DOI 10.31489/2023Ped4/86-98

UDC 372.854

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Chemical language in multilingual education system in Kazakhstan. Features of chemical terminology teaching and learning

Today, in the context of internationalization and integration innovative processes are intensively carried out in the educational systems of different countries of the world. They are the primary pillars that direct contemporary social development. These changes are having a significant impact on the education system. In past few decades, there has been a reassessment of modern approaches and standards for all levels of education. Nevertheless, despite considerable progress in multilingual education in the natural sciences, many questions remain about the quality of teaching, the perception of the material by the students and thus the quality and depth of knowledge. Herein, the most important approaches for multilingual chemistry education in the Republic of Kazakhstan are briefly analyzed. Common principles and problems of chemical language and trilingual chemical nomenclature are also discussed. The test results showed that students of the University have a sufficient level of knowledge of fundamental scientific terminology for successful study.

Keywords: multiculturalism, trilingualism, chemical elements, chemical nomenclature, trivial names, chemical education, chemical substances.

Introduction

Multilingualism is one of the key principles of modern education [1–3]. It means that educational process must reject any forms of discrimination (racial, linguistic, religious, gender, etc.), promote principles of social justice and support the formation of tolerance towards social and cultural differences. Without multicultural education and upbringing, it is impossible to set and complete the tasks of modernizing education, intellectual and moral development, personality formation and preparing the young generation for intercultural interaction in the context of complex social and economic relations of the modern world solve.

In a rapidly globalizing world, borders between countries are blurring, and people of different cultures interact more and more intensively with increasing communication opportunities. Now students, teachers and scientists are not limited to their own countries but can easily participate in educational and scientific activities around the world [4]. In recent decades, this has been actively developed through the use of the Internet and various digital resources [5]. The implementation of Internet technologies in the educational process requires serious additions to the pedagogical skills, the ethics and discipline of the students, and the content of the disciplines [6].

Banks highlighted five dimensions of multicultural education including content integration, knowledge construction process, prejudice reduction, equity pedagogy and empowering school culture [7-8]. In this regard, one of the important tasks of the universities is the expansion of the multicultural component of the higher education content and thus the increase the requirements for mastering the world cultural heritage and foreign languages for future specialists. One of the ways to achieve these goals is to introduce multilingual education from primary school.

Today's common is to be a multilingual person than monolingual [9]. An improperly planned educational process can also become a barrier to student learning, especially among students who are diverse in terms of culture, language, and prior knowledge. It should not also be forgot that an integral part of the educational process is the development of students' understanding of the country's natural resources, the role of chemistry and chemical technology in their development, and solving environmental problems.

The development of multilingual education in Kazakhstan educational system plays a central role and is developing rapidly [10]. As a new educational model, multilingual teaching has gradually moved into the focus of society and science. The multilingual system in Kazakhstan education is the union of the Kazakh language, the Russian language and the English language. The linguistic situation in Kazakhstan is that Russian is designated as the language of inter-ethnic communication and has a status of an official equal to the state language, Kazakh. The Russian language holds a strong position in Kazakhstan and continues to perform important social and humanitarian functions [11]. In this case, foreign language teaching is one of the main elements of the modern vocational education system at all levels in the Republic of Kazakhstan.

In Kazakhstan, more than 80% of secondary and university students study English. Fluency in English became the norm for scientists and researchers in most developed countries because of English language functions as the working language of the vast majority of international scientific, technical, political and professional international conferences, symposiums and seminars.

In Kazakhstan, a home to more than 130 ethnic groups, the policy of trilingualism in the modern education system is supported by 83.6% of respondents, but English is not a spoken language in everyday life in Kazakhstan due to its status in the country [12].

Teaching in the system of multilingualism amounts to solving two major tasks: learning discipline through foreign language acquisition and learning a foreign language through the study of discipline. Since Kazakhstan's independence in 1991, various reforms have been implemented in the higher education system [13]. Plans were announced in the country in 2015 to use English as one of the languages of teaching and learning. Nevertheless, attitudes towards teaching through the English medium remain rather skeptical [14].

The success of chemistry education depends on effective pedagogical strategies. Johnstone [15] represented three levels of chemical education (Fig. 1):

1. macro, that is what can be seen, touched and smelled;
2. sub-micro, that is atoms, molecules, ions and structures;
3. representational, symbolic meaning, representations of formulae, equations, mathematical expressions and graphs.

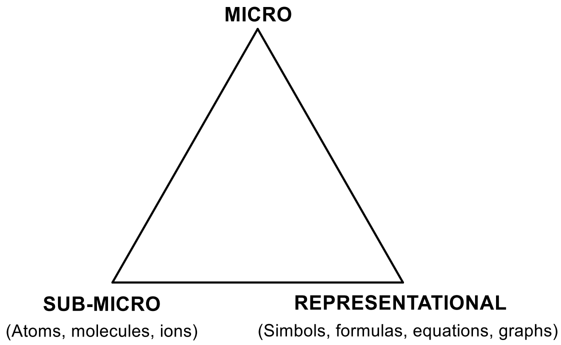


Figure 1. Conceptual triplet of chemistry learning (*by Jonhstone*)

Johnstone placed these levels at the vertices of an equilateral triangle to indicate equal, complementary meaning. Studying takes place “within” the triangle, assuming all levels are equally well understood. A successful learner must develop the skills to relate these three aspects to one another and learn to move between levels, often without notice or explanation.

In addition to the direct English language studies, the professionally oriented English language is also taught at the universities. The purpose of the discipline is the full integration of the disciplines of the specialty with a foreign language. Studying the professionally oriented English language comes after learning all the general chemical disciplines. It builds on knowledge of the main programs in Inorganic, Organic, Analytical and Biological Chemistry and does not provide for learning the new materials in specialized areas. For a more complete and in-depth exploration of this course, students must have at least a basic knowledge of English, the ability to work with educational and scientific literature, to search for scientific and technical information, and user-level computer and Internet skills.

Chemical specialties that are currently being opened at universities only offer courses in English during the entire studying period. In this case, special requirements apply to both teachers and students for the English level in order to teach or study in English-speaking groups. Knowledge of English is also mandatory for admission to the master's and PhD program.

Lecturers who teach in English must be proficient in the English language and pay particular attention to the academic style of speaking. The teacher must adhere to a strict vocabulary when presenting the material and correctly correct stylistic inaccuracies in the students' work. The teacher must be able to adapt the materials provided to the students to ensure a full understanding of the core of the problem. Methodological methods of multilingual chemistry teaching can be verbal, visual and practical. Active forms of educational work can be frontal, group, pair and individual. In addition, the students' level of language skills must be taken into account.

At all stages of chemical education, students meet new concepts *via* linguistic terms. Studying and a better understanding of professionally-oriented English language for students, which are studying in Kazakh language, strongly promotes by the knowledge of Russian language, even on an elementary level. The reason of this is a great similarity in the writing and pronunciation of specific scientific terminology in Russian and English, as well as Latin that they belong to a nearby language groups. For example, names of chemical elements in four languages are listed in Table 1. For a better understanding of the peculiarities of the pronunciation of the names of the elements, all names are given in Latin transcription.

Table 1

The names of the Chemical elements in Latin, Russian, Kazakh and English languages.

Atomic number	Symbol	Russian name	Latin name	English name	Kazakh name*
1	H	Vodorod	Hydrogenium	Hydrogen	Sutek
2	He	Geliy	Helium	Helium	Geliy
3	Li	Litiy	Lithium	Lithium	Litiy
4	Be	Berilliy	Beryllium	Beryllium	Berilliy
5	B	Bor	Borum	Boron	Bor
6	C	Uglerod	Carboneum	Carbon	Kömirtek
7	N	Azot	Nitrogenium	Nitrogen	Azot
8	O	Kislorod	Oxygenium	Oxygen	Ottek
9	F	Ftor	Fluorum	Fluorine	Ftor
10	Ne	Neon	Neon	Neon	Neon
11	Na	Natriy	Natrium	Sodium	Natriy
12	Mg	Magniy	Magnesium	Magnesium	Magniy
13	Al	Alyuminiy	Aluminium	Aluminium	Alyuminiy
14	Si	Kremniy	Silicium	Silicon	Kremniy
15	P	Fosfor	Phosphorus	Phosphorus	Fosfor
16	S	Sera	Sulfur	Sulfur	Sera
17	Cl	Khlor	Chlorum	Chlorine	Khlor
18	Ar	Argon	Argon	Argon	Argon
19	K	Kaliy	Kalium	Potassium	Kaliy
20	Ca	Kaltsiy	Calcium	Calcium	Kaltsiy
21	Sc	Skandiy	Scandium	Scandium	Skandiy
22	Ti	Titan	Titanium	Titanium	Titan
23	V	Vanadiy	Vanadium	Vanadium	Vanadiy
24	Cr	Chrom	Chromium	Chromium	Chrom
25	Mn	Marganets	Manganum	Manganese	Marganets
26	Fe	Zhelezo	Ferrum	Iron	Temir
27	Co	Kobal't	Cobaltum	Cobalt	Kobal't
28	Ni	Nikel'	Niccolum	Nickel	Nikel'
29	Cu	Med'	Cuprum	Copper	Mys
30	Zn	Tsink	Zincum	Zinc	Myryş
31	Ga	Galliy	Gallium	Gallium	Galliy
32	Ge	Germaniy	Germanium	Germanium	Germaniy
33	As	Mysh′yak	Arsenicum	Arsenic	Küşän
34	Se	Selen	Selenium	Selenium	Selen
35	Br	Brom	Bromum	Bromine	Brom
36	Kr	Kripton	Krypton	Krypton	Kripton
37	Rb	Rubidiy	Rubidium	Rubidium	Rubidiy

38	Sr	Strontsiy	Strontium	Strontium	Strontsiy
39	Y	Ittriy	Yttrium	Yttrium	Ittriy
40	Zr	Tsırkoniy	Zirconium	Zirconium	Tsırkoniy
41	Nb	Niobiy	Niobium	Niobium	Niobiy
42	Mo	Molibden	Molybdaenum	Molybdenum	Molibden
43	Tc	Tehnetsiy	Technetium	Technetium	Tehnetsiy
44	Ru	Ruteniy	Ruthenium	Ruthenium	Ruteniy
45	Rh	Rodiy	Rhodium	Rhodium	Rodiy
46	Pd	Palladiy	Palladium	Palladium	Palladiy
47	Ag	Serebro	Argentum	Silver	Kümıs
48	Cd	Kadmiy	Cadmium	Cadmium	Kadmiy
49	In	Indiy	Indium	Indium	Indiy
50	Sn	Olovo	Stannum	Tin	Qalaiy
51	Sb	Sur’ma	Stibium	Antimony	Sürme
52	Te	Tellur	Tellurium	Tellurium	Tellur
53	I	Iod	Jodum	Iodine	Iod
54	Xe	Ksenon	Xenon	Xenon	Ksenon
55	Cs	Tseziy	Caesium	Caesium	Tseziy
56	Ba	Bariy	Barium	Barium	Bariy
57	La	Lantan	Lanthanum	Lanthanum	Lantan
58	Ce	Tseriy	Cerium	Cerium	Tseriy
59	Pr	Prazeodim	Praseodymium	Praseodymium	Prazeodim
60	Nd	Neodim	Neodymium	Neodymium	Neodim
61	Pm	Prometiy	Promethium	Promethium	Prometiy
62	Sm	Samariy	Samarium	Samarium	Samariy
63	Eu	Evropiy	Europium	Europium	Evropiy
64	Gd	Gadoliniy	Gadolinium	Gadolinium	Gadoliniy
65	Tb	Terbiy	Terbium	Terbium	Terbiy
66	Dy	Dısproziy	Dysprosium	Dysprosium	Dısproziy
67	Ho	Gol’miy	Holmium	Holmium	Gol’miy
68	Er	Erbiy	Erbium	Erbium	Erbiy
69	Tm	Tuliy	Thulium	Thulium	Tuliy
70	Yb	Itterbiy	Ytterbium	Ytterbium	Itterbiy
71	Lu	Liutetsiy	Lutetium	Lutetium	Liutetsiy
72	Hf	Gafniy	Hafnium	Hafnium	Gafniy
73	Ta	Tantal	Tantalum	Tantalum	Tantal
74	W	Volfram	Wolframium	Tungsten	Volfram
75	Re	Reniy	Rhenium	Rhenium	Reniy
76	Os	Osmiy	Osmium	Osmium	Osmiy
77	Ir	Iridiy	Iridium	Iridium	Iridiy
78	Pt	Platina	Platinum	Platinum	Platina
79	Au	Zoloto	Aurum	Gold	Altyn
80	Hg	Rtut’	Hydrargyrum	Mercury	Synap
81	Tl	Talliy	Thallium	Thallium	Talliy
82	Pb	Svinets	Plumbum	Lead	Qorğasyn
83	Bi	Vismut	Bismuthum	Bismuth	Vismut
84	Po	Poloniy	Polonium	Polonium	Poloniy
85	At	Astat	Astatium	Astatine	Astat
86	Rn	Radon	Radon	Radon	Radon
87	Fr	Frantsiy	Francium	Francium	Frantsiy
88	Ra	Radiy	Radium	Radium	Radiy
89	Ac	Aktiniy	Actinium	Actinium	Aktiniy
90	Th	Toriy	Thorium	Thorium	Toriy
91	Pa	Protaktiniy	Protactinium	Protactinium	Protaktiniy
92	U	Uran	Uranium	Uranium	Uran
93	Np	Neptuniy	Neptunium	Neptunium	Neptuniy
94	Pu	Plutoniy	Plutonium	Plutonium	Plutoniy
95	Am	Ameritsiy	Americium	Americium	Ameritsiy

96	Cm	Kyuriy	Curium	Curium	Kyuriy
97	Bk	Berkliy	Berkelium	Berkelium	Berkliy
98	Cf	Kaliforniy	Californium	Californium	Kaliforniy
99	Es	Einshteiniy	Einsteinium	Einsteinium	Einshteiniy
100	Fm	Fermiy	Fermium	Fermium	Fermiy
101	Md	Mendeleviy	Mendelevium	Mendelevium	Mendeleviy
102	No	Nobeliy	Nobelium	Nobelium	Nobeliy
103	Lr	Lourentsiy	Lowrencium	Lawrencium	Lourentsiy
104	Rf	Rezerfordiy	Rutherfordium	Rutherfordium	Rezerfordiy
105	Db	Dubniy	Dubnium	Dubnium	Dubniy
106	Sg	Siborgiy	Seaborgium	Seaborgium	Siborgiy
107	Bh	Boriy	Bohrium	Bohrium	Boriy
108	Hs	Hassiy	Hassium	Hassium	Hassiy
109	Mt	Meitneriy	Meitnerium	Meitnerium	Meitneriy
110	Ds	Darmshtadtiy	Darmstadtium	Darmstadtium	Darmshtadtiy
111	Rg	Rentgeniy	Roentgenium	Roentgenium	Rentgeniy
112	Cn	Kopernitsiy	Copernicium	Copernicium	Kopernitsiy
113	Nh	Nihoniy	Nihonium	Nihonium	Nihoniy
114	Fl	Fleroviy	Flerovium	Flerovium	Fleroviy
115	Mc	Moskoviy	Moscovium	Moscovium	Moskoviy
116	Lv	Livermoriy	Livermorium	Livermorium	Livermoriy
117	Ts	Tennesin	Tennessine	Tennessine	Tennesin
118	Og	Oganesson	Oganesson	Oganesson	Oganeson

*translation of the Kazakh language from Cyrillic to Latin was carried out using the site www.qazlat.kz in accordance with the Decree of the President of the Republic of Kazakhstan No. 569 dated October 26, 2017 (as amended on February 19, 2018) and the new version presented at the meeting of the National Commission for the Translation of the Kazakh alphabet into the Latin script dated January 28, 2021.

In most cases, the names of chemical elements in the Kazakh language completely coincide with Russian. However, in a number of examples (Fe, Ag, Sn, Au, Hg, Pb, As, etc.), the names of chemical elements are significantly differ in all four languages. Therefore, studying the names of chemical elements is usually not a problem.

The situation is more complicated with the names of complex substances. In addition to the nomenclature names, they can have historical (trivial) names, which are also widely used in scientific language. The compound names can be significantly differ in all languages. It is not uncommon for trivial names to be widespread in one language but absent in another. Tables 2 and 3 represent the IUPAC and trivial names of the most important inorganic and organic acids in three fundamental languages for multilingual chemical education in Kazakhstan. The most difficult to remember are the names of organic acids, which have nomenclatures and common names in all languages (Table 3).

Table 2

Names of the most important inorganic acids in three languages fundamental for multilingual chemical education in Kazakhstan (trivial names are given in parenthesis).

Chemical formula	Russian name	English name	Kazakh name
HF	Ftoristovodorodnaya (plavikovaya) kislota	Hydrofluoric acid	Ftorsutek (balqytqyş) qyşqyly
HCl	Khloristovodorodnaya (solyanaya) kislota	Hydrochloric (muriatic) acid	Khlorsutek (tūz) qyşqyly
HBr	Bromistovodorodnaya kislota	Hydrobromic acid	Bromsutek qyşqyly
HI	Yodistovodorodnaya kislota	Hydroiodic acid	İodsutek qyşqyly
H_2CO_3	Ugol′naya kislota	Carbonic acid	Kömır qyşqyly
H_2SiO_3	Kremniyevaya kislota	Metasilicic acid	Kremni qyşqyly
HNO_2	Azotistaya kislota	Nitrous acid	Azotty qyşqyl
HNO_3	Azotnaya kislota	Nitric acid	Azot qyşqyly
HPO_3	Metafosfornaya kislota	Metaphosphoric acid	Metafosfor qyşqyly
H_3PO_3	Fosforistaya kislota	Phosphorous acid	Fosforly qyşqyl

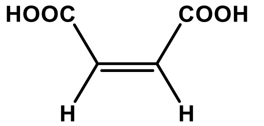
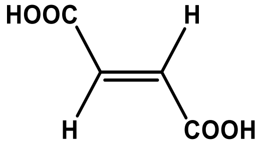
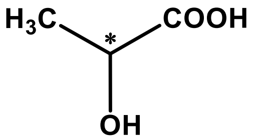
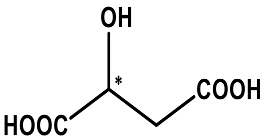
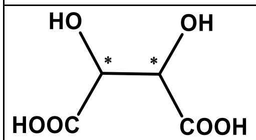
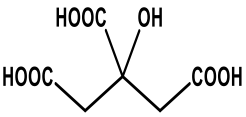
H_3PO_2	Fosfornovatistaya kislota	Hypophosphorous acid	Fosforlylau qyşqyl
H_3PO_4	Ortofosfornaya kislota	Orthophosphoric acid	Ortofosfor qyşqyly
$H_4P_2O_7$	Pirofosfornaya kislota	Pyrophosphoric acid	Pirofosfor qyşqyly
$HClO$	Khlornovatistaya kislota	Hypochlorous acid	Khlorlylau qyşqyl
$HClO_2$	Khloristaya kislota	Chlorous acid	Khlorly qyşqyl
$HClO_3$	Khlornovataya kislota	Chloric acid	Khlorlau qyşqyl
$HClO_4$	Khlornaya kislota	Perchloric acid	Khlor qyşqyl
$HBrO$	Bromnovatistaya kislota	Hypobromous acid	Bromlylau qyşqyl
$HBrO_2$	Bromistaya kislota	Bromous acid	Bromly qyşqyl
$HBrO_3$	Bromnovataya kislota	Bromic acid	Bromlau qyşqyl
$HBrO_4$	Bromnaya kislota	Perbromic acid	Brom qyşqyly
HJO	Yodnovatistaya kislota	Hypoiodous acid	İodtylau qyşqyl
HJO_2	Yodistaya kislota	Iodous acid	İodty qyşqyly
HJO_3	Yodnovataya kislota	Iodic acid	İodtau qyşqyl
HJO_4	Yodnaya kislota	Periodic acid	İod qyşqyly
HCN	Tsianistovodorodnaya (sinil′naya) kislota	Hydrocyanic acid	Tsiansutek (kögertkış) qyşqyly
$HSCN$	Tiotsianistovodorodnaya (rodanistovodorodnaya) kislota	Thiocyanic acid	Tiotsiansutek (rodanid-sutektı) qyşqyl
$HMnO_4$	Margantsovaya kislota	Permanganic acid	Marganets qyşqyly
H_2MnO_4	Margantsovistaya kislota	Manganic acid	Marganetsti qyşqyl
H_2CrO_4	Khromovaya kislota	Chromic acid	Khrom qyşqyly
$H_2Cr_2O_7$	Dvukhromovaya kislota	Dichromic acid	Dikhrom qyşqyly
H_2MoO_4	Molibdenovaya kislota	Molybdic acid	Molibden qyşqyly
H_2S	Sernistovodorodnaya kislota	Hydrosulfuric acid	Kükirtsutek qyşqyly
H_2SO_3	Sernistaya kislota	Sulfurious acid	Kükirtti qyşqyl
H_2SO_4	Sernaya kislota	Sulfuric acid	Kükirt qyşqyly
H_2Se	Selenistovodorodnaya kislota	Hydroselenic acid	Selendisutek qyşqyly
H_2SeO_3	Selenistaya kislota	Selenous acid	Selendi qyşqyl
H_2SeO_4	Selenovaya kislota	Selenic acid	Selen qyşqyly
H_2Te	Telluristovodorodnaya kislota	Hydrotelluric acid	Tellursutek qyşqyly
H_2TeO_3	Telluristaya kislota	Tellurous acid	Tellurli qyşqyl
H_2TeO_4	Tellurovaya kislota	Telluric acid	Tellur qyşqyly
HBO_2	Metabornaya kislota	Metaboric acid	Metabor qyşqyly
H_3BO_3	Ortobornaya kislota	Orthoboric acid	Bor qyşqyly
$H_2B_4O_7$	Tetrabornaya kislota	Tetraboric acid	Tetrabor qyşqyly
H_3AsO_3	Mysh′yakovistaya kislota	Arsenous acid	Küşändi qyşqyl
H_3AsO_4	Mysh′yakovaya kislota	Arsenic acid	Küşän qyşqyly

Table 3

IUPAC and common (trivial) names of the most important organic acids in three languages fundamental for multilingual chemical education in Kazakhstan (trivial names are given in parenthesis).

Chemical formula	Russian name	English name	Kazakh name
MONOCARBOXYLIC ACIDS (R-COOH)			
R = H	Metanovaya (murav′inaya) kislota	Methanoic (formic) acid	Metan (qūmyrsqa) qyşqyly
R = CH_3	Etanovaya (uksusnaya) kislota	Ethanoic (acetic) acid	Etan (sirke) qyşqyly
R = C_2H_5	Propanovaya (propionivaya) kislota	Propanoic (propionic) acid	Propan (propion) qyşqyly
R = n-C_3H_7	Butanovaya (maslyanaya) kislota	Butanoic (butyric) acid	Butan (mai) qyşqyly
R = n-C_4H_9	Pentanovaya (valerianovaya) kislota	Pentanoic (valeric) acid	Pentan (valerian) qyşqyly
R = n-C_5H_{11}	Geksanovaya (kapronovaya) kislota	Hexanoic (caproic) acid	Geksan (kapron) qyşqyly
R = n-C_6H_{13}	Geptanovaya (enantovaya) kislota	Heptanoic (enetic) acid	Geptan (enant) qyşqyly
R = n-C_7H_{15}	Oktanovaya (kaprilovaya) kislota	Octanoic (caprillic) acid	Oktan (kapril) qyşqyly

R = n-C_8H_{17}	Nonanovaya (pelargonovaya) kislota	Nonanoic (pelargonic) acid	Nonan (pelargon) qyşqyly
R = n-C_9H_{19}	Dekanovaya (kaprinovaya) kislota	Decanoic (capric) acid	Dekan (kaprin) qyşqyly
R = n-$C_{11}H_{23}$	Dodekanovaya (laurinovaya) kislota	Dodecanoic (lauric) acid	Dodekan (laurin) qyşqyly
R = n-$C_{13}H_{27}$	Tetradekanovaya (miristinovaya) kislota	Tetradecanoic (myristic) acid	Tetradekan (miristin) qyşqyly
R = n-$C_{15}H_{31}$	Geksadekanovaya (pal'mitinovaya) kislota	Hexadecanoic (palmitic) acid	Geksadekan (palmitin) qyşqyly
R = n-$C_{16}H_{33}$	Geptadekanovaya (margarinovaya) kislota	Heptadecanoic (margaric) acid	Geptadekan (margarin) qyşqyly
R = n-$C_{17}H_{35}$	Oktadekanovaya (stearinovaya) kislota	Octadecanoic (stearic) acid	Oktadekan (stearin) qyşqyly
R = n-$C_{19}H_{39}$	Eykozanovaya (arakhinovaya) kislota	Icosanoic (arachidic) acid	Eikozan (arakhin) qyşqyly
DICARBOXYLIC ACIDS (HOOC-$(CH_2)_n$-COOH)			
n = 0	Etandiovaya (shchavelevaya) kislota	Ethanedioic (oxalic) acid	Etandi (qymyzdyq) qyşqyly
n = 1	Propandiovaya (malonovaya) kislota	Propanedioic (malonic) acid	Propandi (malon) qyşqyly
n = 2	Butandiovaya (yantarnaya) kislota	Butanedioic (succinic) acid	Butandi (yantar) qyşqyly
n = 3	Pentandiovaya (glutarovaya) kislota	Pentanedioic (glutaric) acid	Pentandi (glutar) qyşqyly
n = 4	Geksandiovaya (adipinovaya) kislota	Hexanedioic (adipic) acid	Geksandi (adipin) qyşqyly
n = 5	Geptandiovaya (pimelinovaya) kislota	Heptanedioic (pimelic) acid	Geptandi (pimelin) qyşqyly
n = 6	Octandiovaya (suberinovaya, probkovaya) kislota	Octanedioic (suberic) acid	Oktandi (tyğyn) qyşqyly
n = 7	Nonandiovaya (azelainovaya) kislota	Nonanedioic (azelaic) acid	Nonandi (azelain) qyşqyly
n = 8	Decandiovaya (sebatsinovaya) kislota	Decanedioic (sebacic) acid	Dekandi (sebatsin) qyşqyly
AROMATIC ACIDS			
C_6H_5COOH	Fenilkarbonovaya (benzoinaya) kislota	Phenylcarboxylic (benzo-ic) acid	Fenilkarbon (benzoi) qyşqyly
o-$C_6H_4(COOH)_2$	Benzol-1,2-dikarbonovaya (ortoftalevaya) kislota	benzene-1,2-dicarboxylic (orthophthalic) acid	Benzol-1,2-dikarbon (ortof-tali) qyşqyly
m-$C_6H_4(COOH)_2$	Benzol-1,3-dikarbonovaya (isoftalevaya) kislota	benzene-1,3-dicarboxylic (isophthalic) acid	Benzol-1,3-dikarbon (izoftal) qyşqyly
p-$C_6H_4(COOH)_2$	Benzol-1,4-dikarbonovaya (tereftalevaya) kislota	benzene-1,4-dicarboxylic (terephthalic) acid	Benzol-1,4-dikarbon (tereftal) qyşqyly
o-$C_6H_4(OH)COOH$	2-gidroksibenzoynaya (salitsilovaya) kislota	2-hydroxybenzoic (sali-cylic) acid	2-gidroksibenzoi (salitsil) qyşqyly
UNSATURATED CARBOXYLIC ACIDS			
CH_2 = CH - COOH	Etenkarbonovaya (propenovaya, akrilovaya) kislota	Ethylenecarboxylic (acryl-ic, propenoic, vinylformic) acid	Etenkarbon (propen, akril) qyşqyly
CH_3 - CH = CH - COOH	2-butenovaya (krotonovaya) kislota	but-2-enoic (crotonic) acid	2-buten (kroton) qyşqyly
HC ≡ C - COOH	Atsetilenkarbonovaya (propino-vaya, propiolovaya, propar-gilovaya) kislota	Acetylenecarboxylic (pro-piolic, propargyl) acid	Atsetilenkarbon (propin, pro-piol, propargil) qyşqyly
CH_3 - C ≡ C - COOH	2-butinovaya (propinkarbonovaya, tetrolovaya) kislota	but-2-ynoic (tetrolic) acid	2-butin (propinkarbon, tetrol) qyşqyly
C_6H_5 - CH = CH - COOH	3-fenilpropenovaya (fenil-akrilovaya, korichnaya) kislota	3-Phenylprop-2-enoic (phenylacrylic, cinnamic) acid	3-fenilpropen (fenilakril, darşyn) qyşqyly

CH_3 - $(CH_2)_7$ - CH = CH - $(CH_2)_7$ -COOH	9-oktadetsenovaya (oleinovaya) kislota	Octadec-9-enoic (oleic) acid	9- oktadesen (olein) qyşqyly
CH_3 - $(CH_2)_4$ – (CH = CH - $CH_2)_2$ -$(CH_2)_6$ – COOH	9,12-oktadekadienovaya (linolevaya) kislota	9,12-Octadecadienoic (linoleic) acid	9,12- oktadekadien (linol) qyşqyly
CH_3 - CH_2 – (CH = CH - $CH_2)_4$ -$(CH_2)_6$ – COOH	9,12,15-oktadekatrienovaya (linolenovaya) kislota	9,12,15-Octadecatrienoic (linolenic) acid	9,12,15- oktadekatrien (linolen) qyşqyly
	(Z)-Butendiovaya (maleinovaya) kislota	(Z)-Butenedioic (maleic) acid	(Z) - Butendi (malein) qyşqyly
	(E)-Butendiovaya (fumarovaya) kislota	(E)-Butenedioic (fumaric) acid	(E) - Butendi (fumar) qyşqyly
CARBOXYLIC OXOACIDS			
	2-gidroksipropanovaya (molochnaya) kislota	2-hydroxypropanoic (lactic) acid	2-gidroksipropan (süt) qyşqyly
	2-gidroksiyantarnaya (yablochnaya) kislota	2-hydroxysuccinic (malic) acid	2-gidroksiyantar (alma) qyşqyly
	2,3-digidroksiyantarnaya (vinnaya) kislota	2,3-dihydroxysuccinic (tartaric) acid	2,3- digidroksiantär (şarap) qyşqyly
	2-gidroksipropan-1,2,3-trikarbonovaya (limonnaya) kislota	2-hydroxypropane-1,2,3-tricarboxylic (citric) acid	2- gidroksipropan-1,2,3-trikarbon (limon) qyşqyly

It was found that students have difficulty in understanding the scientific language of chemistry and abstract concepts described in English [16]. Therefore, new terms should be used only in exact context. Students need to pay more attention to them. This is also due to the fact that in many languages the same word can have several meanings and be used in completely different contexts (ex. "tin" – 1) chemical element Sn, 2) metallic jar for canned food). Other examples of polysemantic words are "iron", "solution" etc. Moreover, teachers should be extremely careful when students studying the names of substances in other languages, and under no circumstances should they try to translate the trivial names literally from their native language into a foreign language! This leads to serious errors! For example, translation of the names of fruit acids from Russian into English. There are no "milk acid", "apple acid", "wine acid" or "lemon acid" in English nomenclature. There are only "lactic acid", "malic acid", "tartaric acid" and "citric acid" respectively. In contrast, the trivial names of above acids in Kazakh language are a direct translation from Russian ("süt" – milk, "alma" – apple, "şarap" – wine etc.).

The knowledge acquired in the course of study of the professionally oriented English language course is necessary in order to be able to teach special subjects in English at secondary schools. To achieve this goal a teacher can use all known methods, methodical techniques, means and forms of organization of educational activities. The choice of methods depends on the goals and objectives of a particular lesson, the content of the studied chemical material and the level of language education of students. When creating teaching material for multilingual groups, the focus should not be on the amount of information. Instead of a large number of disparate facts, it is better to offer some of the most important concepts. The Table 4 lists the most common methodological techniques that successfully used in chemistry studies in a multilingual environment.

Table 4

Basic methodological techniques useful in chemistry studies in multilingual education.

Method	Explanation
Context replacement.	Transition from the name of a chemical element, substance, term or equipment in one language to its name in another language according to the context.
Visual support	Presentations, diagrams, pictures, schemes involves writing a foreign name on natural objects or their images during work. It makes possible to adhere to the close connection of the chemical language with real chemical objects. Visual support can be used at all stages of the implementation of any method or form of educational work. Tasks with visual support can be as follows: - explain the process shown in the diagram (for example, liquid distillation, ammonia production, etc.), - give names to substances or apparatus shown in the scheme, - illustrate the scheme with equations of chemical reactions and give names to all substances
Consecutive translation	Method involves the translation of individual sentences or semantic parts of a sentence immediately after the speaker. At the initial stage, the teacher acts as an interpreter, later, students themselves can be gradually involved in this. Consecutive translation is carried out both from a foreign language into a native language, and vice versa. For example: teacher can offer students to formulate a chemical law in English based on a known formulation in native language.
Dialogue	It is a general method that allows you to simultaneously develop most of the necessary skills: listening, speaking, etc. The general procedure for applying the dialogue at the initial stage will be as follows: - teacher asks the students a question in English, - students translate the question into their native language, - students formulate the answer to the question in native language, - students translate answer into English. With the advent of experience, stages 2 and 3 will gradually be abolished by themselves, and dialogues, conversations, discussions will be only in English.
Dictation	It is the main way to develop writing skills by writing down the words, phrases, definitions, descriptions of the properties of a substance, what the teacher said. At the same time, the teacher can write new words or words that are difficult to write correctly on the board.

All methods can be used within one lesson or combined and applied alternately, depending on the content, goals and objectives of a particular lesson, the number of students and their language skills.

Experimental

The experiment has included a survey of secondary school teachers, as well as testing of students to determine their general level of knowledge and understanding of chemical terminology in three languages.

Results and Discussions

To determine the most effective method of teaching chemistry in English, a survey was conducted among teachers of Uralsk city schools with Kazakh and Russian languages of education. The number of respondents was 42 from Russian-language schools and 60 from Kazakh-language schools. The question was "Arrange the given methods of teaching chemistry in English in order of increasing of their effectiveness (1 – the least effective, 5 – the most effective)". Figure 2 displays the survey results.

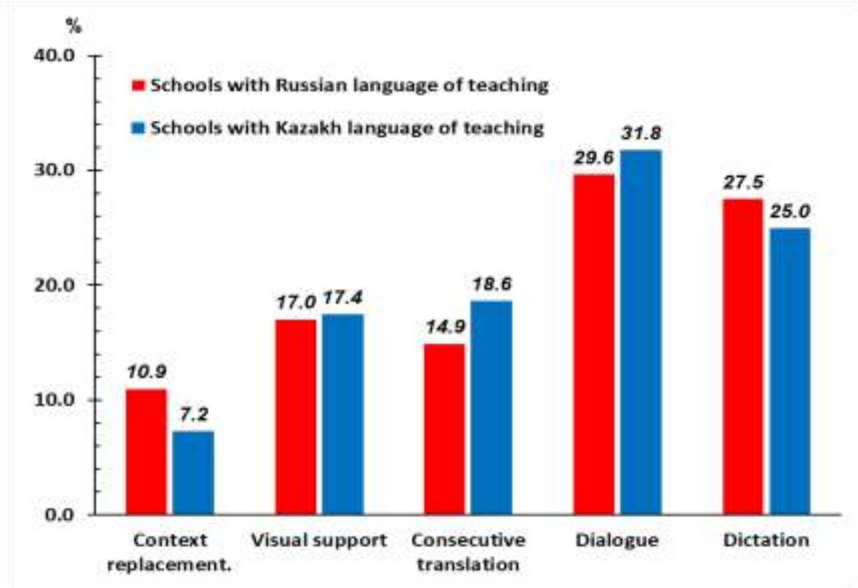


Figure 2. The results of a survey of Uralsk schools chemistry teachers on the effectiveness of the methods used in teaching chemistry in English

Survey results show that on teachers' opinion the most effective methods are dialog and dictation independently from native language of learning.

We assumed that the most objective assessment of the quality of trilingual teaching of chemistry at school could be obtained by assessing the knowledge of terminology of first-year students enrolled in the specialty "Chemistry". This is because students have different educational background and came to the University from different regions and cities. All of them had different academic performance at school and different levels of English and non-native language skills. In our opinion, this will allow us to most reliably assess how ready students are to master university educational programs in three languages.

For this purpose, we have prepared several variants of tasks including names of chemical elements, and the most important organic and inorganic acids (only those that are in school curriculum were included in tests). For a more objective assessment, both nomenclatural and trivial names of compounds were included in the test. Respondents were required to fill in the blanks and indicate their native language and language of learning. In addition, for the most objective assessment, students were not warned about testing in advance. The survey involved 84 first-year students of chemical specialties of M. Utemisov West Kazakhstan University. The testing results are shown in Figure 2.

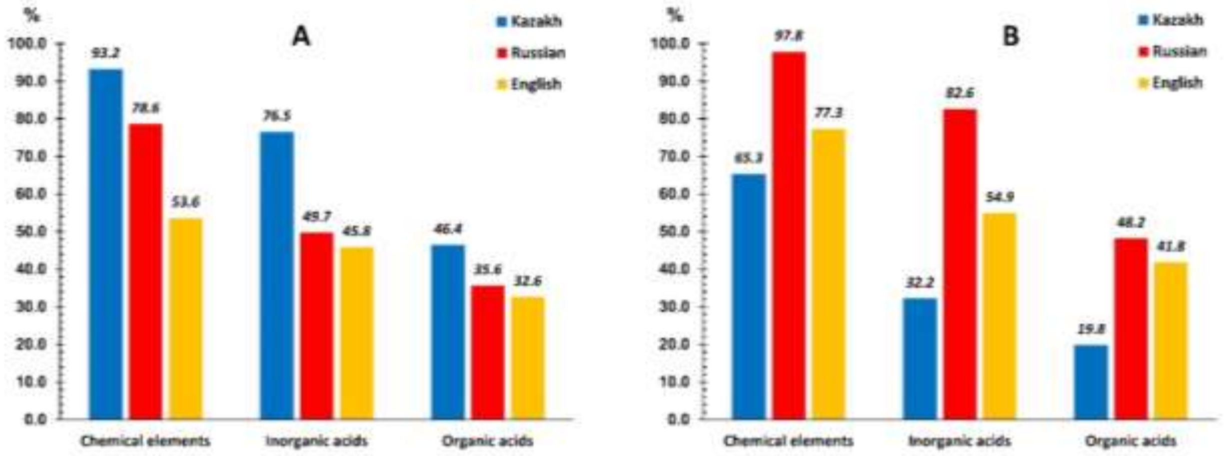


Figure 2. The results of a survey among 1st year students to assume the level of chemical terminology knowledge in three languages in Kazakh (A) and Russian (B) language of learning

As can be seen, the knowledge of the fundamental terminology in three languages is at a sufficient level. The highest results of terminology knowledge, students demonstrate in their native languages. The general level of knowledge of the students in basic chemical terminology is estimated at 57.4%. Students with Kazakh language as native demonstrate 56.9%, and Russian-speaking students demonstrate 57.8% of basic chemical terminology knowledge. The individual results vary over a wide range from 15.3 to 98.1%. It is noteworthy that students learning in Russian know the Kazakh names of chemical elements quite well (65.3%). At the same time, Kazakh-speaking students know Russian chemical elements names better (93.2%). This is so because people from the Kazakh ethnic group are mostly bilingual. Learning a scientific terminology in the Kazakh language is more difficult for Russian speakers. On the other hand, Russian-speaking students demonstrate a better knowledge of terminology in English. As discussed above, this is most likely due to significant similarity between the Russian and English terminology because of their belonging to close language groups.

Inside the types of chemical compounds, level of students' knowledge of chemical terminology decreases in order of chemical elements > inorganic acids > organic acids both for Russian and Kazakh-speaking students. Firstly, this is due to the corresponding complication of terminology and the appearance of trivial names. Nevertheless, in spite of the fact that the names of some organic acids are not included in the regular school curriculum, we have included these terms in testing because they are encountered in the problems of chemical olympiads, and many of the students took part in them. In addition, many gymnasiums and lyceums hold extra-curricular chemistry classes, including in English, where additional terminology is studied. Among the 1st year students there are those who finished such schools.

For comparison, we tested students of two schools, general secondary school and gymnasium. In a typical secondary school, chemistry is studied only in accordance with the common school curriculum. In gymnasiums, extra-curricular classes in chemistry are additionally can be held. We randomly chose a typical school and a gymnasium with extra-curricular chemistry classes and conducted a test among 8th grade students. Obtained results show that knowledge of the names of chemical elements in three languages are better in gymnasium than in typical school (84% against 72% respectively). In case of inorganic acid names, results are 78% for gymnasium and 66% for regular school.

The language of science is rather rich in specific terminology and discourse structures. This makes learning science challenging for students from different language groups. Nevertheless, the language must not be an obstacle to learning science. In order to be versatile and easy to learn, the course should be prepared as for students with English skills at the elementary level. This is done to make it easier to study a subject in English, since students who come to the university to study have different levels of English proficiency. Despite this, even those who speak the language at a reasonable level (e.g. intermediate) do not often have specific terminology. To improve the results of learning the scientific terms by all groups of students, the scientifically based framework Universal Design for Learning (UDL) can be also successfully used for creating materials for multilingual groups [17]. UDL strategy is one of the modern educational system development trend includes principle of multiculturalism among others. Because of one group of students may have different needs, educational background, attention spans and interests, different language abilities and cultural backgrounds, there is a need of universal learning mechanism giving equal access to education for all students at all levels. This is an inclusive teaching methodology promoted as a set of principles to support all students through planning the educational process by considering all potential student needs [18]. UDL approach has repeatedly demonstrated its effectiveness in teaching chemistry for students with and without learning disabilities [19]. To use the UDL strategy, special attention should be paid to teacher training. Teachers should not only be able to plan a UDL unit, but be able to successfully implement it [20]. The experience and developments of Nazarbayev Intellectual Schools (NIS) can be helpful [21].

Conclusions

Multilingual education is a step into the better future [22]. It is the most important stage on the way to multicultural education, which is a necessary condition for existence in modern society. This involves the development and implementation of new strategies and ways of implementing them, both in the area of educational content and in teacher training. Knowledge of native, state, Russian and foreign languages expands a person's mind, promotes its full development and formation of tolerance and a comprehensive worldview. Implementing the policy of multilingualism in all levels of chemical education there is a need to stay chemical language equally accessible to all learners so that Kazakhstan universities graduates could be competitive on the local and international labor market. Therefore, all educational organizations of the Republic of Kazakhstan must ensure the appropriate level of knowledge by students of the Kazakh language as the state language, Russian and one of the foreign languages (especially English) in accordance with state educational standards of the appropriate level of education. It will enable the development of language, scientific and intercultural skills, which are currently at the heart of the education system. In addition, students will reap the benefits of a multilingual education through the opportunity to participate in multilingual modules that can help them to develop both academic and language skills important for future academic careers in the sciences.

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Қазақстандағы көптілді білім беру жүйесіндегі химия тілі. Химиялық терминологияны оқыту және меңгеру ерекшеліктері

Бүгінгі таңда интернационалдандыру және интеграция жағдайындағы әлемнің әртүрлі елдерінің білім беру жүйелерінде инновациялық процестер қарқынды жүргізіліп жатыр. Олар қазіргі заманның әлеуметтік дамуының негізгі бағыттаушысы болып саналады. Бұл өзгерістер білім саласына айтарлықтай әсер етеді. Соңғы онжылдықта білім берудің барлық деңгейлері үшін заманауи тәсілдер мен стандарттарына қайта бағалау жүргізілді. Алайда, жаратылыстану ғылымдары саласында көптілді білім берудегі елеулі жетістіктерге қарамастан, оқытудың сапасы, оқушылардың материалды қабылдауы және сәйкесінше, олардың алатын білімінің сапасы мен тереңдігі туралы көптеген сұрақтар туындайды. Мақалада көпмәдениеттілік принципін жүзеге асыру аясында Қазақстан Республикасындағы көптілді химия білімін игерудің ең маңызды тәсілдері қысқаша қарастырылған. Сондай-ақ химиялық тіл мен үш тілді химиялық номенклатураның жалпы принциптері мен мәселелері талқыланған. Тестілеу нәтижелері жоғары оқу орындары студенттерінің табысты оқуы үшін іргелі ғылыми терминология бойынша базалық білімдерінің жеткілікті деңгейде екенін көрсетті.

Кілт сөздер: көпмәдениеттілік, көптілділік, үштілділік, химиялық элемент, номенклатура, тривиалды атау, химиялық таңба, бейорганикалық қышқыл.

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Химический язык в системе многоязычного образования в Казахстане. Особенности преподавания и изучения химической терминологии

Сегодня в условиях интернационализации и интеграции инновационные процессы интенсивно осуществляются в образовательных системах разных стран мира. Они являются основными столпами, направляющими современное социальное развитие. Эти изменения оказывают существенное влияние на систему образования. За последние несколько десятилетий произошла переоценка современных подходов и стандартов для всех уровней образования. Тем не менее, несмотря на значительный прогресс в полиязычном образовании в области естественных наук, остается много вопросов к качеству преподавания, восприятию материала учащимися и, следовательно, к качеству и глубине знаний. В настоящей статье кратко проанализированы важнейшие подходы к полиязычному химическому образованию в Республике Казахстан. Также обсуждены общие принципы и проблемы химического языка и трехъязычной химической номенклатуры. Результаты тестирования показали, что студенты университета имеют достаточный уровень знаний фундаментальной научной терминологии для успешного обучения.

Ключевые слова: мультикультурализм, трехъязычие, химические элементы, химическая номенклатура, тривиальные названия, химическое образование, химические вещества.