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CLIL application in the chemistry laboratory

Abstract. *This article considers the integration of all four elements of CLIL into a laboratory workshop in the «Chemistry of Elements of the Periodic Table» course. The workshop was aimed at 3 aspects such as improving English skills of students (L2), developing research (observe) skills, and critical thinking. The workshop was conducted for the 2nd year students in Chemistry with English proficiency of no less than B1. Students worked in groups in the laboratory with two instructors. During the lesson, students were taught to «think» in different languages (Kazakh and L2 English), which helped to develop their cognitive processes and conceptualization. Also, several activities were performed using various tools to increase students' motivation, involvement, and self-expression.*

After the lab workshop, a survey was conducted by the authors. The questions referred to satisfaction, difficulties in completing tasks, and the benefits of integrating a second language into the learning process.

The article might be interesting and useful for school and university chemistry teachers applying CLIL in their classes.

Keywords: *teaching methods, inorganic chemistry, CLIL technology, laboratory workshop, questionnaires, integration.*

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Introduction

The Ministry of Education and Science of Kazakhstan in the framework of the project on the transition to trilingual education has developed a "Roadmap for the development of trilingual education in 2015-2020". English proficiency is necessary for communication, studying and doing business anywhere in the world, so the goal of the program is the progressive integration of trilingual education at all levels of education.

In the course of trilingual education (Kazakh, Russian, English), it is common to teach non-language subjects using CLIL technology in Kazakhstan.

The article provides the experience of implementing CLIL in laboratory practice. CLIL is a «dual educational approach in which an additional language is used to learn and teach both content and language» [1]. Various types of CLIL programs can be found from full immersion to partial immersion. We choose the full immersion lab workshop because it allows students to get into the language environment, and to move from the concrete (observation of phenomena) to the abstract (understanding of principles or theories derived from observation of phenomena). In addition, lab classes represent a unique scenario for using language in a variety of situations, such as collaborating with colleagues

Table 1. Integrating «5Cs» in laboratory practice

5C	Activity	Description
Content	1) Synthesis technique.	Here the course of synthesis and all necessary chemical compounds are prescribed. The student should study the synthesis procedure before the workshop.
	2) Lab work report sheet.	The student must complete the table with all the «Formula, Molar Mass, State of matter, Color, smell, Solubility, Air Stability, Precautions» for all chemical compounds used for synthesis. This will help the student remember the names of the compounds, their spelling in English, and their physical state.
	3) Schemes of instruments used in the synthesis	The student should illustrate a diagram of the instruments used for synthesis.
	4) Laboratory glassware and reagents	In this column, the student must list the lab utensils and reagents used
Cognition.	5) Questions for admission to work.	Cognition includes thinking skills (HOTS&LOTS). The questions aim to identify HOTS as well as LOTS. The student must answer and write down the underlying synthesis reaction equations.
	6) Write reaction equations of synthesis and calculations	
	7) List of operations during the synthesis (with indication of substances (the amount and formulas), glassware, and equipment)	The student must write out the course of the synthesis from beginning to end.
Competence	8) Do the synthesis according to point #1 and calculate the product yield	After receiving permission to perform the work from the instructor, the student must perform the synthesis and calculate the product yield. The student participates in the discussion, interpretation of results, and presentation of evidence.
Communication	9) Study of the properties of the obtained substance.	The student should investigate the substance obtained, write a reactions equation and, using the words given, compose sentences.
Community	10) Presentation the laboratory workshop	There are 20 students in the group (the group is divided into 4 for the synthesis). The student, working in a group, learns to respect the ideas and knowledge of others, to work safely in the laboratory. When defending the laboratory practice student uses all the knowledge gained, both content and language.

to assign tasks, discussing results, or agreeing on meaning, reading experimental protocol in the target language, or writing a final report, not forgetting about the importance of using scientific vocabulary in the appropriate context.

We have determined the effectiveness of using CLIL at chemistry lessons in English, showing an increase in students' enthusiasm for the learning process, enriching their vocabulary with chemical terms [2].

The laboratory room as a learning environment in CLIL was suggested by Tibaldi. E, as the CLIL approach aims to put students at the center of the process of learning a non-linguistic subject by developing cognitive and communicative skills using a second language [3].

In the study conducted by Escobar and Sanchez [4], where the main pedagogical approach was the use of exercises done by students while studying science, it was found that students significantly improved their vocabulary, fluency, and use of chemical terms within the discipline. Also, there are studies, which demonstrate that using CLIL in the field of natural sciences significantly improves the language skills of students and it is positively viewed by students and teachers [5].

Experiment

The article [6] concludes that teaching and learning with CLIL have yielded positive learning outcomes among chemistry learners with low English proficiency. The study showed that students are motivated when they use L2 as a tool for communication and when they see the goal of language learning. [7]

Lab worksheet «Obtaining a complex salt (copper tetraamine sulfate) [Cu (NH3) 4] SO4 • H2O and study of its chemical properties» is offered to second-year students who are not interested in learning a foreign language and English skills below the level B1, so we have prepared materials considering their level of proficiency.

Students in groups of five worked in the laboratory with two instructors, when one of them was the chemistry teacher, and another was a chemistry teacher with decent English skills.

In Appendix 1 the course of the workshop is presented. CLIL is the result of a combination of five elements called the «5Cs» [8]: Content, Communication, Cognition, Community, and Competence. Table 1 presents the integration of the «5Cs» into the learning process.

Communication involves teachers and students in the use and development of [8]:

Language of learning is a language in which students need to access the basic concepts and skills related to the subject topic, i.e., the necessary scientific vocabulary during class. It includes nouns, adjectives, and verbs.

Coordination complex compounds: ligand, complexing agent, central atom, donor atom, coordination bond, coordination number, the first coordination sphere, the second coordination sphere

Types of ligands: monodentate ligands (anions, molecules, cations), didentate ligands (anions, molecules), polydentate ligands.

Classification of complex compounds:

Complexes with monodentate ligands: ammonia, aqua complexes, hydroxo- complexes, acid- complexes, with mixed ligands

Complexes with bi- and polydentate ligands: chelating complexes

Lab equipment: mortar and pestle, laboratory beaker, flask, desiccator, test tube, filter paper

Lab processes: adding, evaporating, selecting, pouring, filling.

Language for learning is a language used to work in a foreign language environment that includes the following types of expressions:

Compounds have the same/different type of crystal structure; this complex compound consists of a central atom/ion (--------) - a complexing agent bound to ions / neutral molecules (--------) - ligands

Language through learning is a language that supports and enhances students' cognitive processes while acquiring new knowledge. It is based on the principle that effective learning cannot occur without the active use of language and thinking. Language through learning means effective language learning as it is used by students:

Expressing opinions: I think that, in my opinion, from my point of view, I agree with you, I disagree with you, that is a good idea, you are right, you are wrong.

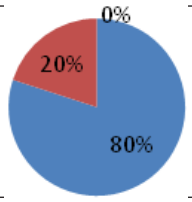
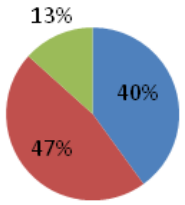
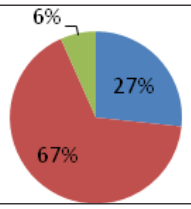
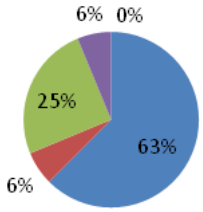
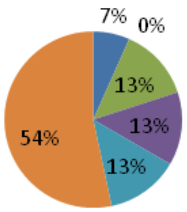
Explaining processes: first, second, then, next, after that, finally, above, below, behind, beyond, across.

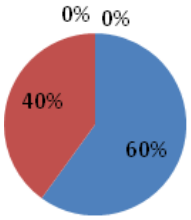
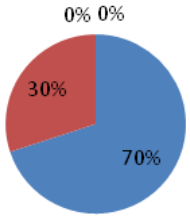
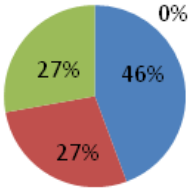
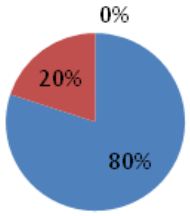
After the lab workshop, students were asked to complete a questionnaire to assess their overall satisfaction with the learning process, difficulty in completing tasks and mastering the material, etc.

Discussion and results

Teachers noticed the good activity and students' enthusiasm for the learning process and active use of chemical terms in English. It also was noticed that using the second language (L2) as a tool of communication with other students

Table 2. Survey after the workshop

How do you feel the last laboratory workshop? - Enjoyed – 80% - Do not mind – 20% - Do not enjoyed –0 %	
What was the most difficult thing in the last laboratory workshop? - Difficult vocabulary, spelling, pronunciation, grammar – 40 % - To understand the content of the lesson – 47 % - Follow the instructions – 13 %	
What was the new vocabulary like? - Easy to deduce the meaning – 27 % - Difficult to understand – 67 % - Easy to understand – 6 %	
Which strategies did you find more useful to accomplish the tasks? - Listening to the teacher's explanations – 63 % - Answering to the teacher's questions – 6 % - Repeating verbally what I had previously heard, read or written – 25 % - Trying to express orally, in my own words what I had heard, read or written – 6 %	
When you spoke in a foreign language in a subject you consider important? - the correct pronunciation of words -13 % - the ability to improvise - 0 - knowledge of vocabulary - 7% - knowledge of the contents – 7 % - grammatical correctness – 7 % - check that the others understand me when I speak – 53 %	

Did this experience helped you to improve your ability to express yourself in a foreign language? - A lot – 60 % - Enough – 40 % - A little 0 - None 0	
How do you evaluate your learning of the subject studied in the foreign language? - Very positive – 70 % - Positive – 30 % - Partially positive 0 - Negative 0	
What problems did you have? - the language of the materials is too difficult – 27 % - the teacher's questions and explanations were too difficult – 27 % - the pace of the lesson was to high – 46 %	
Did you enjoy working with «The course of the laboratory work and the study protocol» and was it helpful - yes, I liked it and it was all useful - I liked that everything was written, but I can't evaluate the usefulness - I liked neither	

and instructors made students more motivated. Table 2 shows the survey questions and the results in percentage.

Conclusion

Based on the results of the survey, we can conclude that overall students liked the learning process. It is worth noting that in most cases the vocabulary, spelling, pronunciation, grammar, and the pace of the lesson were difficult for students. Most found the instructor's explanations more helpful in completing the assignments. When speaking in a foreign language, most students were concerned about whether the other student understood their speech correctly. Most of the students were positive about the integration of language into the learning process. Teachers in some cases found it difficult to properly integrate the language into the subject matter. Teachers noted difficulties in balancing the necessity of teaching the required amount of material in the subject while integrating CLIL technology into the learning process. It was observed that this sometimes resulted in the teacher not having time to teach the exact material on the topic of the lesson in time.

Overall, both students and teachers liked the idea of a lesson with CLIL elements. It was noted that integrating language into the learning process in most cases increased the students' activity as well as improved their cognitive skills.

In the future, there are also plans to develop a full course of the discipline with integrated elements of CLIL technology. It is also planned to study the possibility of applying CLIL technology in other chemical disciplines as well as in interdisciplinary disciplines.

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Химия зертханасында CLIL тәсілін қолдану

Аңдатпа. Бұл мақалада CLIL-дің барлық төрт элементінің (мазмұны, байланысы, таным және мәдениеті) «Периодтық кесте элементтерінің химиясы»курсының зертханалық практикумына енгізілуі көрсетілген. Семинар 3 аспектіге бағытталған: студенттердің ағылшын тілін (L2) жетілдіру, зерттеу дағдыларын (байқайлау) және сыни ойлауды дамыту. Ол «5В011200 - Химия» мамандығының 2 курс студенттері үшін ағылшын тілін В1-ден төмен меңгеру деңгейімен өткізілді. Бес адамнан тұратын студенттер зертханада екі оқытушымен жұмыс істеді. Сабақ барысында оқушыларға әртүрлі тілдерде (қазақ және L2 ағылшын) «ойлау» үйретілді, бұл олардың танымдық процестері мен тұжырымдамаларын дамытуға көмектесті. Сонымен қатар, студенттердің мотивациясын, қызығушылығын және өзін-өзі көрсетуін арттыру үшін әртүрлі құралдарды қолдана отырып, бірнеше іс-шаралар өткізілді.

Зертханалық семинардан кейін сауалнама жүргізілді. Сұрақтар қанағаттану, тапсырмаларды орындаудағы қиындықтар және оқу процесіне екінші тілді енгізудің артықшылықтары туралы болды.

Бұл мақала CLIL-ді өз сабақтарында қолданатын мектеп және университет химия мұғалімдері үшін қызықты және пайдалы болуы мүмкін.

Түйін сөздер: оқыту әдістемесі, бейорганикалық химия, CLIL технологиясы, зертханалық жұмыс, сауалнама жүргізу, интеграция.

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Применение CLIL в химической лаборатории

Аннотация. В этой статье показана интеграция всех четырех элементов CLIL (содержание, коммуникация, познание и культура) в лабораторный практикум курса «Химия элементов Периодической таблицы». Семинар был направлен на 3 аспекта: улучшить навыки английского языка студентов (L2), раз-

вить исследовательские навыки (наблюдение) и критическое мышление. Он проводился для студентов 2 курса специальности «5В011200 - Химия» со степенью владения английским языком ниже В1. Студенты в группах по пять человек работали в лаборатории с двумя преподавателями. Во время урока учеников учили «думать» на разных языках (казахский и L2 английский), что помогло развить их познавательные процессы и концептуализацию. Кроме того, было выполнено несколько мероприятий с использованием различных инструментов для повышения мотивации, вовлеченности и самовыражения студентов.

После лабораторного семинара был проведен опрос. Вопросы касались удовлетворенности, трудностей с выполнением заданий и преимуществ включения второго языка в процесс обучения.

Эта статья может быть интересной и полезной для школьных и университетских учителей химии, применяющих CLIL на своих занятиях.

Ключевые слова: методика преподавания, неорганическая химия, CLIL технология, лабораторная работа, анкетирование, интеграция.

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