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INTEGRATIVE CHEMISTRY EDUCATION AT THE TECHNICAL COLLEGE OF THE REPUBLIC OF KAZAKHSTAN

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Abstract

The article discusses the experience of students of Kazakhstani colleges in integrated chemistry education. There is a contradiction between the objective necessity of providing multilateral natural-science training for students of technical colleges and the relatively narrow focus of the learning process in these educational institutions, which is complicated by the objectively existing specifics of each of the main natural-science subjects.
The scientific novelty of the work is to develop an integrated chemistry course as a general educational discipline. It is established that an integrated chemistry course for students of a technical college helps to improve the quality of knowledge in the subject, the resulting quality of learning and the effectiveness of training.
The results of studies to establish the features of an integrated chemistry course, as well as methodological recommendations aimed at increasing the effectiveness of studying chemistry as a general discipline in a technical college, can be used to develop a chemistry course and methods of studying it in other TVE institutions.

Key words: integration; didactic conditions, integrated approach, technical and vocational education; updated educational content.

Introduction

The state program of forced industrial and innovative development of Kazakhstan required updating the structure and content of technical and vocational education (hereinafter - TVE), focused on the effective work of educational institutions (vocational lyceums and colleges) in training qualified personnel in accordance with the requirements and priorities of the country's economy.

Such requirements have a direct impact on the reform of Kazakhstani secondary vocational

education organizations. It is necessary to identify new strategic and tactical decisions on the organization and content of the educational process in vocational lyceums and colleges in the context of updated educational content. Therefore, the modernization of the system of technical and vocational education, in our opinion, should be ahead of schedule, taking into account the state compulsory standard of technical and vocational education of the Republic of Kazakhstan (hereinafter - RK), new educational paradigms.

TVE in the Republic of Kazakhstan is offered by two types of institutions - vocational schools (vocational lyceums) and colleges. Vocational schools provide primary vocational education aimed at preparing students to enter the labor market as qualified technical and service workers. Vocational school programs last two to three years. Colleges provide more theoretical training in science and prepare students to work as technical specialists, foremen and mid-level managers. At present, there are 821 VET educational institutions operating in the republic, with seats for 531,254 students, the total contingent is 488,712 people. At the same time, in 23% of colleges, the number of students is from 18 to 200 people.

However, in the Kazakhstani economy, there is still a shortage and vacancies of technical specialists and skilled workers. The answer is simple - the TVE system provides neither the quality nor the number of skills needed for a market economy. Rigid institutional structures and nonrational financing mechanisms determine the existence of an inflexible system that does not provide incentives for the efficient and rational use of resources. The TVE system in Kazakhstan was faced with enormous problems related to its relevance, management, quality and internal rationality.

The curricula of vocational lyceums and colleges of Kazakhstan include both special and general educational disciplines. The study of general educational disciplines in colleges provides secondary general education and simultaneously serves as the basis for mastering special disciplines, and at the same time it is necessary to rely on the basic knowledge of students obtained in the study of general educational disciplines in a basic school. However, based on practice, there is a weak level of knowledge of students in general subjects of the basic school, in particular in chemistry, lack of interest in this subject and difficulties in mastering the college chemistry program. Questioning among teachers also indicates that a lack of interest in the study of chemistry as a general discipline takes place today in many VET institutions.

Priority resolution requires the question of the goals and content of chemistry education in college: (a) what to give preference to, what knowledge to attribute to basic, meeting the requirements of fundamentality and commitment for all levels of general secondary education; (b) the process of extracting and transferring knowledge from an increasing information array in a fixed period of study, systematization and structuring of knowledge; and (c) didactic tools for learning effectiveness.

The work of researcher L.A. Tsvetkova is also important for our research. We adhere to the views of the researcher on the apparent contradictions of the educational process:

- the lack of modern scientific knowledge to prepare students for work, that is, "insufficient didactic justification of the levels of general education and professionalism of the secondary school";

- replacement of “general education by profile”, which requires the inclusion in the chemistry courses of increasingly complex theoretical knowledge without increasing the scope of study time;

- uncertainty in the structure of the school subject correlation between factual and theoretical knowledge;

- “the need to study science not only as a result of cognition, but also as a developing system that improves the field of human activity, revealing the essence and laws of natural phenomena” [1]. All these contradictions are relevant at the present time, which leads to a decrease in the quality of knowledge of the subject in a technical college, the resulting quality of learning and the effectiveness of training.

The purpose of the study is to develop an integrated approach in the teaching of chemistry, to identify the features of teaching this subject in the context of updated education content to improve the quality of knowledge in

the subject, the resulting quality of learning and the effectiveness of training.

Literature review

The modern educational process is a complex, multidimensional phenomenon, the leading basis for the development of which is integration. This concept has many interpretations, and, accordingly, there is a plurality of classification of integration processes [2].

V.P. Maksimova believes that the ideas underlying the modern complex of scientific, economic and social problems are an integrating factor. Combining the teaching of disciplines of all three cycles into a single whole is a goal whose achievement will significantly improve the quality of training of qualified mid-level specialists (специалист среднего звена). The development of any methodology or system of methods cannot be sufficiently effective without the implementation of intersubject communications. Without this, it is impossible to correctly build the educational process, successfully form the dialectical-materialistic worldview" [3, p. 117].

Further analysis showed that works of V.S. Bezrukova, A.A. Bogdanova, N.K. Chapaeva and others are devoted to the ideas of integrated learning.; general theoretical problems of integration were solved by A.L. Danilyuk, B.M. Kedrov, Yu.A. Kustov, M.G. Chepikov and etc.; various approaches to determining the directions of integration in educational systems were studied by Z.Sh. Karimov, N.A. Krel, M.V. Pravdina and others.; M.N. Berulava, V.G. Ivanov, Z.I. Ishembitova, T.A. Sannikova, E.A. Uvarov, I.P. Yakovlev and others were engaged in the implementation of interdisciplinary integration in the conditions of secondary vocational education. The methodological foundations of an integrative approach to teaching chemistry are presented in the works of A.E. Shilnikova, V.P. Garkunova, N.B. Simakova, Yu.V. Shibanova, D.B. Baranova, L.G. Davydova, F.T. Guseva, I.Ya. Kuramshina, L.A. Kazantseva, T.D. Kolpakova, E.G. Matveeva, M.S. Park, K.A. Aldiyarova, J.R. Orynbaeva, E.Y. Baidabekova, Muldagalieva I.Kh. and etc.

The analysis of psychological and pedagogical literature, the study of the experience of vocational lyceums and colleges allow us to state, firstly, that pedagogical integration is studied at all three basic levels of its functioning - methodological, theoretical and practical; secondly, currently there are approaches to determining the objective grounds and factors of pedagogical integration (G.I. Baturina, A.P. Belyaeva, M.N. Bezrukova, M.N. Berulava, V.I. Zagvyazinsky, V.C. Lednev , V.N. Maksimova, Yu.S. Tyunnikov, etc.); to identify its structural components (A.S. Belkin, N.N. Tulkibaeva); the development of technological support tools for pedagogical integration (M.N. Bezrukova, M.N. Berulava, Yu.S. Tyunnikov, A.V. Usova, N.K. Chapaev, etc.); thirdly, there are some contradictions: between the holistic nature of a person (student) and the presence of a powerful system of differentiated education (P.M. Asadullin, A.S. Gayazov, T.A. Ilyina, Z.A. Reshetova); theories of selection and construction of the content of natural-scientific education (I.Yu. Aleksashina, E.L. Arshansky, Yu.Yu. Gavronskaya, A.A. Zhurin, O.S. Zaitsev, M.V. Zueva, N.E. Kuznetsova , O.I. Kurdumanova, E.E. Minchenkov, V.M. Nazarenko, P.A. Orzhekovsky, M.S. Park, V.P. Solomin, I.M. Titova, E.I. Tupikin, G. .N. Fadeev, G.M. Chernobelskaya, M.A. Shatalov, etc.).

At present, the implementation of continuous natural-scientific training of specialists does not allow achieving high efficiency due to the lack of sufficient integration links between levels and grades of education, models of multilevel educational systems, and also due to the orientation of organizational forms of the learning process implementation towards the traditional educational paradigm. Many countries are looking for their models of continuing education [4]. In this regard, in order to understand the dynamics of changes in the leading ideas of the Kazakhstan school of chemistry teaching methods, we first indicate the current state of the problem presented in the concept of the State Compulsory Standard for of Technical and Vocational Education (hereinafter - the Standard). It is distinguished by: (a) the revision and development of educational standards and model curricula (at the state level) as the basis for the development of new academic programs by educational

institutions, (b) the development of teacher training programs on the development and training of module-based competency-based programs; and (c) the development and implementation of Institutional Development Plans (IDP) to enhance the capacity of TVE institutions (lyceums and colleges), including the development and training of competency-based programs in accordance with new professional and educational standards and standard curricula.

General educational natural science training in the system of technical and vocational education is mandatory in Kazakhstan and significantly affects the formation of personality and professional qualities of a future specialist, the level of his mobility, competitiveness and demand on the labor market.

The results of the analysis on the research problem confirm that students who have gaps in knowledge of chemistry then encounter serious problems in studying a number of special disciplines, the material of which could be learned only if students had knowledge of certain chemical concepts and laws. In this regard, the objective construction of the curriculum creates the danger of isolation in the student's consciousness of knowledge of one subject from the knowledge of another, the skills and abilities given in one academic subject, from specific skills and abilities formed in the study of another" [5, p. 64].

G. A. Baymakhanova, a deputy of the Majilis of the Parliament of the Republic of Kazakhstan, believes that "in connection with Kazakhstan's entry into the Bologna process, higher schools have switched to training specialists according to new standards (Bachelor's program, Master's program, Doctoral program), and the country's colleges are training specialists in Soviet programs of narrow specialties. The principles of training specialists are blurred, there is no full-fledged professional practice, but most importantly, the connection between industry and educational organizations is lost" [6].

The teaching of chemistry should include a large number of experiments, both demonstration and conducted by students themselves. This requires well-organized chemistry laboratories without a lack of reagents and equipment, with well-designed safety procedures, with competent laboratory assistants and teaching staff. However, in Kazakhstani colleges there is a lack of a chemistry laboratory with the necessary equipment, taking into account not only the educational standard, but also the creative approach. Nazarova T.S. believes that the small runs of teaching aids, and sometimes their complete absence, led to an almost complete ignorance of the educational equipment necessary for demonstration and student experiment, practicum, solving experimental problems, and, in essence, to the loss of many valuable traditions of the domestic school of chemistry methodology. Today, teachers often do not "recognize" the devices shown to them, and accessories, cannot name their purposes, are afraid to show a chemical experiment, and do not know the terminology [7].

Training a competent specialist requires great attention to the development of independent work skills, but most of the students in lyceums and colleges are not ready to increase the volume of independent work. The main problem of the qualitative assimilation of chemistry is the contradiction between the increasing volume of new factual material and the strict regulation of the educational standard, the outdated material and technical base of colleges does not ensure the quality of training of specialists and the attractiveness of the TVE system. The problem of a systematic shortage of applicants has led to the emergence of the phenomenon of "low-grade colleges" with a contingent of less than 200 students.

Thus, on the basis of the foregoing, we conclude that at the present stage in Kazakhstan, the issues of rational construction of the educational process on an integrative basis in Kazakhstani secondary vocational education institutions, in particular in the process of studying chemistry, have not been sufficiently studied. The study revealed that the contradiction between integrated training (penetration of elements of one field of knowledge into others) and the fragmentation of disciplinary knowledge existing in educational institutions of secondary vocational education in Kazakhstan has not been resolved to date.

By the development of an integrated approach to the teaching of chemistry, we mean the

creation of a curriculum, the compilation of a textbook, laboratory practicum and methodological recommendations for organizing the study of the discipline.

Methods

During the study, the following methods were used:

- theoretical analysis of scientific, educational and methodical literature on the research problem; the study and analysis of regulatory documents governing the structure and content of training in the subjects of the natural science cycle in colleges; the content of textbooks on general chemistry in the basic school and colleges of Kazakhstan, methodological approaches to their study were systematized and compared.

The analysis of the features of the system of technical and vocational education in the Republic of Kazakhstan was conducted; development of a system of integrative for academic studies, the method of reference diagnostic diagnostics (including monitoring, conducting surveys, conducting tests) was also applied.

- statistical methods for processing experimental data, cluster and methodological analyzes, digital, graphical and verbal presentation of the results.

Participants

An experimental study was conducted in educational organizations: the Almaty College of Telecommunications and Engineering, the Almaty College of Technology and Floristry, the Almaty Automotive College of Almaty city, the Republic of Kazakhstan. The first-year students of the training areas participated in the pedagogical experiment: “Operation of linear telecommunication and wire broadcasting facilities”, “Cable installer”, “Radio electronics and communications”, “Postal operator” and “Postal technician”.

A total of 128 people took part in the experiment. During the joint study, two experimental groups were created in the Almaty College of Telecommunications and Engineering and three control groups in other colleges in Almaty.

Study design

Based on research (Park, M.S. [8], Germogenova N.I., Egorova K.E. [9]; Kureneva T.V. [10]; Vlasova T.G. [11]; Aldiyarova K. T. [12], Rakhmatullina M.T. [13], Shtrempler G.I., Kuzeikina E.V. [14] and practical work, we suggested that if we develop and implement an integrated chemistry course in the technical college’s educational process, to identify the features of teaching this subject in the conditions of the updated content of education, it will be possible: to improve the quality of students' knowledge, the resulting quality of learning and the effectiveness of training.

A learning strategy was chosen, where the form of the lesson was put forward in the first place, which, in turn, determines the type of lesson, and, based on the type of lesson, the teaching methods are determined. Note that in the process of teaching students at a technical college, well-known methods of teaching chemistry, adapted by us to the goals of our study are used.

We consider four groups of methods:

- methods for creating a positive motivation for learning (building a system of professional perspectives, emotional stimulation, taking into account personal learning achievements, creating psychologically comfortable learning conditions);

- methods of organizing cognitive and practical activities of a student (collective conversations, discussions, problem solving based on analysis of specific situations, educational experiments, projects, educational and professional studies, etc.);

- reflexive-evaluative methods (analysis of the results of control and self-control, diagnosis of educational difficulties, assessing the significance of acquired knowledge and skills, etc.);

- methods for developing a personal educational learning environment (attracting the student’s personal experience, practical

orientation, open learning planning, working with additional sources of information, etc.).

Integrated materials were included in the calendar-thematic planning in the content of topics and classes. The introduction of an integrative approach to teaching chemistry was carried out in three stages, respectively. At the first stage, the development of classes and laboratory work of an integrative nature for students was carried out. During such work, students learned to draw knowledge and skills from related subjects to explain chemical processes and phenomena. Thus, the integrative approach acted as an important structural element of the material content in chemistry, not only at the theoretical, but also at the practical level. Here, special requirements are presented to the content of the tasks, namely: the integrative nature of the tasks: the relationship with other disciplines, as well as with practice. Tasks with production content are offered. The construction of classes using a set of tasks and assignment reflect such approaches as:

1. A systematic approach (tasks and assignment of an integrative nature contribute to a comprehensive study of the most significant laws as a whole).

2. Integrative approach (tasks of an interdisciplinary nature contribute not only to the development of knowledge and skills in chemistry, but also are the initial stage in the development of the chosen profession).

3. Competency-based approach (integrative tasks with practical content allow students to demonstrate their willingness to analyze and solve practical situations, problems of a professional plan).

4. An active approach (as a result of completing tasks, the student acquires the skills necessary in practice - the use of chemical formulas to solve professional problems, a description of professional processes in a chemical language).

5. A personality-oriented approach (students learn cognitive strategies of modeling and design processes).

The establishment of prompt feedback of the teacher and students contributed to the timely receipt of information and the elimination of shortcomings. The result of the implemented approach is a new quality of student training, which manifests itself in the optimization of the content and technology of training, visualization of processes, properties and objects, the integration of the content components of natural science and professional disciplines, etc., as well as the formation of professional competencies and personal qualities of students.

The complex of didactic tools of the integrated approach in chemistry included physical models, demonstration experiments, experimental setups, dynamic posters that contribute to the realization of the cognitive, formative and didactic functions of the integrated natural science course. The didactic requirements for the preparation and conduct of generalized integrated classes were: systematization of knowledge, consolidation of the methods of educational research in solving non-standard interdisciplinary cognitive tasks of a problem nature, a personality-oriented approach, a variety of forms of students' independent creative activity. At the same time, attention was drawn to acquainting students with the use of scientific knowledge in the field of industry and agriculture, to forming a general idea of production based on the material of its main industries, to equipping students with practical skills, ensuring the connection of training with socially useful work, subordinate to educational goals of the college.

Results and discussion

Entrance control was carried out using questionnaires, which did not reveal fundamental differences between the experimental and control groups. For further research, we identified the motives that affect learning activities:

motives of duty and responsibility - “the choice of a profession corresponds to the interests of the family”, “I want to know more”;

motives of self-determination and self-improvement - “I will make a successful career”, “I am a persistent and confident person, so I will become a good organizer”;

motives of well-being - the prestige of the profession, a clear example of parents (friends), confidence in the future;

prestigious motivation - high wages, good working conditions, privileges in rail transport;

motivation for avoiding trouble - “I study so that my parents don’t scold”, “I study so as not to get a low grade”, “I learn so as not to be worse than others”;

motives associated with the learning process, communication with friends, the opportunity to become more confident in yourself;

motives related to the content of the teaching - "this is a difficult period that must be experienced, since it is an integral part of achieving the goal". The survey data are given in table1.

Table 1. Indicators of motivation for educational activities

Motives	The beginning of experiment		The ending of experiment	
	Control group	Experimental group	Control group	Experimental group
Motives of duty and responsibility	5	3	4	2
Motives of self-determination and self-improvement	4	6	7	8
Motives of well-being	3	2	2	4
Prestigious motivation	6	7	8	7
Trouble avoidance motivation	2	2	3	6
Motives associated with the learning process	8	5	5	3
Motives related to teaching content	7	8	6	5

The table shows that at the beginning of the experiment in the experimental group the first place was occupied by the motives of well-being, the second by the motives of duty and responsibility, and finally, the third place by the motivation to avoid troubles. At the end of the experiment, there is a shift in the motives of learning towards the motive of duty and responsibility (first place), motives associated with the learning process move to the second,

and motives of well-being to third place. This suggests that the negative motivation for learning has weakened. There were no significant changes in the control class.

At the stage of formative research, cognitive interest was studied. This happened by observing the course of the educational process during the year and questionnaire. We used a questionnaire to determine how each student prepares for a chemistry lesson, whether he willingly participates in work in the classroom, whether in his spare time he reads additional literature on the subject, uses his knowledge in life, does he consider it necessary to receive further education in the subject.

The results are presented in table 2.

Table 2. Indicators of cognitive interest

Indicators	The beginning of experiment		The ending of experiment	
	Control group	Experimental group	Control group	Experimental group
How do you do your chemistry homework?				
voluntarily and willingly	12%	8%	9%	27%
constantly forcing yourself to do it	29%	37%	28%	17%
it depends	64%	59%	65%	62%
Do you read non-fiction and other chemistry literature in your free time that contains information				
on new discoveries in chemistry	9%	6%	5%	17%
on the history of chemistry development	43%	24%	49%	39%
on applying the achievements of chemistry at engineering enterprises	12%	22%	20%	48%
Do you like to come up with any information on chemistry?				
like	36%	30%	16%	56%
do not like	12%	26%	25%	16%
it depends	58%	50%	65%	34%
Are you already using some of the knowledge gained in chemistry lessons?				
yes	20%	25%	45%	66%
no	26%	12%	27%	10%
very little	60%	70%	34%	31%
Do you consider it necessary to further study chemistry?				

yes	30%	25%	27%	45%
no	50%	54%	44%	32%
don't know	26%	27%	36%	30%

An analysis of this questionnaire shows that in the experimental group, due to the motivational approach (a system of interconnected knowledge), the cognitive interest in the subject "Chemistry" increased during the school year, the attitude to the process of preparing homework has changed significantly. If at the beginning of the experiment, 8% of students voluntarily and willingly completed their homework in chemistry, then by the end - this figure increased more than three times (27%). In addition, the attitude towards reading and using additional information from the scientific and educational literature on chemistry has positively changed. Work in the classes became more active, many students began to express a desire to prepare a report or essay, the activity of students was especially noticeable during the organization and conduct of the Chemistry Week in college.

Teachers during the survey noted that students who studied chemistry at the integrated course have sufficient knowledge of the retained knowledge in chemistry necessary for the further study of special and technical disciplines.

The reliability of the obtained experimental results was checked using a parametric indicator - the multifunctional Fisher criterion φ (with the probability of an admissible error $p \leq 0,05$, $\varphi^{*}cr. = 1,64$) and the nonparametric method - the Wilcoxon criterion T (with the probability of an admissible error $p \leq 0, 05$). The value of φ for internal motivation was 2.84, for the cognitive component - 4.69, for operational-activity component - 4.2, for reflective component - 13.25. The Wilcoxon criterion was used only for the statistical processing of the cognitive and operational-activity components, in both cases Tem is less than Tcr.., which indicates a logical shift in the level of quality of knowledge of students, the resulting quality of learning and the effectiveness of training.

Thus, the results of the pedagogical experiment made it possible to prove the effectiveness of the integrated chemistry course developed and introduced into the educational process of the technical college.

Conclusion

Based on the results of the study, the following conclusions can be formulated:

The TVE system in the Republic of Kazakhstan does not prepare a sufficient number of graduates with competencies that are in demand on the market. The forced industrial and innovative development of the country needs a new generation of qualified technical and professional personnel to ensure continuous success amid growing globalization.

The problems of technical and vocational education in Kazakhstan include: (a) lack or shortage of communication with employers and the labor market; (b) preferential focus on the offer, the main stimulus of which is the desire to fill in the existing programs and involve existing teachers and the material and technical base, and not adapt to changes in the market; (c) updated program content and incompatibility with market requirements; (d) standards and content of education that are not based on analysis of professions; and (e) overly specialized curricula leading to narrow skills and a lack of general skills for on-the-job training and continuing education as required by modern economies.

General educational natural science training in the system of technical and vocational education is mandatory in Kazakhstan and significantly affects the formation of personality and professional qualities of a future specialist, the level of his mobility, competitiveness and demand on the labor market. In this regard, the issue of rational construction of the educational process in front of the modern professional school of Kazakhstan is being updated on an integrative basis, in particular, in the process of studying chemistry on the basis of the formation of professionally significant knowledge and skills

necessary for successful mastery of the specialty. This fact allows us to conclude that the innovative way of developing the system of vocational education in Kazakhstan should be based on the idea of forming the scientific thinking of students, which would allow them to make decisions in everyday life from a holistic scientific point of view.

The results of studies to establish the features of an integrated chemistry course, as well as methodological recommendations aimed at increasing the effectiveness of studying chemistry as a general educational discipline in a technical college, can be used to develop a chemistry course and methods of studying it in other TVE institutions.

The practical value of the work lies in the fact that the theoretical provisions of the study have been brought to the level of guidelines and study guides addressed to students and teachers of vocational lyceums and colleges dealing with urgent problems of modern chemical education in secondary vocational education organizations.

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