ХИМИЯНЫ ОҚЫТУ ӘДІСТЕМЕСІ
МЕТОДИКА ОБУЧЕНИЯ ХИМИИ
METHODS OF TEACHING CHEMISTRY

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Presenting lecture materials in English using CLIL technologies

The article shows the integration of all four Content and Language Integrated Learning elements (content, communication, cognition, and culture) into the «Chemistry of Elements of the Periodic Table» course. Second year students of «5B011200 — Chemistry» major, Institute of Natural Sciences and Geography of Kazakh National Pedagogical University named after Abai listened to lectures of the subject in English using CLIL technology. The course of modelling a lecture using CLIL and results of the evaluation survey are presented. The survey questions were aimed at researching of students' motivation to study the course using CLIL technologies. Also, students' satisfaction with the learning process and the relevance of the course were assessed. The results of the test, which were carried out after the lecture are presented to consolidate the learned material. The results show students' enthusiasm for the learning process and enrichment of their vocabulary with chemistry terms. The article will be of interest of chemistry teachers in higher and secondary educational institutions.

*Keywords: t*eaching methods, inorganic chemistry, CLIL technology, lecture, questionnaires, test control, language skills, integration.

Introduction

The practice experience of recent decades shows that the welfare of a country is determined by the availability of competent human resources. Such resources are formed by improving the level of knowledge obtained in higher education institutions. Thus, teacher's task is to find new effective technologies, forms and methods of education, which allow to give students relevant knowledge.

In terms of multilingual education in Kazakhstan teaching basic subjects in English is an actual problem. Since English is a foreign language, there is a problem of presenting materials at an affordable level for students.

Dr. Vinke A. has identified both positive and some negative aspects of the transition to English in the training of engineering students in Dutch universities. As an example, the workload and strain of teachers and students have increased, thus quality of training of engineers as professionals has worsened. Moreover, the quality of training has become highly dependent on the level of teacher's English language skills, so students' performance has slightly decreased. Studies at Korean and Japanese universities during the first decade of the 21st century have generally confirmed these findings [1, 2]. However, considering mentioned disadvantages of teaching students in a foreign language, in terms of the current needs of the country, the demand for specialist who are fluent in English and knows professional terminology is increasing. Considering the world's pedagogical experience, CLIL shows good results in solving this problem. Twenty years ago, the European Union countries recognized CLIL as one of the effective technologies for the development of multilingualism and have successfully applied it in both school and higher education [3]. Bilingual program like CLIL were launched in the Murcia region of Spain in 2009, and since then it has established thorough the country as one

of the best teaching technologies [4,5]. Coyle, Hood, and March [6] defined CLIL as a dual educational approach in which an additional language is used to learn and teach both content and language.

CLIL combines four elements, which authors [6,7] called '4C' — content, communication, cognition, and culture. Within the course «Chemistry of elements of the periodic system» these elements are described and presented as follows (Table 1).

Table 1

CLIL elements and their description within the course

CONTENT	COGNITION	CULTURE	COMMUNICATION
Includes the basic concepts – electron configuration; – change of properties of elements according to their group; – general descriptions of groups and subgroups; – structural features of atoms of d- and f-elements	Involves thinking skills: – identification and classification of elements. – data collection for lab report	Includes the student's communication and civic position: – group work; – lab safety; – work presentation.	Includes improving the language skills of both teachers and students.

All these components are in constant communication with each other.

Considering all the advantages and disadvantages of CLIL, the decision to apply this technology in elemental chemistry teaching was based on the fact that CLIL allows students to communicate more effectively with each other using a foreign language, develop communication skills, thinking and creativity. Thus, the main tool for preparing students is a lecture, but such types of work as a laboratory workshop, independent work of students and consultations with the instructor are not excluded. In turn, with this knowledge, skills and abilities, students can use them in the study of subsequent topics, practice and self-study.

The goal of our pedagogical experiment is to activate students ' cognitive creative activity and develop their cognitive interest through CLIL training, involving students in independent practical activities. And also, to interest students in the learning process by adapting the educational material to different levels of English language proficiency, conducting questionnaires and testing.

Experiment

Pedagogical experiment was conducted in the English group of the 2nd year students of Chemistry Department, Institute of Natural Sciences and Geography of the Kazakh National Pedagogical University named after Abai. Second year students of the specialty «5B011200 — Chemistry», listened to lectures of the discipline «Chemistry of Elements of the Periodic Table» in the first semester of 2019–2020 academic year in English using CLIL technologies.

According to the educational and methodical complex of the discipline the main task of the subject includes the integration of content (C) and language (L):

1. To know and formulate all basic stoichiometric laws of chemistry. Be able to apply these laws to solving computational problems; (C)

2. To be able to record the electronic configuration of any element on the basis of its position in the periodic system; theoretically describe changes in the properties of elements in the period, as well as in rows s, p, d, f-elements (common properties and differences); (C)

3. To be able to give in English a general description of the group, subgroup, basic chemical properties of the element and its compounds based on the electronic structure of the element's atom; (L)

4. To know the chemistry of elements of the main subgroups; (C)

5. To know the structural features of atoms of d- and f-elements, physicochemical properties of simple substances and features of chemical properties of their compounds. (C)

6. To be able to write laboratory report in English using a specific vocabulary; (L)

7. To present a report on laboratory work to a group of students in English. (L)

Presentation of lecture materials. As an example of CLIL implementation, let's consider lecture No. 10 «Elements of subgroup II-B. Scandium, yttrium, thallium. Obtaining, properties, compounds». The lecture was delivered using Hard CLIL, where teaching and learning is focused mainly on the content of the subject and therefore oriented to the content [5]. Since the requirements for the content of the lecture have changed over time, in addition to the fact that the lecture should have a systematic, consistent, and accessible presentation

of the teaching material, it is necessary to visualize it; special attention was paid to the preparation of visual and schematic teaching material using MS Power Point.

Considering the fact that students' English skills vary for certain reasons, the following measures have been taken to avoid difficulties in understanding:

– a glossary of chemical terms has been compiled and integrated into the lecture (Table 2).

– the material has been adapted to different levels.

A glossary of chemical terms was integrated into the lecture in English and Russian, for better understanding of the term.

Table 2

Chemistry Terms Glossary

Leach	When a chemical substance leaches or is leached from a material, especially soil, it is removed by the action of water passing through the material.
сущ. выщелачиватель гл. выщелачивать	Перевод в раствор (обычно водный) одного или нескольких компонентов твёрдого вещества.

In the introductory part of the lecture the topic and questions were indicated (Fig. 1).

The questions of the lecture, presented in Figure 1, were discussed in the lesson, using various methods, which in our opinion contributed to better learning and memorization of the material. The main attention during the lecture was to the characteristic properties of the elements, which help to distinguish them from each other. A table of physical and chemical properties of the elements was created to visually compare their characteristics (Fig. 2).

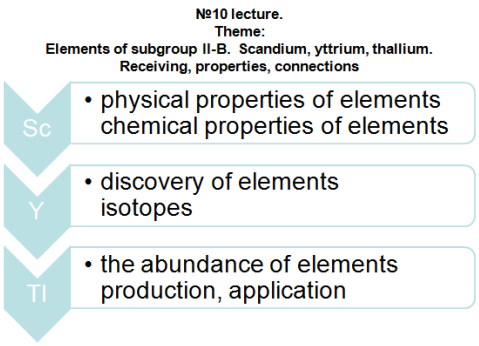


Figure 1. Introduction to the lecture

	Sc	Y	Tl
Classification:	Scandium is a transition metal and rare earth (due to similar chemical properties and existence in the same ores)	Yttrium is a transition metal & rare earth	Thallium is a post-transition
Color:	silvery-white	silvery-white	silvery-gray
Atomic weight:	44.9559	88.9059	204.383
State:	solid	solid	solid
Melting point:	1540 °C, 1813.2 K	1525 °C, 1798 K	304 °C, 577 K
Boiling point:	2830 °C, 3103 K	3340 °C, 3613 K	1473 °C, 1746 K
Electrons:	21	39	81
Protons:	21	39	81
Neutrons in most abundant isotope:	24	50	124
Electron shells:	2,8,9,2	2,8,18,9,2	2,8,18,32,18,3
Electron configuration:	[Ar] 3d1 4s2	[Kr] 4d1 5s2	[Xe] 4f14 5d10 6s2 6p1
Density 20°C:	3.0 g/cm³	4.47 g/cm³	11.85 g/cm³

Figure 2. Comparison table of physical and chemical properties of elements

Visual presentation of the lecture helps to increase the mastery of the teaching material in a foreign language, so the slides show photos of discoverers, minerals, schemes of extracting materials from ores, application, etc. (Fig. 3)

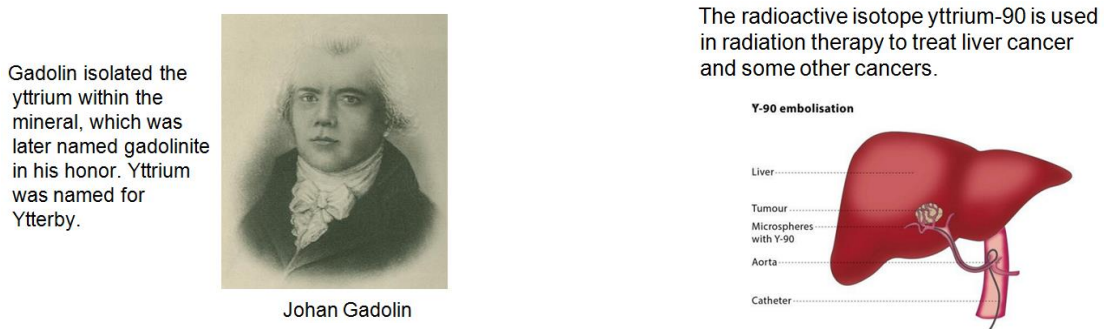


Figure 3. Examples of visual follow-up of the lecture

When developing the teaching material, the lectures used information from scientific articles, monographs, visual materials and other. Besides the description of the main physical and chemical characteristics, the lecture contained general information about the stages of production of the elements, their cost to date the (Fig. 4).

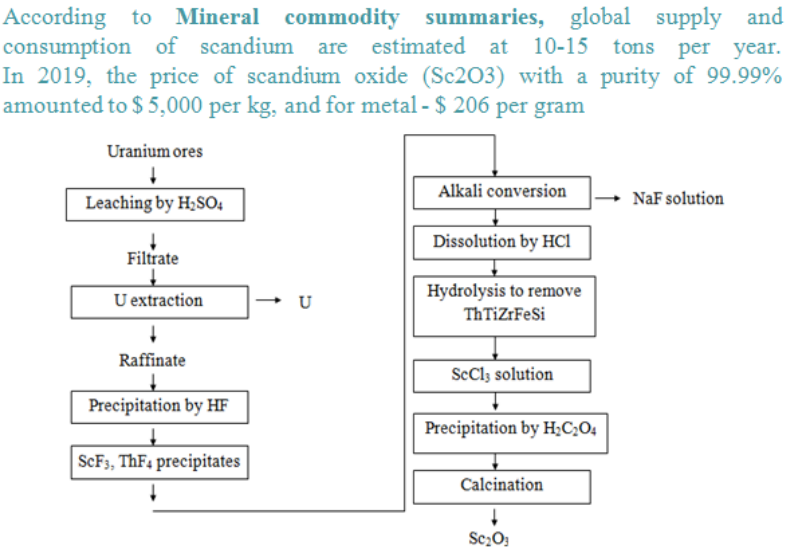


Figure 4. Scheme of scandium extraction from uranium ores

In order to consolidate the information of the slides, the students were presented with a summary slide with key data of the learned materials (Fig. 5).

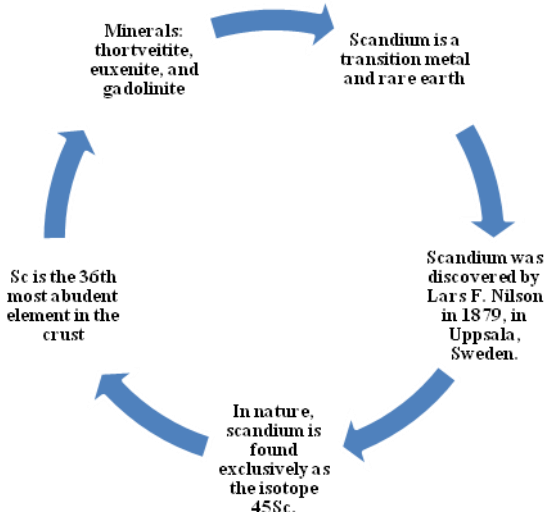


Figure 5. Review slide with key data

According to the results of the lecture, all the set tasks were achieved, and the goals of developing the skills of communicative, informational and subject competencies as well. The students have acquired knowledge of «Elements of subgroup II-B: Scandium, yttrium, thallium. Obtaining, properties, compounds», learned a lot of new terms in English, and worked in groups using play methods of learning.

Conducting a survey. A three-stage questionnaire was conducted to assess learning outcomes. The first stage was organized at the beginning of the lesson, and the topics of the questions asked were aimed at researching the motivation of students to study the course, assessing their satisfaction with the learning process and the overall assessment of the importance of the course for the professional skills development. The survey was attended by 22 students. Results of the survey are given below.

1. Do you think your English is good enough to study this course?
2. How important is a course in elemental chemistry in English to your professional activity?
3. Have you previously dealt with CLIL training technology?
4. Do you know what does CLIL and its basic principles mean?

The second stage took place in the middle of the course. Questions explored satisfaction with the learning process.

5. Are you satisfied with your teacher's English level?
6. Did you face difficulties in understanding new material?

The third phase of the survey was conducted to evaluate the course.

7. How satisfied are you with the implementation of CLIL techniques in this course?
8. Do you think your listening skills in English have improved?

Test control. After the lecture, students were offered a test control to assess the level of learning material. Since the discipline is taught in a foreign language, it is much more difficult to assess the knowledge and skills of students, it is necessary to assess the knowledge of subject terminology in English and the educational thematic material. For this reason, tests were compiled in which students were asked to summarize their answers within 15 minutes. Examples of the test assignments are given below.

Control questions

1. Describe the chemical element (3 points).
   Yttrium is_____
   Scandium is_____
   Thallium is _____

2. Match the electronic configurations of elements (3 points).

Scandium	[Kr] 4d1 5s2
Thallium	[Xe] 4f14 5d10 6s2 6p1
Yttrium	[Ar] 3d1 4s2

3. Match when and by whom the elements were discovered (3 points).

Thallium	Lars F. Nilson in 1879, Sweden
Scandium	Carl Axel Arrhenius in 1787, Sweden
Yttrium	Sir William Crookes in 1861, London.

4. Write compound name, the formula, the description and application of the studied material in the table (9 points).

№	Name of compound	Formula	Description	Application
1	Scandium fluoride	ScF_3	White powder	For the production of optical glass, catalyst, electroceramics, lasers

5. Write about the toxic properties of thallium, and about precautions when working with it (2 points)

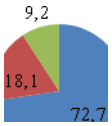
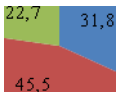
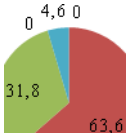
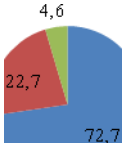
Results and discussions

By analyzing the answers shown in Table 3, it can be concluded that not all students were ready to study the teaching material in a foreign language, but most students understood the importance of studying the course of chemistry of elements in English. Students are not familiar with CLIL technology and its principles. The teacher's English level satisfied 70 % of the students. And most students had no difficulty understanding the material in English. Overall, according to the results of the survey the trends are positive.

It took 15 minutes to pass the test control. Figure 5 shows the results of the test on «Elements of subgroup II-B. Scandium, yttrium, thallium. Obtaining, properties, compounds». On average, 14 out of 20 points were scored.

Table 3

Survey results

Answers and questions	Graphical representation
1. Do you think your English is good enough to study this course? Yes — 27.2 % No — 9.2 % Not sure — 63.6 %	
2. How important do you think a course in elemental chemistry in English is to your professional activity? The knowledge gained during the course is very important for future activities — 72.7 % I think the impact of English on chemistry is slightly overrated — 18.1 % Hard to answer — 9.2 %	
3. Have you previously dealt with CLIL training technology? Yes, I have — 0 % No — 100 %	
4. Do you know what does CLIL and its basic principles mean? Yes — 0 % No — 100 %	
5. Are you satisfied with your teacher's English level? Yes, I'm satisfied — 77.2 % No, I'm not — 22.8 %	
6. Did you face difficulties in understanding new material? Yes — 31.8 % No, the materials were easy to understand — 45.5 % Not sure — 22.7 %	
7. How satisfied are you with the application of CLIL techniques during this course? Excellent — 0 % Good — 63.6 % Satisfactory — 31.8 Unsatisfactory — 0 % Very bad — 4.6 %	
8. Do you think your listening skills in English have improved? Yes — 72.7 % I don't see much change — 22.7 No — 4.6 %	

Conclusions

According to the results of the pedagogical experiment, 63.6 % of students said that training using CLIL technology is effective. Also, 45.5 % of students understood the material in English well, and 72.7 % of students showed an improvement of their listening skills.

Therefore, it can be noted that students can show positive results in learning through integration with the language of instruction. Implementation of the subject-language teaching method helps students to form a whole view of the properties of the elements and the relationship between them. Subject-language integration

performs a number of functions in teaching and their planning helps the teacher to successfully implement all these functions, consider all types of independent work of students.

The use of CLIL technology is not a new practice. In our opinion, the use of CLIL technology allowed us to get specific data that tells us about the students' enthusiasm for the learning process, enriching their vocabulary and chemical terms.

In our opinion, the data obtained show that students are interested in the learning process and enrich their vocabulary with chemical terminology in a foreign language, which in turn sets us the task of further optimization of teaching materials using CLIL technology.

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CLIL технологиясын қолдану арқылы ағылшын тіліндегі дәріс материалын ұсыну

Мақалада «Chemistry of Elements of the Periodic Table» пәнінің шеңберінде CLIL технологиясының төрт элементінің байланысы, пән аясында мазмұн мен тілдің интегралдануы көрсетілген. CLIL қолдану арқылы дәрісті құру барысы, сондай-ақ бағалау сауалнамасының нәтижелері ұсынылған. Қойылған сұрақтардың тақырыбы студенттердің курсты оқу мотивациясын зерттеуге, оқыту үрдісімен қанағаттанушылықты бағалауға және кәсіби дағдыларды қалыптастыру үдерісі үшін курстың маңыздылығын жалпы бағалауға бағытталған. Өткен материалды бекіту үшін тыңдалған дәрістен кейін тест ұсынылған. Тест нәтижелері студенттердің оқу үрдісімен, олардың сөздік қорын химиялық терминдермен байыта білгенін көрсетті. Мақала химияны ағылшын тілінде оқытатын орта және жоғары оқу орындарының оқытушыларына пайдалы. Әлемдік тәжірибеге сүйене отырып, CLIL технологиясын дәрісте қолдану арқылы бұл мәселелерді шешуге мүмкіндік береді. Абай атындағы Қазақ ұлттық педагогикалық университетінің жаратылыстану және география институтының «5В011200 — Chemistry» мамандығының екінші курс студенттері «Chemistry of Elements of the Periodic Table» пәнін ағылшын тілінде CLIL қолдануымен дәрістер алды.

Кілт сөздер: оқыту әдістемесі, бейорганикалық химия, CLIL, дәріс, сауалнама, тестілік бақылау, тілдік дағдылық, кіріктіру.

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Представление лекционного материала на английском языке с использованием технологии CLIL

В статье показана связь четырех элементов CLIL и интегрирование содержания и языка в рамках дисциплины «Chemistry of Elements of the Periodic Table». Студенты второго курса специальности 5В011200 — «Химия» Института естествознания и географии при Казахском национальном педагогическом университете им. Абая прослушали лекции дисциплины «Chemistry of Elements of the Periodic Table» на английском языке с применением технологии CLIL. Представлен ход построения лекции с использованием CLIL, а также результаты оценочного анкетирования. Тематика задаваемых вопросов

была нацелена на исследование мотивации студентов, изучение курса, оценку удовлетворенностью процессом обучения и общую оценку значимости курса для процесса формирования профессиональных навыков. Представлены результаты теста, выполненного после прослушанной лекции, для закрепления пройденного материала. Результаты теста показали увлеченность студентов процессом обучения, обогащение их словарного запаса химическими терминами. Статья будет интересна преподавателям химии высших и средних учебных заведений, обучающим на английском языке.

Ключевые слова: методика преподавания, неорганическая химия, CLIL технология, лекция, анкетирование, тестовый контроль, языковые навыки, интегрирование.

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