

ASSESSMENT OF THE ENVIRONMENTAL ASPECT IN A CONTEMPORARY TEACHING/LEARNING MODEL OF CHEMISTRY IN BASIC SCHOOLS OF LATVIA

Aira Bartuseviča, Dagnija Cēdere

University of Latvia, Faculty of Chemistry, The Center of Chemistry Education of Latvia

Rudīte Andersone

University of Latvia, Faculty of Education and Psychology, Latvia

Abstract. *Pedagogic investigation, situation study and analysis are presented on one aspect of the previously developed teaching/learning model „Society – Nature – Technology”. The attitude of 600 Latvian students of the 8th and 9th grades towards environmental education, their understanding about particular environmental problems and their place in chemistry teaching and learning content are evaluated in the paper. Comparative research was done resulting in the assessment of the increase in the comprehension of environmental problems of those students who have participated in the approbation of the teaching/learning model.*

Key words: *chemistry education, environmental education, teaching/learning model, basic school.*

Introduction

Chemistry seems to be a difficult and incomprehensible subject for the majority of students. The statement is confirmed both by the comparatively small number of students willing to take the centralized chemistry examination upon graduation from high school¹ (564 students in 2003, 858 in 2004), and the number of people that have decided to connect their future projects with the speciality of chemistry and therefore choose the faculty of chemistry when entering the university. The results of a high school students questionnaire disclose that chemistry is the least popular subject among the natural sciences (Lamanauskas, Gedrovics, Raipulis, 2004).

National and international research results in our country and abroad show very low students' interest in natural sciences – in Latvia and Lithuania (Geske, Kangro 2002; Gedrovics, Lamanauskas, 2001; Lamanauskas, 2003a), Bulgaria (Toshev, 2002), Finland and approximately 20 other countries (Sjøberg, 2002), and Germany (Gräber, 1993). It is worth mentioning that problems urgent in Germany (Pfeiper, Häusler, 1992; Christen, 2000) or USA² some 6 – 10 years ago have very much in common with those that Eastern Europe faces nowadays. Comparison of all the research results reveals one more tendency – students' motivation to acquire chemistry is higher in industrially developed countries than in ex-communist countries with a lower level of industrialization (Lamanauskas, 2003b). Insufficient understanding of basic chemistry problems, discrepancy between supplied and received knowledge is still recognized in schools of Latvia (Kakse, 2001; Namsone, 2001), as well as in the universities, the

¹ <http://www.isec.gov.lv/eksameni/eksameni.shtml>; <http://www.isec.gov.lv/eksameni/info.shtml>

² <http://www.chem.sunysb.edu/Hanson-FOC/Conferences/Report.htm>

lack of potential students confirming the fact. Scientists and teachers are looking for solutions to the problem. Publications appear about the necessity of study process humanization (Kincans, 2003), theoretical and practical aspects of humanization (Arshansky, 2004), about the place and significance of Green Chemistry in the chemistry teaching process in the USA (Slabin, 2004), about compliance with labour safety during chemical experiments (Davidov, 2004), about integration of environmental education into chemistry classes (Zhukova, 2004), etc. A multishaped spectrum of these findings confirm once more the fact that chemistry teaching should be very flexible in basic school, that suitable didactic solutions should be used for every earmarked audience. Only an integrated approach to teaching the subject will keep students' interest and will motivate students to learn the subject.

Environmental education problems in school should be integrated into the curriculum of all the natural sciences because the environmental problems are not separate from problems of chemistry, physics, biology, and geography. A joint, complex approach to teaching of overall natural science, a joint approach to chemistry and environmental affairs in the basic school program is the background of our proposed teaching/learning model of chemistry (Bartuseviča, Cēdere, 2004). The pedagogic research described below was done for the evaluation of the efficiency of this model.

We have tried to clarify whether chemistry is so difficult and incomprehensible a subject in the 8th and 9th grades of basic schools, indeed, whether we succeed in connecting chemical reactions and processes with things around students in their everyday life, whether we succeed in incorporating environmental problems in the curriculum of chemistry education, and whether the students have a knack for exploiting the experience obtained in chemistry classes in their lives. We were also interested in clarifying the significance of environmental education and discussions about environmental problems in cognition and interest stimulating chemistry studies from the point of view of students, their parents, and chemistry teachers.

Research methods and respondent characteristics

A questionnaire of students, teachers, and parents as well as *a test* for students about the understanding of several environmental problems were used as pedagogic research methods. 600 students participated in the questionnaire from 11 Latvian schools (Cesis, Valmiera, Jelgava, Daugavpils districts), 230 from 8th grade, and 370 from 9th grade. 95 chemistry teachers from all over Latvia answered the questionnaire, 48.7% of them teach chemistry in city schools, including 7% in the capital Riga, but the others – in country schools. 307 parents shared their views about the mentioned problems, 150 of them being parents of the 8th grade students and 157 - of the 9th grade students.

The test as a pedagogic research method was exploited repeatedly for evaluation of our previously developed teaching/learning model „Society – Nature – Technology” (Bartuseviča, Cēdere, 2004). The questionnaire for the teachers involved in the approbation of the mentioned model, as well as interviews with students, their parents, and teachers were also used repeatedly.

Our pedagogic experiment was assessed in two steps:

- 1) situation analysis when starting the approbation of our teaching/learning model;
- 2) results after the approbation of our teaching/learning model.

Estimation of the situation when starting the approbation of the teaching/learning model

Environmental education enters the curriculum of natural sciences including chemistry as an integrated subject. It might be a way to diversify and enrich the chemistry curriculum if it is presented in an exciting and comprehensible way. The concept *environmental education* involves knowledge and comprehension about ecological, social and political processes and their influences. It is education

about the environment, in the environment and for the environment; it is the teaching about the mutual relationship of the environment and man, its development and regularity.

Respondents were asked to give only one, the most accurate answer to the question *What is environmental education?* 12% of the 8th grade students and the same percentage of the 9th grade students selected two answer versions (not to mention the comment “another answer”) confirming their inability to make a choice. Only 38.3% of the 8th grade students and 40% of the 9th grade students have clear insight about the concept environmental education, and that is less than a half of all the students. The phrases found most frequently in the comment “another answer” are as follows: teaching about locality, teaching about nature and its particularities, teaching about the way to protect nature, teaching about the cleanliness of the locality and behaviour in the locality, teaching about the maintenance of cleanliness in the locality, teaching how to protect nature against pollution, as well as – don’t understand, don’t know what it is. It should be mentioned that the question raised doubts for parents also: 73.3% of parents presented the exact answer; more than 10% of the interviewed parents chose two or even three answer versions.

Answers to the question *Are you/students interested in environmental issues?* allowed us to learn the opinion of students about themselves and to compare it with the position of teachers and parents of the same students. Around 70% of students, their parents and teachers share the view that students are interested very much or just interested in environmental issues. The interest of the 9th grade students is even higher than that of the 8th grade students. Not all environmental problems are interesting for 37.4% of the 8th grade students and for 34.7% of the 9th grade students. 28.4% of teachers and 23.5% of students’ parents share this opinion. There is only a small fraction of the students that state that environmental issues are of no interest to them - 5.7% in the 8th grade and 6.2% in the 9th grade. One can also encounter statements such as: *it might interest one day, it becomes interesting only when something particular happens, some disaster or catastrophe, some items are interesting, others – not at all.*

Both the 8th grade students (73.0%) and the 9th grade students (78.9 %) place radio and TV in the first place when answering the question *How do you learn about environmental problems in your locality?* Further priorities differ a little in both grades. The explanation of this small difference of opinions lies in the particularities of the teenagers. The 8th grade students accept the teacher’s opinion more; conversations in the family seem more significant to them by comparison with their own observations and impressions obtained during discourses with friends. The students have become more independent in the 9th grade, they are more self-reliant, they evaluate independently the information found in magazines and newspapers, and discourse with friends has become more significant to them than conversations in the family.

These small differences between the views of the 8th and the 9th grade students are not statistically significant. Much more disturbing is another tendency that is reflected in students’ answers – only 8.3% of the 8th grade students and 14.1% of the 9th grade students have learned about environmental problems from books; much more information is obtained from radio and TV.

In general the views of the 8th grade students and the 9th grade students are very similar. The correlation coefficient between their opinions is $r = 0.98$ (Pearson correlation). This demonstrates a direct connection between questionnaire results of the students of both grades, the starting level of knowledge and information in both grades being equal.

Air and water quality problems have a substantial place in the content of chemistry teaching and learning – their purity and pollution, influence of detergents on the environment and health, waste problems, and consequences caused by transport pollution.

The question *What environmental issues are discussed in chemistry lessons?* has been asked in order to find out whether and how much chemistry teachers have spoken about these matters in their

lessons, and whether students have comprehended and noticed the material. Answers of the students and teachers showed that most attention in chemistry lessons is paid to air and water quality issues. Answers of students and teachers have an acceptable correlation ($r = 0.88$) which indicates a close relationship. Unfortunately the number of teachers' affirmative answers has exceeded those of students 1.4 – 4.5 times. Only 68.3% of the 8th grade students and 69.2% of the 9th grade students have confirmed the fact that the state of water, its purity and pollution has been discussed in chemistry lessons as compared with 93.7% of teachers. Only 10.0% of all the 8th and 9th grade students have heard about agriculture problems in chemistry lessons but 45.3% have spoken about it in lessons. A similar connection can be observed in comparing answers to other questions – those about air quality, the influence of detergents on the environment, etc.

This tendency has other motives that might become the object of an independent research study. There is no doubt that teachers have tried to speak about the mentioned problems but they have not succeeded. Students correspondingly have mentioned only the facts they have seen and therefore remember in their answers. It is true that the teacher does not have time and opportunity enough to teach particular environmental problems in chemistry lessons in the 8th grade, aside from basic chemistry. However, differences between the answers of 8th and 9th grade students are marginal. Therefore, it is doubtful that the observed fact is a result of teacher's efforts during one or two year's time. More likely, the level of students' information in environmental problems has increased together with their general awareness level.

There is no reason to question the honesty of the answers of both teachers and students. It is evident that discussion about these items has taken place but not always in a comprehensible (for students), interesting and exciting way. The view of parents and teachers has an acceptable correlation ($r = 0.89$) in the question about what should be discussed and what is discussed in chemistry lessons that show close relationship of the answers. A similar question about the discussion of environmental problems in families has given a very close result ($r = 0.90$). Half of the parents are convinced that environmental problems should be discussed in chemistry lessons, at the same time confirming that these questions are discussed in their families. It is difficult to judge whether this statement also represents the opinion of society at large because many parents did not return the questionnaires.

8th and 9th grade students also completed tests together with questionnaires. The test included the environmental problems mentioned in the questionnaires: water and air quality, pollution caused by transport, the influence of detergents on environment and health, "green house" effect, acid rains, and ozone layer disintegration. Students' insight in the mentioned problems was evaluated in four levels: E–excellent (7 points); O – optimal (5 – 6 points); S – sufficient (3 – 4 points); I – insufficient (0 – 2 points). One point corresponds to a complete comprehension of one environmental problem (Figure 1).

Results of the test confirm surprisingly low comprehension of environmental problems. No 8th grade student answered correctly all the test questions, and only 1.6% of the 9th grade students reached the highest level (excellent). Insufficient answers were presented by 51.7% of the 8th grade and 45.4% of the 9th grade students. In total, the share of correct answers to the test questions was only 34.7% for the 8th and 39.6% for the 9th grade students. These results are not encouraging.

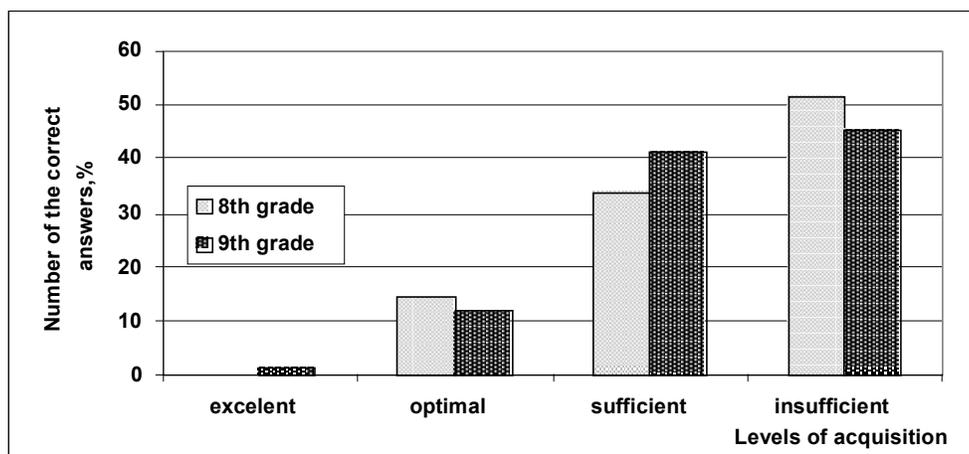


Figure 1. Level of student acquisition of environmental problems in chemistry lessons.

The obtained results were a surprise also to those twelve teachers that agreed to participate in the pedagogic experiment and to work according to the teaching/learning model for two years. They have enabled us to approbate of our model „Society – Nature – Technology” (Bartuseviča, Cēdere, 2004) in practice.

Results after approbation of the teaching/learning model „Society – Nature – Technology”

Restructuring of the existing curriculum of chemistry teaching according to society needs, the principles of sustainable development and contemporary demands are the most significant driving forces for changes in chemistry education in Latvia. The discrepancy between the curriculum and the information necessary for life in modern society was the main reason for the necessity of our new teaching/learning model. The pedagogic approach involved in our didactic model contrary to the existing approach to chemistry teaching in Latvia proposes a substantially increased proportion of applied chemistry, environmental protection laboratory exercise methods in chemistry classes and teaching methods that stimulate thinking. In the frame of the teaching/learning model, interaction of three mutually connected aspects (society, nature, technologies) form significant qualities of chemistry teaching – a meaningful mode of chemical thinking, a caring and understanding attitude towards environmental processes, and skills and attitude useful for practical life (Bartuseviča, Cēdere, 2004). Mutual respect and understanding between a teacher and a student form the backdrop of the pedagogic approach, including observance of personality, necessity and ability of every student.

The teaching model together with a teaching aids package consisting of student’s laboratory workbook, teacher’s guide and worksheets for students was approbated in 11 schools of Latvia during several school years. Further the result of approbation is presented – assessment of the growth of understanding about environmental problems on three levels:

- 1) in schools;
- 2) in grades and groups of grades;
- 3) the growth of a student in a grade.

Table 1. Plan of the pedagogic research (approbation of the teaching/learning model).

	8th grade students	9th grade students	Didactic solutions
2001/2002 school year Estimation of situation Questionnaire of students, teachers, and parents Test for students about several environmental problems	Answer questions of the questionnaire and test at the beginning of school year Answer questions of the test at the end of school year (second time)	Answer questions of the questionnaire and test at the beginning of school year Answer questions of the test at the end of school year (second time)	Search for new teaching/learning organizing forms Shift of accents in chemistry curriculum Practical work of the students in chemistry classes with simple well-known substances and cheap available materials
2002/2003 school year Approbation of the teaching/learning model	Continue the approbation of the teaching/learning model Answer questions of the test at the end of school year (third time)		Consideration of the warning signs, security symbols characterizing properties of substances, warning signs for self-protection and environmental protection
2003/2004 school year Estimation of the results Data processing Questionnaire of teachers Interviews with students and parents	RESULTS Students' interest has increased about the subject Students' understanding has enlarged about several environmental problems Approval of students, parents and teachers has emerged		Laboratory experiments that model environmental processes and are environmentally friendly; the final step is neutralization and recyclization of final products of reactions

Two schools were selected for repeated testing – 83 students of the 8th grade and 77 students of the 9th grade. One was a city basic school with 51 students in the 8th grade and 40 students in the 9th grade (school No 1). The other was a country basic school with correspondingly 32 and 37 students (school No 2). Chemistry teachers had worked for a long time in both schools, plenty of attention being paid to environmental education in their classes. Both schools have received notable results in the field of environmental education and ecological upbringing of the students.

We compared test results before and after the pedagogic experiment in selected grades, in order to assess, the growth of the students during one (or correspondingly two) school years. Both 8th and 9th grade students were tested at the beginning of the experiment and after one school year. In addition the 8th grade students were tested repeatedly in two-years time (when finishing the 9th grade). In total, 77.8% of the answers to the test questions were right for the 8th grade students and correspondingly 75.1% for the 9th grade students.

Acquisition level of the 8th grade students has grown considerably during the two school years working within the framework of our model (see figure 2). After one year 9.4% of students showed excellent knowledge. The number of students that have received optimal assessment increased 2.6 times (from 15.1% to 38.8%) and the number of students that have received insufficient assessment at

the beginning decreased 3.6 times (from 41.9% to 11.8%). The third time, when graduating from basic school, more than a half of the students (53%) received optimal assessment, 24.1% - excellent, 22.9% sufficient assessment. No student received insufficient assessment.

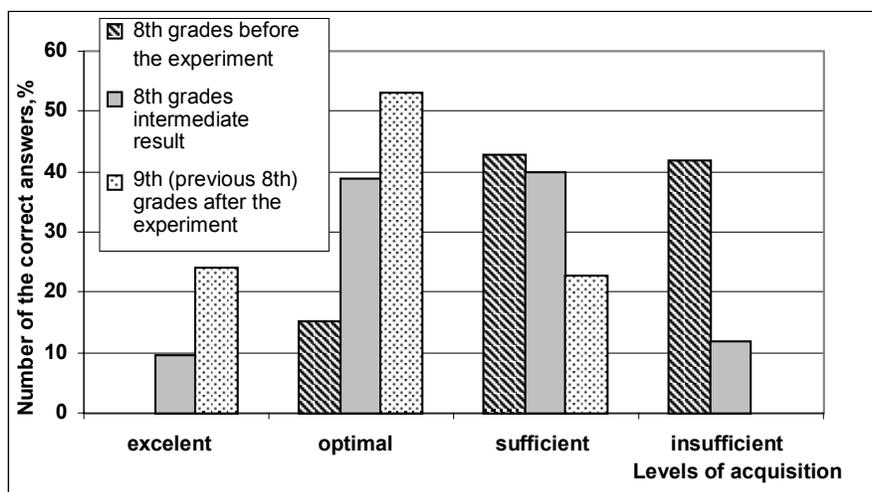


Figure 2. Results of the test in the 8th grades.

Among the 9th grade students, excellent assessment was gained by 33.8%, optimal - 29.9%, sufficient - 32.4% of students and only 3.9% of students (3 from 77) received insufficient assessment (Figure 3). These results show that good results can be reached even during one school year working within the proposed framework. It is worth mentioning that the interest about chemistry in both schools increased as a result of the pedagogic experiment. The assessment of chemistry subject after every term has also increased in all eight grades participating in the experiment.

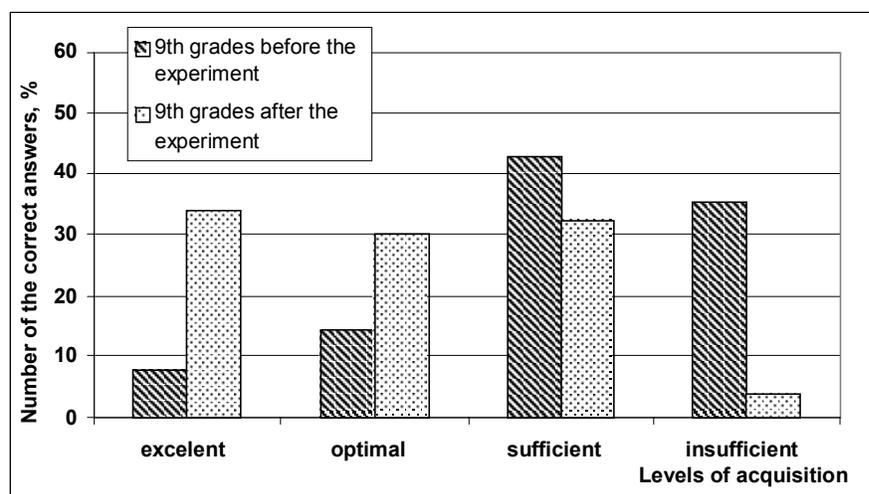


Figure 3. Results of the test in the 9th grades.

We analysed the dynamics of environmental problems comprehension during two school years time in detail (in the 8th grade of the school No 1 with 25 students). At the very beginning, optimal

assessment was received by only five students, sufficient assessment – ten students, and insufficient – also 10 students. On graduating from the 8th grade (intermediate result), excellent assessment was received already by four students including one that received only sufficient assessment in his first test. Only one student received lower assessment in his second test than in the first, probably by accident. The number of students receiving insufficient assessment decreased to 12% (three students). On graduating from the 9th grade, the results of all the students increased (40%) or maintained the same level (60%) in comparison with the intermediate result. Twelve students increased their comprehension for two levels, another twelve – for one level, and only one student reached no progress. The calculated average difference is 1.44 levels after the experiment, and it is a high growth indicator.

In the final stage of the experiment, the twelve teachers involved in the pedagogic experiment answered the questionnaire once again. All the teachers appreciated the changes in teaching/learning enclosed in the model – successful shift of accents in the curriculum, efficiency of the chosen methods, joint approach to chemistry education and environmental education. The teachers emphasized that unlimited increase of curriculum volume is unacceptable. Revision of the syllabus and the inclusion of topics for basic school might be a topic for of an independent study.

The most interesting statements of teachers made after the approbation are presented below:

- such a curriculum is welcome because it joins chemistry with everyday life and material possibilities;
- unconventional and original approach to habitual subjects;
- we were stimulated to think more ourselves when preparing classes;
- that is what chemistry should be in basic school;
- Such an approach allows chemistry to become a subject that children learn with pleasure.

The feelings of students' parents were also surveyed. There were three core ideas in them:

- children's positive and interested attitude towards chemistry;
- emergence of family discussions about chemistry problems initiated by some students;
- children's desire and ability to express their own attitude towards problems in environment.

Successful implementation of environmental issues in the chemistry curriculum is a process that stimulates intersubject connections. It makes chemistry livelier, more interesting for the student, it brings closer and helps to observe the processes in animate and inanimate nature thus motivating the students to care about environment protection and maintenance for further generations.

Conclusions

Situation analysis before the approbation of our teaching/learning model „Society – Nature – Technology” (Bartuseviča, Cēdere, 2004) confirms insufficient comprehension of environmental issues and problems among respondents in the 8th and 9th grades in schools of Latvia.

The developed approach – teaching/learning model considering three mutually joint aspects (society, nature, and technology) is proved in practice. Students' comprehension about chemistry increased during the pedagogic experiment. The test results have shown that students' acquisition level has increased by 38.4% in the 8th–9th grades (during two school years), and by 26.8% in the 9th grades (during one school year).

Approbation results validate the following approaches:

- considerably increased proportion of applied chemistry in chemistry curriculum;
- environmentally friendly laboratory exercises in chemistry classes;
- methods that stimulate thinking and emphasize the significance of chemistry in everyday life.

References

- Arshansky, Y. (2004). About the Elective Course “Introduction in Methodic of Teaching Chemistry” for Classes of Pedagogical Profile. Kn.: *Chemija mokykloje – 2004: Konferencijos pranešimų medžiaga* (pp. 52-55). Kaunas.
- Bartuseviča, A., Cēdere, D. (2004). Formation of a Contemporary Teaching/Learning Model of Chemistry in Basic School. *Journal of Baltic Science Education*, 1 (5), 49-56.
- Christen, H. R. (2000). Chemieunterricht gestern, heute, morgen. *CHEMKON*, 2, 64-68.
- Gräber, W. (1993). Favorite Subject: Chemistry? Some Ideas about Chemistry Lessons that Promote Interest: *Conference of the Finnish Association of Mathematics and Science Education Research*. Tampere.
- Gedrovics, J., Lamanaukas, V. (2001). Science Education for Prospective Pre-School and Primary School Teachers: Students Attitude. In.: *Science and Teaching Training: III-rd International Scientific Conference* (p.44). Riga.
- Geske, A., Kangro, A. (2002). Evolution of Latvia's Science Education in the IEA TIMSS and OECD PISA Framework. *Journal of Baltic Science Education*, 2, 59-66.
- Lamanaukas, V., Gedrovics, J., Raipulis, J. (2004). Senior Pupils' Views and Approach to Natural Science Education in Lithuania and Latvia. *Journal of Baltic Science Education*, 1 (5), p.13-23.
- Lamanaukas, V. (2003a). Natural Science Education in Lithuanian Secondary School: Some Relevant Issues. *Journal of Baltic Science Education*, 1 (3), 44-65.
- Lamanaukas, V. (2003b). *Natural Science Education in Contemporary School*. Monograph. Šiauliai: Šiauliai University Publishing House.
- Kakse, V. (2001). Izmaiņas prasībās ķīmijas mācību satura apgūvē pamatskolā. In.: *Dabaszinātnes un skolotāju izglītība: III starptautiskā konference* (pp. 18-20). Rīga.
- Kincans, V. (2003). Lifelong Learning and the Issue of Formation Creative Personality. In.: *Lifelong Learning - a Path to Social Capital: Conference* (pp. 37-45). Riga.
- Namsone, D. (2003). Jauna pieeja dabaszinību saturam pamatskolā. In.: *Dabaszinātnes un skolotāju izglītība. 4. starptautiskā konference* (pp. 107-111). Daugavpils.
- Pfeifer, P., Häusler, K. u. a. (1993). *Konkrete Fachdidaktik Chemie*. München: Oldenbourg, p.358.
- Sjøberg, S. (2002). *Three Contributions to Science Education*. Oslo, p.31.
- Slabin, U. (2004). Green Chemistry in Oregon to be implemented at our Schools. Kn.: *Chemija mokykloje – 2004: Konferencijos pranešimų medžiaga* (pp. 48-51). Kaunas.
- Toshev, B.V. (2002). Chemistry Curriculum in Bulgarian Secondary School: Errors or Misunderstandings. *Bulgarian Journal of Chemical Education*, 11 (6), 447-452.
- Давидов, В. Н. [Davidov] (2004). Повышение эффективности обучения учащихся правилам техники безопасности при работах по химии. Kn.: *Chemija mokykloje – 2004: Konferencijos pranešimų medžiaga* (pp. 22-25). Kaunas.
- Жукова, М. И. [Zhukova] (2004). Экологическое воспитание учащихся на уроках химии в 9 классе. В кн.: *Актуальные проблемы модернизации химического образования и развития химических наук* (с. 78-80). Санкт–Петербург: РГПУ им. Герцена.

Резюме

ОЦЕНКА ЭКОЛОГИЧЕСКОГО АСПЕКТА СОВРЕМЕННОЙ МОДЕЛИ ОБУЧЕНИЯ ХИМИИ В ОСНОВНЫХ ШКОЛАХ ЛАТВИИ

Айра Бартусевича, Дагния Цедере, Рудите Андерсоне

В разработанной модели обучения химии для основной школы „Общество – Природа – Технологии” (Bartuseviča, Cēdere, 2004) большое внимание уделяется экологическому образованию, формированию у учащихся экологически мотивированного отношения к природе. В течении двух лет

проводились исследования с целью оценки нашей модели в школьной практике. В настоящей статье обсуждаются результаты апробирования разработанной методики обучения химии, в частности экологического аспекта модели.

В статье отражён сравнительный анализ мнений 600 учеников, 95 учителей и 307 родителей из разных районов Латвии, основанный на результаты опроса. В статье отражён сравнительный анализ мнений всех респондентов. Отличия в ответах учеников восьмых и девярых классов являются статистически несущественными.

Проводился тест знаний для учеников до и после апробирования. При анализе ситуации до апробирования учебной модели было констатировано недостаточное понимание экологических проблем у большинства опрошенных учащихся - общее количество правильных ответов на вопросы теста было только 34,7% в восьмых классах и 39,6% в девярых классах. Результаты тестирования после апробирования показали результативность учебной модели. Уровень понимания экологических проблем повысился на 38,4% в восьмых классах и на 26,8% в девярых классах. Констатировано также улучшение общей успеваемости по химии.

Как показал проведённый педагогический эксперимент, на практике оправдался подход нашей разработанной модели „Общество – Природа – Технологии”, что характеризуют следующие признаки:

- значительное увеличение доли практической химии;
- ориентация на понимание экологических проблем, на сохранение окружающей среды в лабораторных работах;
- думать, рассуждать и действовать способствующая методика с акцентированием роли химии в повседневной жизни.

Удачная интеграция вопросов экологии в естественнонаучном образовании, в частности в химии, способствует интерес к учёбе, делает более близкими и понятными для учащихся процессы в природе, формирует мотивацию заботиться об охране окружающей среды, сохранить её для будущих поколений.

Ключевые слова: химическое образование, экологическое образование, модель обучения химии, основная школа.

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Aira Bartuseviča

Doctor's Degree Candidate
University of Latvia, The Center of Chemistry Education
K. Valdemara Str.48, Riga, LV-1013, Latvia,
Phone: +371 7378719
E-mail: aira.bartusevica@lu.lv

Dagnija Cēdere

Dr. chem.
University of Latvia, The Center of Chemistry Education
K. Valdemara Str.48, Riga, LV-1013, Latvia,
Phone: +371 7378719
E-mail: dagnija.cedere@lu.lv

Rudīte Andersone

Dr. paed.
University of Latvia, Faculty of Education and Psychology,
Jurmālas Str. 74/76, Riga, LV-1083, Latvia,
Phone/Fax: +371 7034896
E-mail: ruditean@latnet.lv

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