes in the Comprehensive Secondary and Vocational Secondary Chemistry Education's Content

Theme	The content of comprehensive secondary school chemistry education	Percentage from total number of lessons	Theme	The content of vocational secondary school chemistry education	Percentage from total number of lessons
1.	Research activity in chemistry	4	1.	Research activity in chemistry	3
2.	The disperse system	7	2.	The disperse system	9
3.	The structure of atoms and chemical compounds	5	3.	The structure of atoms. Periodic table of chemical elements. The structure of chemical compounds*	10
4.	Periodic table of chemical elements	4	4.	Chemical reactions and their proceedings**	7
5.	Electrolytic dissociation	4	5.	Electrolytic dissociation	6
6.	The reactions in electrolyte solutions	4		The reactions in electrolyte solutions	5
7.	Proceedings of chemical reactions	4			
8.	General characteristics of metals	4	6.	Metals and their compounds***	9
9.	Chemical properties of metals and their compounds	4			
10.	Properties and application of nonmetals	5	7.	Nonmetals and their compounds****	12
11.	The compounds of nonmetallic elements	8			
12.	The variety of inorganic compounds and their transformations in nature*****	5			
13.	Molecular structure and nomenclature of hydrocarbons	4	8.	Organic compounds Hydrocarbons	6
14.	Reactions of hydrocarbons	4	9.	Reactions of hydrocarbons	6
15.	The hydroxyl and carbonil derivatives of hydrocarbons	5	10.	The hydroxyl and carbonil derivatives of hydrocarbons	5
16.	Carboxylic acids and their derivatives	5	11.	Carboxylic acids and their derivatives	7
17.	Natural materials	6			
18.	Chemical compounds and materials in everyday life	6	12.	Chemical compounds and materials in everyday life******	7
19.	Chemical and environmental technologies*******	6	13.	Natural materials	8
20.	Chemistry and sustainable community development********	6			
		100%			100%

Note. *: essential structural changes.

In our opinion, the most fundamental changes in the content of chemistry in professional secondary education are:

* In the theme "The structure of atoms", we suggest combining "Periodical table of chemical elements" and "The structure of chemical compounds" as done in general secondary education "Structure of atoms and

substances" and "Periodic table of chemical elements";

** In the theme "Chemical reactions and their proceedings" in professional secondary schools themes, division has been postponed until after "Theory of electrolytic dissociation" and "Reactions in electrolyte solutions", because the author considers that before learning about ion exchange theory, students must have a complete understanding of chemical reactions;

*** In the theme "Metals and their compounds", "Characterization of metals" and "Metals and its chemical properties" as done in general secondary education;

****In the theme "Nonmetals and their compounds", the themes "Use of nonmetals and its compounds" and "Compounds of nonmetallic elements" are combined;

***** In the theme "Chemical compounds and materials in everyday life", questions have been divided, according to themes of professional secondary schools—"Metals and their compounds" and "Nonmetals and their compounds" (see Table 1).

The shift of accent in content of professional education was done in such a way that students could completely master the subject having a fewer number of lessons. Quantitative changes in lesson division give evidence of a shifting process. As we can see in Table 1, in general, secondary school 58% of the total number of lessons is provided for acquisition of general and inorganic chemistry, while in vocational schools, this amount is 61%. The number of lessons for the majority of themes can be increased by 1% to 2%, because studying the theme "Nonmetals and their compounds" occupies less time. We have increased time that is provided for acquisition of organic chemistry in professional secondary school, id est. 39% of the total number of lessons (in general, secondary school approx. 30%). This is done because the developed content of the subject does not anticipate teaching such themes as "The chemical and environmental technologies" and "Chemistry and sustainable community development".

Each theme has been constructed from different units (see Figure 2.).

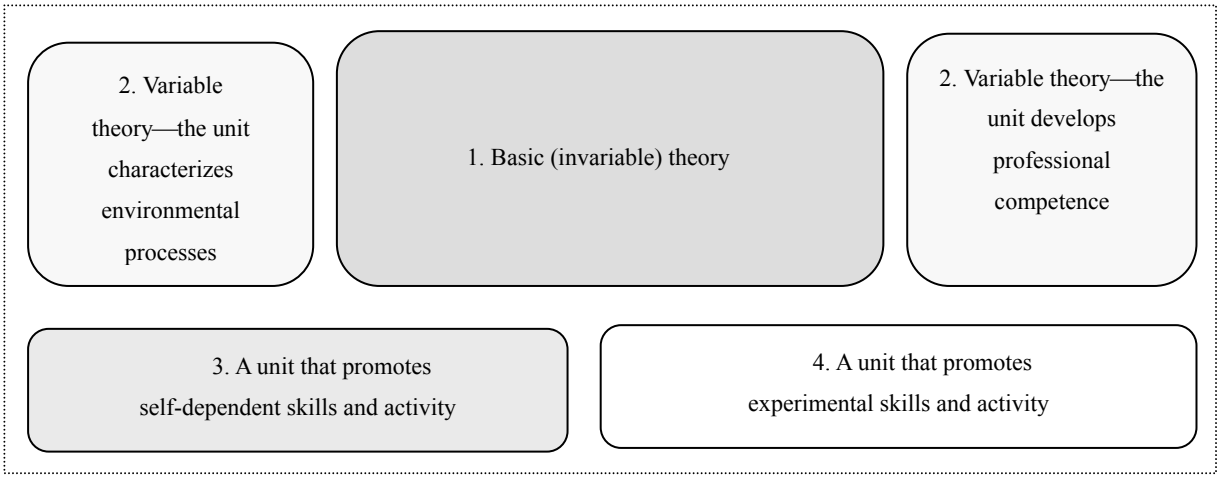

Figure 2. The structure of teaching content of a concrete theme (scheme).

As mentioned above, teaching material has been developed so that each of the 14 themes consists of several units. The teaching material "Chemistry for students of professional secondary and comprehensive schools" is designed in such a way that every teacher who chooses to work with this material in his/her every day work will use only the basic part "Content of chemistry subject" as an invariable part of subject content.

Basic invariable theory frames the contents of chemistry based on the State Educational Standard. Theory is reflected in such amounts that students who link their future with study programs connected with chemistry are able to master the subject intensively and unaided (see Figure 2).

Teaching material consists of several variable units:

(1) Variable theory contains specific information about chemical processes in the environment and work places that is necessary to know in everyday life and acquire skills in one's chosen profession. The research of authors (Priede, Krumina, & Kupse, 2009; Krumina, Priede, & Kreile, 2010; Priede & Krumina, 2010) has proven that students of professional secondary schools often have problems linking knowledge acquired in chemistry lessons with processes of everyday life and those going on in work places of their chosen specialty;

(2) A unit that promotes self-dependent skills and activity consists of calculation exercises at three levels of difficulty that are based on the didactic approach "knowledge → comprehension → usage". The subdivision "usage" is meant for development of independent working skills. To successfully complete the exercise, the student has to read the materials that are given in the second unit;

(3) A unit promotes experimental skills and activity—consists of descriptions of environmentally-friendly laboratory exercises. This unit realizes the didactic principle of integration (unity of theory and practice). It realizes the performance of experimental activities that are vital for the acquisition of theoretical and professional knowledge and acquisition of practical skills (see Figure 2).

Teaching Focused on Advancement of Professional Competence

We implement not only structural, but also qualitative changes in the contents of chemistry in professional education. The priority of our work is the advancement of professional competence. Therefore, we structure our materials in such a way that they can be easily adapted to students of different professions. Every theme includes several topics whose division by number of lessons depends on the specifics of the student's specialty. The success of this division depends on professional competence and readiness of the chemistry teacher. For example, studying the theme "Metals and their alloys", students from metal-fabricating, mechanics and auto-mechanics specialties should be introduced to mechanical and technological properties of metal alloys, while electricians should be introduced to such properties of metals and their alloys as thermal and electro conductivity. Learning the theme about substances of organic origin, such as natural polymers, tailors should understand the structure and properties of natural fibers, while food technologists should learn about properties of fats, carbohydrates and proteins in various aspects of the human diet. When students specializing in hairdressing are studying the theme, they should learn how denaturation of hair proteins happens during chemical processing of hair.

Teaching Focused on Comprehension of Environmental Problems

Local and international research shows that interest in natural sciences and chemistry among graduates of primary schools and students of high schools has a tendency to decrease (Andersson & Wallin, 2000; Schmidt, 2000; Bartusevica, 2006; Lamanauskas & Vilkonis, 2007).

Similarly, international research (incl. Latvia) proves that students' knowledge about natural sciences (incl. chemistry) is fragmentary and lacking general comprehension (PISA (Programme for International Student Assessment), 2006; 2009). In the future, these young people can meet with difficulties in their homes and work places that are caused by lack of knowledge. For example, "How to help a man gassed in the garage? What to do if a child has accidentally swallowed some detergent? How to choose detergents that are environmentally

friendly?". These questions can arise at any time for specialists of different professions.

Comprehension about environmental problems within the framework of our approach is created by descriptions of chemical processes in the environment and concrete professions.

Our approach predicts concrete solutions, for example, emerging auto mechanics, learning the theme about nonmetallic elements and their reactions, acquiring knowledge how sulphur affects corrosion, how it gets into petrol and how it has an inimical influence on engine parts. In their turn, emerging office staffers learn about cellulose in the theme "Natural materials" and find out about the influence of the paper industry on the environment. Students calculate expenditures of wood necessary to produce a concrete amount of paper and unaided come to a conclusion about which way of producing paper is more environmentally-friendly, from wood to waste paper.

Calculation Exercises That Develop Students' Independent Learning

The concept of "exercise" in our approach is something more than calculation of an equation. These exercises are formulated in different kinds of worksheets, like texts with missing words, connections of different statements and problem tasks. Solving exercises of different types, students repeat and strengthen knowledge, and develop logical thinking and independent work skills. Our approach defines that exercises are completed at the end of a concrete theme, doing them individually and in groups in the classroom, as well as doing homework. The content of the exercise has to excite curiosity in students. The content must concern questions of practical life (everyday life or work place) that are mentioned in books or discussed in the classroom. Each student of different specialties must solve the same exercises within the framework of a concrete theme. However, the compiler must take into consideration the specific issues of every profession. Our approach provides exercises at three levels of difficulty that are designed according to the didactic approach "knowledge → comprehension → usage". The student himself/herself has to decide which level of difficulty he/she is able to solve. It is advised that the student himself/herself compares his/her results with answers provided by the teacher and rates his/her performance. Of course, in the final exam, every exercise is estimated in summary according to an evaluation scale prepared by the teacher.

Laboratory Exercises That Develop Students' Experimental Skills and Activities

Chemistry is an experimental science. Therefore, the mastery of chemistry cannot be imagined without laboratory exercises. Taking into account the number of hours that is allocated for chemistry lessons, the teacher does not have time to schedule many laboratory experiments. Developing our approach to the mastery of chemistry in vocational schools, we adhere to the following criteria:

(1) Laboratory exercises must be understandable for the student;

(2) Laboratory exercises must be connected with social life, wild life or the work place;

(3) In the laboratory, students should use environmentally-friendly substances.

Thus, a part of the laboratory exercises can be similar for students of different professions, especially those connected with everyday life. For example, the laboratory exercise "Natural indicators" when learning the theme about hydrolyses of salts. However, we advise adjusting laboratory exercises by profession, for example, "Recognition of fibers" for textile specialists and "Determination of hydrocarbons and proteins" for food technologists. We believe that laboratory activities in which students have the opportunity to express their creativity should be rated by marks.

Conclusions

Consequently, we have developed a contemporary didactic approach for teaching chemistry in secondary professional education that is based on advancement of competence and improvement of understanding of sustainable development. The approach is based on the following principles: principle of complement, principle of variable choice and principle of professional evolution and motivation, and has been introduced in the concrete teaching material "Chemistry for students of professional secondary and vocational schools".

According to the developed approach, the contents of secondary professional chemistry education have been optimized. The shifting of accent in contents of professional education was done in such way that students could completely master the subject having a fewer number of lessons. The developed teaching material is designed in such a way that the student, supervised by his/her teacher, would acquire every theme in an identical four-unit system. This means that participants of the study process consistently use just one basic part of material: Basic invariable theory.

The variable parts of the developed approach are:

(1) Variable theory that contains specific information about chemical processes in the environment and work places that is necessary to know in everyday life and acquire skills in ones chosen profession.

(2) Exercises at three different difficulty levels. Tasks are composed according to the didactic approach "knowledge → comprehension → usage". Exercise content is aimed at improving the professional competence of the students.

(3) Descriptions of environmentally-friendly laboratory exercises. This part improves student experimental skills.

In conclusion, we want to note that essential features of our approach or novelties are:

(1) Content of chemistry that is focused on advancement of professional competence;

(2) Approach to teaching chemistry that is focused on comprehension of environmental problems;

(3) Exercises that cultivate skills of independent learning;

(4) Laboratory exercises that develop skills of experimental activities.

The developed approach already has been validated. Presently, data have been collected and are being processed.

References

Ministry of Education and Science of the Republic of Latvia. (2009). *Informative notification about the procedure of the structural reform of educational system and the planned measures for it's further securing.* Retrieved July 12, 2011, from http://www.scribd.com/doc/20099870/Informat%C4%ABvais-zi%C5%86ojums-par-izgl%C4%ABt%C4%ABbas-sist%C4%93mas-struktur%C4%81l%C4%81s-reformas-norisi-un-pl%C4%81notajiem-pas%C4%81kumiem-t%C4%81s-t%C4%81l%C4%81kai-%C4%ABsteno%C5%A1anai

Ackerman, T. A. (1992). A didactic explanation of item bias, item impact, and item validity from a multidimensional perspective. *Journal of Educational Measurement, 29*(1), 67-91.

Actualities of Educational Statistics in Academic Year 2010/2011. Retrieved May, 13 2011, from http://www.csb.gov.lv/notikumi/ par-aktualitatem-izglitibas-statistika-20102011-macibu-gada-31940.html

Amonashvili, S. (1989). Non-directive teaching and the humanization of education. Prospects (quarterly review of education). *United Nations Educational, Scientific and Cultural Organization (UNESCO), XIX*(4), 581-590.

Andersson, B., & Wallin, A. (2000). Students' understanding of the greenhouse effect, the societal consequences of reducing CO_2 emissions and the problem of ozone layer depletion. *Journal of Research in Science Teaching, 37*(10), 1096-1111.

Anon, A. (2008). Thinking across disciplines-interdisciplinarity in research and education. *The Danish Business Research Academy (DEA/Denmark's Erhvervs for sknings Akademi) and the Danish Forum for Business Education (FBE).*

Anthology of Human Pedagogy. (1996). Moscow, Prentice Hall Shalvy Amonashvili, (p. 1220).

Bartusevica, A. (2006). Formation of environmental competence in chemistry classes of Latvian students during recent years. *The Issue of Publications of International Scientific Conference "The Theory for Practice in Contemporary Community Education"*. Riga, pp. 27-32.

Craig, G. J., & Baucum, D. (1999). *Human development* (9th ed., p. 940). Prentice Hall.

Dictionary of Foreign Words (p. 800). (2003). Riga: Norden AB, (Latvian).

Ding, S. (2005). *Children's personal and social development.* Malden: Blackwell Publishing House.

Holbrook, J. (2008). *Paradigm shifts in science education. The need for a paradigm shift in science education for Post Soviet Societies: Research and practice (Estonian example)* (pp. 7-24.). University of Tartu.

Krumina, A., Priede, D., & Kreile, S. (2010). Students' comprehension of environmental concepts in chemistry. *Innovations and Technology News, 3*(8), 8-21. Riga.

Lamanauskas, V., & Vilkonis, R. (2007). The most complex topics of the introductory course on chemistry: The limiting factors and potential of innovated information technologies to solve the problem. *6th IOSTE Symposium for Central and Eastern Europe. Science and Technology Education in the Central and Eastern Europe; Past, Present and Perspectives* (pp. 80-88). Siauliai.

PISA (Programme for International Student Assessment). (2006). *Results.* Retrieved September 20, 2010, from http://www.oecd.org/document/2/0,3343,en_32252351_32236191_ 39718850_1_1_1_1,00.html

PISA. (2009). *Results.* Retrieved June 15, 2011, from http://www.oecd.org/document/61/0,3746,en_32252351_32235731_46567613_1_1_1_1,00.html

Priede, D., & Krumina, A., & Kupse, I. (2009). The need for the integration of environmental studies and chemistry education in the professional educational system. *XIX. International Conference on Chemistry Education "Research, Theory and Practice in Chemistry Didactics"* (pp. 558-566). 1st Part: Research Articles and Theoretical Studies, Hradec Králové.

Priede, D., & Krumina, A. (2010). *The assessment of different age students' comprehension about environmental chemical processes in Latvia* (pp. 307-312). Monograph: Research in Didactics of the Sciences Pedagogical University of Krakow.

Sahlberg, P. (2007). *Secondary education in OECD countries.* Retrieved from http://www.mp.gov.rs/resursi/dokumenti/dok7-eng-

Schmidt, H. (2000). Should chemistry lessons be more intellectually challenging? *Chemistry Education: Research and Practice in Europe, 1*(1), 17-26.

Van der Stoep, F., & Louw, W. J. (2007). *Introduction to didactic pedagogic.* Retrieved July 3, 2011, from http://www.georgeyonge.net/node/4

Van Marion, P. (2003). Science education in Norway. Countdown to the next reform. *Journal of Baltic Science Education, 2*(4), 21-27.