ISSN 1648-3898 Journal of Baltic Science Education, No.1 (5), 2004-03-30; pp. 49-57.

FORMATION OF A CONTEMPORARY TEACHING/LEARNING MODEL OF CHEMISTRY IN BASIC SCHOOL

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Abstract. A new contemporary teaching/learning model of chemistry in basic school in Latvia is proposed and discussed in the paper. Society's needs, contemporary demands and sustainable development are driving forces of the model. A meaningful mode of chemical thinking, a careful and understanding attitude towards environmental processes, and skills and attitudes useful for practical life result from the application of the mentioned model. The model, together with accompanying didactical material – student's laboratory workbook, teacher's guide and students' worksheets, was tested in several basic schools of Latvia.
Key words: chemical education, teaching/learning model, basic school.

Introduction

The ability of the new generation to judge, analyze, do, compete in the job market and other areas of life will depend in large part on a contemporary, environmental process and phenomenon modeling chemistry curriculum. A student will always find curriculum oriented to understanding phenomena and processes, an immediate connection with the substances and materials participating in natural processes, opportunities for practical action and application of chemical methods interesting and significant. Knowledge and skills are those factors that develop and contribute to the cognitive interest of students, generate motivation of studying and allow to better understand the individual as a constituent of nature responsible for the future of the planet he dwells on.

It is important for an educator to concretize lasting values that start shaping today and stabilize in future viewpoints of a student, understanding about chemical processes ongoing in real life beginning with promoting and understanding chemistry in basic school – 8^{th} and 9^{th} grades. Effective comprehension is limited by the extensive number of facts in the subject, too much information that the student is obliged to accept in form of abstraction, insufficient reflection of the link of chemistry with everyday life. Therefore, a new teaching/learning model is necessary in order to include teaching methods challenging students to think and discuss, stressing the significance of practical chemistry and student's practical activity in classes, and emphasizing the significance and necessity of chemistry and sustainable development of environment in the life of society.

Main trends in the content of teaching models of chemistry

The didactic model of teaching/learning subject is a system of pedagogic methods that includes a plan of what to teach and when, methods for the most effective teaching to guarantee fulfillment of instructional, educational and developmental tasks and attainment of educational goals. The concept "***model***" is reflected differently in various publications. In the Anglo American understanding, it is the background material placed in the didactic model of the subject, taught by the teacher, and acquired by experience that forms the intellectual development of an individual. According to these authors, precise measuring, including test analyses, allows evaluation of the quality of the results and planning of subsequent work. In European, including German and Latvian understanding, the content of an educational model, its diversity and significance in the development of the competence of an individual's capability, are dominating factors in a subject model (Žogla, 2001).

Discussion about not only the theoretical background of teaching models but also their practical solutions, including subject didactics and chemistry didactics, has become more and more topical during the last 20 – 30 years together with increasing interest about empirical teaching/learning models. Serious research is being done and radical changes in chemistry curriculum are being carried out in many countries. Subject didactic models are more oriented towards humanism ideas in European countries, especially in Germany (Barke, Harsch, 2001). The influence of three substantial chemistry sectors – chemical technology, environmental chemistry, and chemistry of every day life – on the teaching content in schools has been emphasized in German chemistry didactic for almost 30 years (Barke, Harsch, 2001). Estonian authors (Tõldsepp, Toots, 2003) discuss a similar model – STL (*Scientific and Technological Literacy*) in the balanced curriculum of the education of the new generation. Science, society, and technology as the existential and instructional environment of a person are at the center of attention of these authors.

Similar problems exist in our country and abroad, regardless of differences in the formation of a teaching model and evaluation of its efficiency. Schoolteachers, scientists (Lamanauskas, 2003; Broks, 2000) and educational methodologists are all looking for their own solutions of these problems. Discrepancy between gained and delivered knowledge, lack of comprehension in basic chemistry issues in schools, shortage of chemistry students in universities are well established (Salickaite-Bunikiene, 2004; Birkun, Kozyrev, 2003, Lakhvich, Travnikova, 2004). The necessity to humanize the teaching process is also discussed (Kincans, 2003). Unfortunately, changes in chemistry curriculum take place at a much slower pace than chemistry science and the chemical industry are progressing. As a result, the knowledge that a young person acquires at school is of little use in his later life. The above mentioned force us to look for new conceptual solutions in chemistry didactics. Teaching methods also have to fundamentally change. They need to be transformed from those oriented to acquiring chemistry fundamentals, to quantitative knowledge and voluminous facts into methods centered on the student – *a scientifically comprehending personality* (Towbridge, Bybee, 1996) capable of using the obtained knowledge and practical skills in his later life. The result will be *a study-capable individual,* and society will be receive the individual – *an educated consumer* (Cēdere, 2001).

The necessity to develop a new teaching model

The historical situation in Latvia in the past limited both the student's and teacher's well-rounded growth and development. It is necessary to develop a teaching model that would have as its basis the above mentioned chemistry curriculum, the humanization and selection of contemporary teaching methods, capable of stimulating students' comprehension of the subject in Latvia today. Chemistry is not more difficult or more unintelligible than other subjects in school. There is no basis to maintain that chemistry teachers in Latvia are more inadequately prepared than teachers of others subjects. Therefore, changes in pedagogic thinking, methodology, and teaching models are necessary because together these factors might cause expected improvement of teaching quality.

No foreign model or approach is applicable directly in contemporary circumstances. Discrepancy between chemistry curricula and the information necessary for modern society to allow its citizens to develop self-dependent as well as motivating and self motivating individuals, desiring a life-long education and willful career, has become a problem. The most essential questions in basic school chemistry education that need to be addressed are as follows:

- Restructuring of teaching content responding to society's demands, environmental sustainability principles, and people's every day needs.
- The chaos caused by the increase of information volume during the last ten - twenty years.
- Mastering the abilities and skills useful for practical life.
- Forming an understanding and caring attitude toward processes in the environment.

Our didactic model for teaching chemistry in basic school has been developed to address the above mentioned questions.

Characteristics of the model

Our teaching/learning model contains three essential features – modified content, different (unconventional) teaching methods, and drawing of chemistry closer to every day life. A shift of emphasis has occurred within the framework of the model:

- concerning content, three joint domains – social sphere, biosphere, and technosphere – now have a joint influence on the chemistry teaching process in basic school;
- concerning methods, teaching strategies that stimulate thinking practical chemistry and development of students' practical work skills (applied skills) are used in chemistry classes;
- concerning practical aspects, significance of chemistry is accented in society's life.

Nature, society, technology… *Natural environment*, *human environment*, and t*echnological environment*… *Biosphere, noosphere*, and *technosphere*… These are three main clusters of categories, expressed in slightly different words, whose interaction forms ideas about the surrounding world and man's place in this world in the human consciousness (Figure 1). Interdependence between nature, man and the achievements of human activity result in a tangency of these spheres that we accept as self-evident values in every day life. Nature is the background of our biological existence; technologies are the result of goal oriented deliberate action of the intellectual sphere over many years; the achievements in chemistry (facts, discoveries, generated production) give testimony of human accomplishments and present a challenge to act in the name of the future.

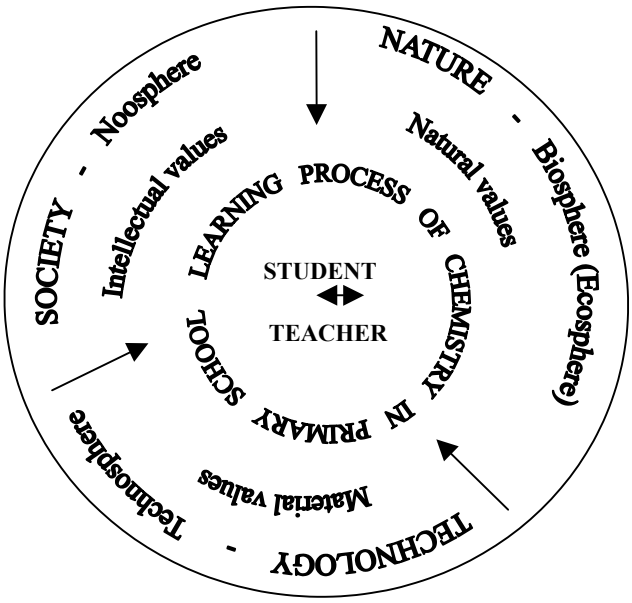

Figure 1. Teaching/learning model „Society - Nature –Technology" of chemistry.

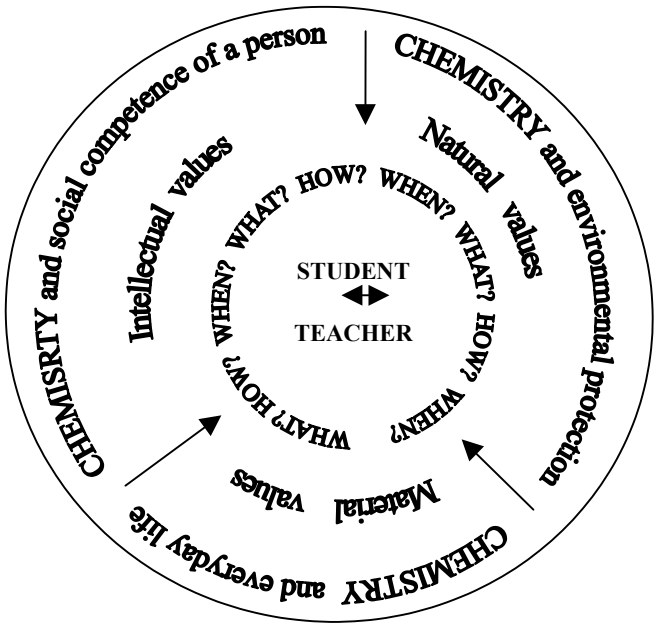

Figure 2. Value-oriented learning of chemistry (development of Figure 1).

The ***student*** is placed at the center of the entire educational process from the point of view of a humane educational paradigm. The pedagogic approach to the student who is at the center of the developed model is based on generally human values – such as mutual regard and love, understanding, consideration of the abilities and interests of the student, understanding his behavior and actions. The ***teacher*** is the person who builds the link between the student, the teacher and the curriculum, selects working methods and pedagogical technique, and the most appropriate teaching strategies.

Chemistry curriculum is a system open to different influences and changes. It helps arrange conceptions of the student about chemistry, insight about chemistry as a science, and helps form his world outlook about natural sciences, when directed and guided in the right way by the teacher. Our model presents answers to the questions "What to teach?", "How to teach?" and "When to teach?" in every sphere of influence (Figure 2).

The developed model allows realizing in practice an integrated multistep approach – to provide knowledge corresponding to students' perception at the proper time and age. Answers to the questions "What?, How?, and When?" are a variable part of the teaching/learning model. Chemistry specifics influence the study of content (What?). Teaching methods (How?) are changing with time. A person-centered approach develops the activity and creativity of the students in due time (When?).

Attitudes and choices offered by the new millennium have changed along with time. Some students have developed the delusion that chemistry is a difficult and unintelligible subject. Other students have the opinion that they will not find a good job in the speciality after graduating. Students reexamine their life values and establish priorities over their entire learning process. The change in values has also entered the chemistry curriculum. A values-oriented class is only one that forms an assemblage of definite values and attitudes, not only values specific to some existential or chemistry aspect (Belickis, 2000). The previously mentioned (in Figure 2) spheres of chemical influence interface once more in teaching/learning chemistry at school in the following items:

1. Chemistry and social competence of a person.
2. Chemistry and environmental protection.
3. Chemistry and everyday life (Figure 3).

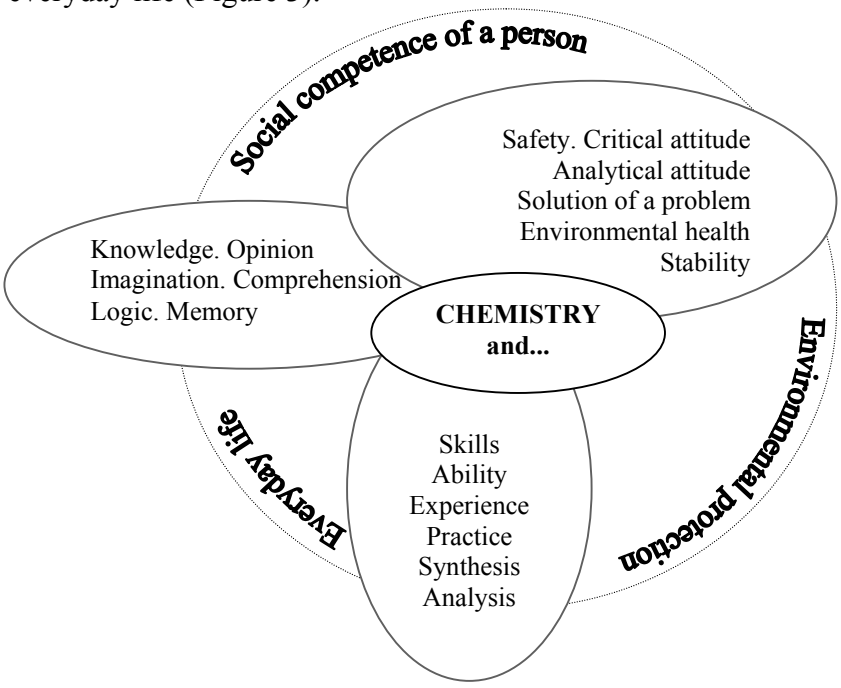

Figure 3. Formation of the values at chemistry classes (development of Figure 2).

Only the most significant values are included in the developed model, those demanding special attention for their formation. They are as follows: knowledge of chemistry, logic and understanding of phenomenona, analytical and critical attitude towards processes in the environment, problem-solving skills, safe and proper handling of substances and materials, opportunities to assess problems connected with environmental health, et. al.

Society's needs, *sustainable development*, and *contemporary demands* are the ***driving forces*** to be considered in changing chemistry teaching curriculum and selecting appropriate teaching/learning methods (Figure 4). The content of chemistry curricula in school can be divided

conventionally in two parts – theoretical chemistry and applied (practical) chemistry. It is impossible to draw a precise borderline between both parts, of course. One can speak only about proportion or meaning of one or another part in the total familiarization of knowledge and skills. Both parts come into contact in definite areas and, therefore, they must be discussed together.

Significant ***qualities of chemistry education*** are crystallized best as a result of the areas of the above mentioned spheres and driving forces. The main qualities of chemistry education in the frame work of this model are as follows.

1. *Meaningful mode of chemical thinking*. It associates chemistry and the social competence of a person and develops the student's personality.
2. *Caring and understanding attitude towards environmental processes*. It joins chemistry and elements of environmental protection in the lesson, and develops the student's personality.
3. *Skills and attitudes useful for practical life*. They combine the science of chemistry with the demands of practical life, and develop the student's personality (Figure 5).

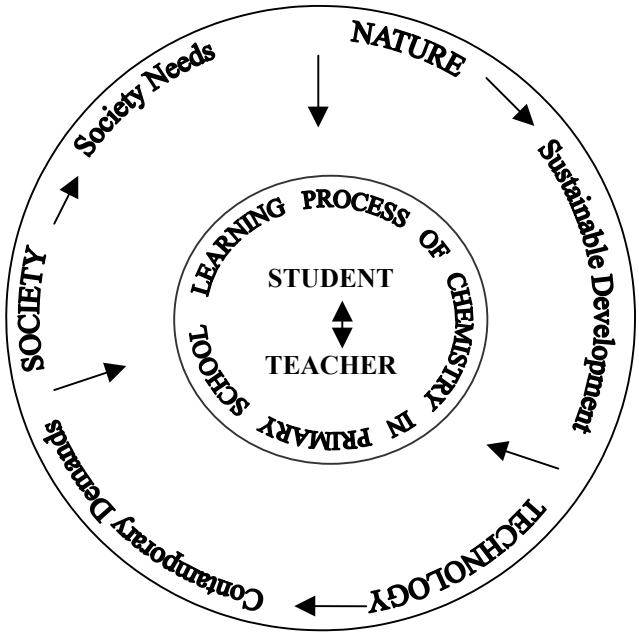

Figure 4. Driving forces of teaching and learning chemistry.

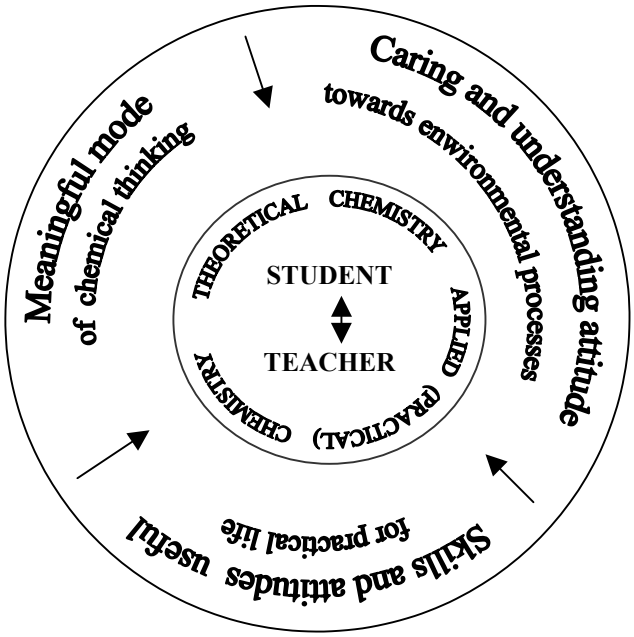

Figure 5. Formation of contemporary qualities of chemistry education (development of Figure 4).

The practical aspect of the developed teaching/learning model was realized in basic schools with a teaching aids package consisting of a student's laboratory workbook, teacher's guide and worksheets for students. The pedagogical approach for realization of the practical aspect, as well as for formation of contemporary qualities of chemical education, is presented in Figure 6. The main emphasis in the realization of practical aspects was placed on the following items:

1. Practical work of the students in chemistry classes with simple known substances and cheap available materials.
2. Consideration of the warning signs, security symbols characterizing properties of substances, warning signs for self-protection and environmental protection.
3. Laboratory experiments that model environmental processes and are environmentally friendly; the final step is neutralization and recyclization of final products of reactions.

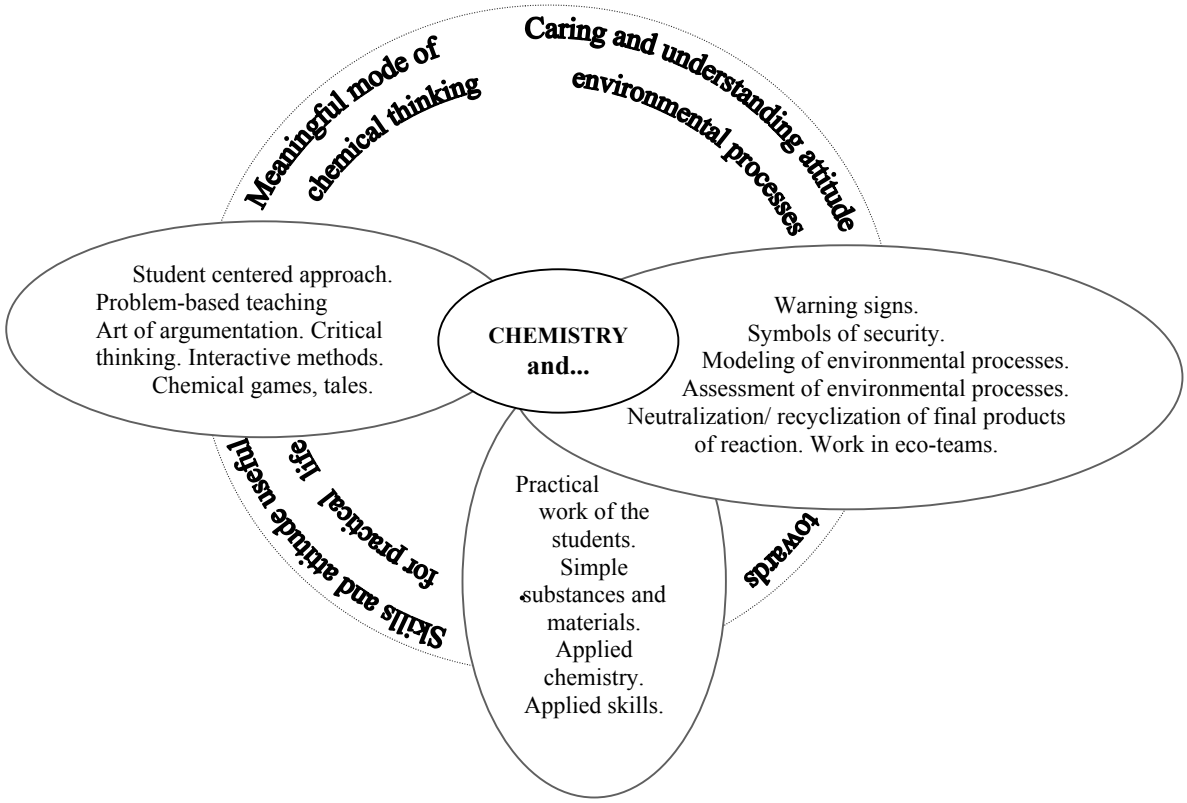

Figure 6. Formation of contemporary qualities of chemistry education (development of Figure 5).

The model, together with accompanying didactical material – student's workbook, teacher's guide and students' worksheets, was tested in several basic schools of Latvia. Six hundred basic school students took part in the assessment of the above mentioned pedagogic experiment conducted by twelve teachers over two years. In total, amelioration of students' performance, increase of learning motivation and activity were observed. Assessment of the results will be published later.

Conclusions

Particular historical and social conditions in Latvia have caused the necessity to change chemistry curriculum and teaching/learning methods in school. Contemporary chemistry education does not provide knowledge and skills corresponding completely to the contemporary demands, modern society's needs and principles of the environment sustainable development.

The new teaching/learning model of chemistry in basic school is developed considering the humanization principle of the teaching process recognized elsewhere in the world. The model is ground on three prior aspects: society, nature, and technologies forming united system. The objective of the model is stimulating student's comprehension of the knowledge and skills of chemistry in society, nature and technologies.

Contrary to the existing approach to chemistry teaching, the developed teaching/learning model includes three main peculiarities: modified content, unconventional teaching methods, and drawing of chemistry closer to every day life. The first involves joint influence of three spheres (*social sphere, biosphere and technosphere*) on the chemistry teaching process. The second promote teaching methods that stimulate thinking. The third includes greater proportion of the applied chemistry: accenting the significance of chemistry in human every day life, adoption of the attitudes and skills that are necessary for every day life and environmentally friendly.

Developed teaching/learning model of chemistry at basic school allows:

- Introduction the student into the unified understanding of intellectual, natural, and material values.
- Demonstration of the student-centered approach in the teaching process of chemistry as the most effective system of pedagogical method in Latvia at the present time.
- Implementation qualitative changes in curriculum, proving the significance of applied chemistry and applied skills as useful for human's practical life.

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Резюме

РАЗРАБОТКА СОВРЕМЕННОЙ МОДЕЛИ ОБУЧЕНИЯ ХИМИИ В ОСНОВНОЙ ШКОЛЕ

Айра Бартусевича, Дагния Цедере

Содержание химического образования и методы обучения в школах Латвии в настоящее время не дают ученикам те необходимые знания, навыки и умения, которые полностью соответствовали бы требованиям современного общества, это вызывает необходимость изменить методику обучения.

В статье предложена и обсуждена новая модель обучения химии для основной школы. Модель разработана при использовании проверенного и одобренного подхода в мировой

практике - гуманитаризации учебного процесса. Подход основан на единую систему „Общество - Природа – Технологии". Эти три мотива модели отражают нужды общества, долгоустойчивое развитие и требования современной жизни.

Разработанная модель обучения отличаеся от традиционного подхода более акцентированной практической химией (в смысле содержания предмета и формирования навыков учащиеся). Методика химического эксперимента предусматривает изучение символов предупреждения и опасности химических веществ, а также способов неитрализации отходов после реакции. В химических экспериментах предлагается использовать простые, в повседневной жизни распространённые вещества и материалы. Модель обучения призвана развивать умения и навыки пригодные в повседневной жизни, бережливое отношение к окружающей среде и обогащенный знанием образ химического и аналитического мышления учеников.

Разработанная методика обучения химии для основной школы позволяет

- формировать понимание учеников об интелектуальных, материальных и экологических ценностях;
- акцентировать гуманный подход к процессу обучения, который является более продходящим в настоящее время в Латвии;
- внести качественные изменения в содержании учебного предмета, особое внимание уделяя практической химии и формированию навыков практической деятельности.

Предложенная модель вместе с разработанным учебным пособием для лабораторных работ, методическим материалом для учителя и рабочими листами для учеников была апробирована в основных школах Латвии. Наблюдалось повышение активности и интереса познания учащихся, а также улучшение успеваемости. Более подробное обсуждение результатов апробирования будет опубликовано позже.

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

Received 25 January 2004; accepted 05 March 2004.

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