Analysis of Teaching Physics Through Interim Language as Preconditions for Humanitarian Training of Science Teachers for Differentiated Approach in CLIL

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The paper studies the humanitarian component of CLIL (Content and Language Integrated Learning) science training of teachers by reviewing theoretical researches and practical approaches presented in scientific reports and analyzing the results of an experiment conducted with international first-year students of Volgograd State Medical University (VolgSMU) when studying physics in English as the interim language. The research design involves seeking the humanitarian components of CLIL science teachers' training by studying scientific reports and analyzing the preparedness of international VolgSMU students in physics. Main findings include determination and the description of significant heterogeneities among the CLIL students related to their preliminary preparedness subject and language components. The research results can be applied to design the CLIL science teachers' training for (1) conducting the educational process in a non-native language with the application of a differentiated approach and relying on integrated linguistic and methodical techniques, and (2) analyzing the preliminary preparedness of students for CLIL education on the example of teaching physics in English.

Keywords: CLIL science teacher training, teaching physics, interim language, humanitarian training of science teachers, differentiated approach in CLIL

INTRODUCTION

CLIL and International Education

Export of education has actively been developing since the beginning of the second half of the 20th century. Its intensive growth in the world can be characterized by an increase of the worldwide number of international students over the past three decades by five. Teaching international students currently takes an important place in the international activities of any university and its positioning on the international educational market (Kunioshi, Noguchi, Tojo & Hayashi, 2015; Macaro, Muñoz & Lasagabaster, 2019; Volchenkova & Bryan, 2019). At the same time, CLIL (Content and Language Integrated Learning) has globally developed and, at present, has covered a considerable number of countries. Since when teaching international students the content of subjects is studied through a non-native or second language, this part of the international activity of educational institutions can be attributed to one of the types of CLIL training. Speaking about teaching international students in Russian universities using interim language, it can be mentioned that Russian medical universities are actively involved in this process. Now, many of them have experience training doctors in English for up to two decades and sometimes even more. CLIL is the most frequently used abbreviation applied for teaching through a non-native language, and in some

sense, it can be applied to both training foreign citizens in Russian universities and teaching science through an interim language to Russian schoolchildren and students. Therefore, in the current paper, the science teachers who carry out an educational process in a foreign or second language will be called CLIL science teachers, which are not regular science teachers (Kampen, Admiraal & Berry, 2018; Lo, Lin & Cheung, 2018; Macaro & Han, 2019).

CLIL Teacher in English-Medium Education

CLIL science teacher is one of the fundamental and most numerous members of the team of professionals who ensure not only the acquisition of knowledge and the development of skills within the selected competencies but also the academic component of students' adaptation to new educational and organizational content and language learning conditions basing on the material of the discipline studied through a non-native language (Couto-Cantero & Bobadilla-Pérez, 2018; Kampen et al., 2018; Cimermanova, 2017; Urmeneta & Evnitskaya, 2014; Dalton-Puffer, 2011; Bicaku, 2011). As many researchers mark (Dimova, 2021; Hu & Gao, 2020; Ramankulov et al., 2020; Fernández-Barrera, 2019; Lo et al., 2018; Volchenkova et al., 2019; Macaro, Curle, Pun, An & Dearden, 2018; Rodríguez & Saray, 2018; Cimermanova, 2017; Bier, 2016; Kunioshi et al., 2015; Airey, 2012; Dalton-Puffer, 2011), English is most often used as an interim language or *lingua franca* in Russia and abroad. As noted in scientific reports (Airey, 2012; Arnándiz & Portolés, 2019; Bier, 2016; Hudson, 2009; Lo et al., 2018; McDougald, 2015), now teaching subjects through English as a non-native language is a prestigious category in many educational institutions. In some countries, teaching subjects through a non-native language of instruction is widespread up to mandatory. The training of physics teachers in English as a non-native language of instructions in the USSR began in 1961. However, multiple changes in the national education systems during recent decades require a review of approaches to teacher training which represents one of the relevant problems of contemporary education (Macaro, Curle, Pun, An & Dearden, 2018). However, one of the priorities for the implementation and development of CLIL education is the training of CLIL teachers (Banegas, 2012; Macaro et al., 2018; Mcdougald, 2016), as the teacher is the one who determines the success of the CLIL studying a subject in another language (Bier, 2016; Lipkova, 2020; Martín del Pozo, 2017; Papaja, 2015). Despite the clear need for both the professional development of CLIL science teachers and their certification in most universities, these issues are not a priority (Macaro et al., 2018).

CLIL Science Teacher Duality

As noted earlier (Kovrizhnykh, 2020; Ramankulov et al., 2020), teaching physics in English as a second language to international and local students and training of CLIL physics teachers represent different methodical sides of the same educational phenomenon - teaching Physics using interim language. CLIL is characterized by a dual goal in which its main content component is aimed at developing the cognitive functions of students. Its complementary language component (as one of the humanitarian components) of the goal aims to develop primarily communicative skills on the material of the studied subject (Airey, 2012; Arnándiz & Portolés, 2019; Bicaku, 2011; Cabezuelo & Pavón, 2019; Cimermanova, 2017; Doiz & Lasagabaster, 2020; Hu & Gao, 2020; Kampen, Admiraal & Berry, 2018; Macaro et al., 2018; Mcdougald, 2016; Meyer, Coyle, Imhof & Connolly, 2018; Rodríguez & Saray, 2018). At the same time, it is evident that the CLIL subject teacher is the response to the current demands of global education, and in addition to science education, they must have a humanitarian background of at least basic language knowledge and skills (Bicaku, 2011; Bier, 2016; Cimermanova, 2017; Fernández-Barrera, 2019; Hu & Gao, 2020; Kampen, Admiraal & Berry, 2018; Kewara, 2017; Lo et al., 2018; Papaja, 2015; Perez, 2019; Piacentini, Simões & Vieira, 2019; Ramankulov et al., 2020; Rodríguez & Saray, 2020; Vilkancienė & Rozgienė, 2017). In the global practice, the content of the educational programs in a second language does not differ from what is provided for students studying in their mother tongue (Cimermanova, 2017; Urmeneta, 2019), even though the language conditions differ significantly, which is true for any training through a non-native language (Couto-Cantero & Bobadilla-Pérez, 2018; Kunioshi et al., 2015; Lo et al., 2018; Mahan, 2020). One crucial issue is how teaching through a foreign

language will affect students' knowledge, skills, and understanding of the subject as the knowledge of the non-native language of instruction is worse than that of native languages for both the student and the teacher. It may cause the reduction of subject competence due to either imperfect understanding (Macaro et al., 2018) or simplifying the subject's content by a teacher (Arnándiz & Portolés, 2019; Dalton-Puffer, 2011). To avoid the latter, it is necessary to develop and apply special science teaching methods (other than traditional ones). One of the approaches is the use of scaffoldings. Despite the existing opinion that CLIL science teacher does not need knowledge of applied linguistics (Airey, 2020), researches do indicate (Doiz & Lasagabaster, 2020; Kunioshi et al., 2015; Urmeneta, 2013; Volchenkova & Bryan, 2019) that the CLIL teacher should have a linguistic training within the subject taught through a second language. That is the primary but, as shown below, not the only humanitarian component of training CLIL science teachers. Despite the significance of the described process, researchers do not pay enough attention to the training of CLIL science teachers in terms of linguistic aspects of teaching a subject through a non-native language (Macaro et al., 2018).

As follows from the above, the CLIL study is one of the most relevant and actively developing trends in contemporary pedagogical science which still has uncertainties and contradictions, primarily relating to the preparedness of CLIL students for a subject in a foreign language and the training of CLIL science teachers. The development of CLIL science teachers' training is one of the essential components of CLIL study efficiency. In other words, it is the key to the success of education through a non-native language. It determines the relevance of the chosen area of research and its specified title. The paper is devoted to the humanitarian aspects of professional training of CLIL science teachers, including the aspect that is poorly represented in scientific works - the consideration of language and subject components of students' preparedness on the example of teaching international medical students physics in English as the interim language. In this regard, there arises the question about the features of the humanitarian component of professional training of CLIL science teachers, including consideration of peculiarities in preliminary subject preparedness of CLIL students in an interim language.

LITERATURE REVIEW

CLIL Science Teacher: Content Versus Language

Among all educational systems related to teaching a subject in a non-native language, it is necessary to note the following:

- ESP (English for Specific Purposes);
- LAC (Language Across the Curriculum);
- CBI (Content-Based Instruction),
- Soft-CLIL (Language driven CLIL);
- Intermediate-CLIL (partial immersion);
- Hard-CLIL (Content Driven CLIL);
- EMI (English as Medium of Instruction);
- ILCHE (Integrated Language and Content in Higher Education).

In the first group (ESP, LAC, CBI, and soft-CLIL), the teachers are foreign language experts, and in the second (hard CLIL, EMI, and ILCHE) - the teachers are subject experts (Cimermanova, 2017; Doiz & Lasagabaster, 2020; Tarasenkova, Akulenko, Kulish & Nekoz, 2020; Volchenkova & Bryan, 2019). The first and second groups have different goals (Airey, 2020). The second group is the area of interest; thus, we pay attention to the researches on the peculiarities of integrating the language and subject components of the research subject in a non-native language (Arnándiz & Portolés, 2019; Cabezuelo & Pavón, 2019; Gustafsson, 2018; Hu & Gao, 2020; Macaro et al., 2018; Urmeneta, 2013). CLIL science teachers should have a level of English language proficiency corresponding to C2 CERF qualification or, at least, qualification C1. But, in practice, B2 is allowed at the very least (Cabezuelo & Pavón, 2019; Dimova, 2021; Fernández-Barrera, 2019; Hillyard, 2011; Macaro et al., 2018; Papaja, 2015; Perez, 2019;

Tarasenkova et al., 2020; Volchenkova & Bryan, 2019). The research will not focus on the differences between CLIL and EMI and will use them as synonyms.

Many researchers (Airey, 2012; Couto-Cantero & Bobadilla-Pérez, 2018; Dalton-Puffer, 2011; Dimova, 2021; Hudson, 2009; Kampen, Admiraal & Berry, 2018; Kunioshi et al., 2015; Lipkova, 2020; Martín del Pozo, 2017; Mcdougald, 2016; Piacentini, Simões & Vieira, 2019; Ramankulov et al., 2020; Urmeneta, 2019) pay attention to the fact that CLIL science teachers are subject experts and for them, the language of instruction is usually non-native. Sometimes, according to student's opinions, the latter could be the reason for the insufficient effectiveness of teaching a subject through interim language (Arnándiz & Portolés, 2019; Choi, Tatar & Kim, 2014; Macaro et al., 2018). While training CLIL science teachers for teaching not in but through the interim language, they should become ready for creating conditions under which non-native language of instruction will be support for education but not an obstacle to study (Airey & Linder, 2006; Arnándiz & Portolés, 2019; Dalton-Puffer, 2011; Kewara, 2017; Macaro et al., 2018). The presence of foreign language education of a science teacher already implies the first humanitarian aspect of the CLIL science teacher training. At the same time, insufficient attention to language issues when teaching science through a second language is noted globally (Banegas, 2012; Fernández-Barrera, 2019; Hu & Gao, 2020; (Hufri, Hidayati, Afrizon, Deswita & Wahyuni, 2019; (Kampen, Admiraal & Berry, 2018; Koponen & Nousiainen, 2018; Lo et al., 2018; Piacentini et al, 2019; Urmeneta, 2019). L. Vilkancienė, I. Rozgienė, A. Bier, A. Doiz, and D. Lasagabaster call language-related issues the weakest part of the development of CLIL education (Bier, 2016; Doiz & Lasagabaster, 2020; Vilkancienė & Rozgienė, 2017). At the same time, the language component of CLIL science teacher training can hardly be covered by traditional categories of vocabulary and grammar. In this sense, it is not clear what language aspects are appropriate in subject teacher training (Gustafsson, 2018). Besides, when teaching science through a non-native language, even the presence of a language component is not reflected in the programs (Lo et al., 2018).

CLIL Science Teacher: Content Through Language

The second humanitarian aspect of CLIL science teacher training manifests itself in the fact that the language in such education acts as an integrating learning tool. In this sense, CLIL science lesson should not be a translation into a foreign language of a regular lesson (Kewara, 2017; Rodríguez & Saray, 2020). In other words, CLIL study does not mean initially learning the content in the mother tongue and then learning the same content in a foreign language (Cimermanova, 2017). Among the existing models of CLIL (Hillyard, 2011) for teaching international students through an interim language, the monolingual type is preferred. CLIL education involves (1) the application of the methods of teaching the science subject and (2) some elements of teaching a foreign language (including EAL and ESP) from content-compatible to content-obligatory language. The linguistic component of CLIL teacher training should consider specific instructional contexts (Gustafsson, 2018; Kewara, 2017). CLIL teachers should also be able to notice difficulties connected to students' language proficiency and be able to apply verbal and non-verbal tools to improve the comprehension of science content (Bier, 2016; Choi et al., 2014; Hillyard, 2011; Hu & Gao, 2020; Kampen, Admiraal & Berry, 2018; Macaro et al., 2018; Papaja, 2015; Robles & Espinet, 2013; Tarasenkova et al., 2020).

The third humanitarian aspect of CLIL science teacher training is due to one of the greatest difficulties for a student – learning the language of science, including support of the mathematic language (Airey, 2012; Cabezuelo & Pavón, 2019; Cimermanova, 2017; Lo et al., 2018; Piacentini et al, 2019), which represents the syntax part of the science language. Since the CLIL science teacher training is a long-term education (Kewara, 2017; Macaro et al., 2018; Mcdougald, 2016), then during the primary study of CLIL, it is necessary not only to develop an extensive teacher's vocabulary of the taught discipline but also develop the ability to explain new physics concepts in their own words, using graphical tools, relying on formulas, etc. (Airey, 2012; Hu & Gao, 2020; Kunioshi et al., 2015; Mahan, 2020; Perez, 2019; Robles & Espinet, 2013; Tarasenkova et al., 2020). The linguistic and didactic competence concept of A. I. Surygin, L. Vilkancienė, and I. Rozgienė (Vilkancienė & Rozgienė, 2017) implies not only the interaction of language and content but also the possession of existing linguistic and methodical tools and

creation of their approaches. It allows expanding the didactic potential of the language as a means of teaching and learning science in the CLIL conditions (Kampen, Admiraal & Berry, 2018; Ramankulov et al., 2020). Since the maximum effect on the students' development is achieved by working in groups with an equal level of training (Hu & Gao, 2020), the fourth humanitarian aspect of CLIL science teacher training involves students with different levels of preliminary training in both the content of the subject and the non-native language of instruction. It implies a combination of methods of teaching the subject and a foreign language (Bier, 2016; Cabezuelo & Pavón, 2019; Couto-Cantero & Bobadilla-Pérez, 2018; Dimova, 2021; Gustafsson, 2018; Hillyard, 2011; Hu & Gao, 2020; Macaro et al., 2018; Papaja, 2015; Tarasenkova et al., 2020), including methods of the flipped classroom (Capone, Del Sorbo & Fiore, 2017), and other approaches in which CLIL teacher should create or find appropriate ways of science study though second language (Ramankulov et al., 2020; Urmeneta & Evnitskaya, 2014).

CLIL Science Teacher as a Creator of Content Through Language Study

CLIL science teachers have to work with heterogeneous groups of international students due to different national education systems and various levels of preliminary subject education, which determines the fifth humanitarian aspect of CLIL science teacher training. In this regard, the CLIL science teacher should be prepared to teach the students whose language and subject knowledge level is below the average level (Gustafsson, 2018; Hu & Gao, 2020; Perez, 2019; Ramankulov et al., 2020; Urmeneta, 2013). Since learning science depends on knowledge of the language of instruction (Airey & Linder, 2006; McDougald, 2015) then while teaching the subject content through a foreign language, it is also necessary to support and balance the language of instruction between the student's and teacher's linguistic abilities as well as balance language and content in CLIL classrooms (Cabezuelo & Pavón, 2019; Choi et al., 2014; Cimermanova, 2017; Hu & Gao, 2020; Kewara, 2017; Lipkova, 2020; Lo et al., 2018; Meyer et al., 2018; Perez, 2019; Vilkancienė & Rozgienė, 2017). In CLIL education, students' content knowledge in a non-native language is usually assessed (Lo et al., 2018), and there is a problem in dividing difficulties to those with content and language cores. Indeed, evaluating achievements in a subject through a non-native language is quite a difficult task (Couto-Cantero & Bobadilla-Pérez, 2018), and it is evident that it is determined not only by the subject and training of the teacher but also by students' knowledge and skills (Hu & Gao, 2020; Papaja, 2015). On the one hand, CLIL science teachers do not expect students to be proficient in language but rather to be able to understand the written texts or oral speech and explain the phenomena or processes (Choi et al., 2014; Cimermanova, 2017). On the other hand, one of perhaps the most challenging aspects of training a contemporary CLIL teacher is the readiness to create material and tools for content learning assessment (Airey, 2012; Perez, 2019), evaluate, and compare the effectiveness of using various scaffoldings in teaching science using CLIL approach (Kampen, Admiraal & Berry, 2018; Kewara, 2017; Lo et al., 2018; Rodríguez & Saray, 2018; Urmeneta & Evnitskaya, 2014). Students with different content knowledge and language proficiency require various scaffoldings during their CLIL science classes (Mahan, 2020; Robles & Espinet, 2013). It represents the current support for the students, which in the future will help them to do it by themselves (Couto-Cantero & Bobadilla-Pérez, 2018). One of the problems is that CLIL teachers do not always provide enough opportunities for more active learning methods (Campillo-Ferrer, Miralles Martínez & Sánchez-Ibáñez, 2020; McDougald, 2015). Therefore, the linguistic peculiarities of CLIL science teacher training can be conceptualized as specific language functions arising from instructional context and determined by the content of the subject and educational activities (Gustafsson, 2018; Martín del Pozo, 2017). According to researchers (Doiz & Lasagabaster, 2020; Hu & Gao, 2020; Urmeneta, 2013), a differentiated approach should be applied to students with a different language and subject training levels. The training of CLIL science teachers is associated with the contradiction between teacher-centered and student-centered approaches and the integration and differentiation of content with the non-native language of instruction. We will pay attention to the fourth and fifth humanitarian aspects of CLIL science teacher training mentioned above.

Humanitarian Features of CLIL Science Teachers

As follows from the above, CLIL science teachers should (1) develop balancing content and language in their creative way (McDougald, 2015; Perez, 2019), (2) be able to expand the students' active subject vocabulary by combining teaching methods - from reproductive to productive exercises, from ensuring satisfactory comprehension to content through language production (Urmeneta & Evnitskaya, 2014). CLIL science teachers should be able to select educational material following the current level of students' foreign language proficiency and subject knowledge, as well as provide a sufficient number of exercises and tasks for comprehension and mastering the material (Tarasenkova et al., 2020). CLIL science teachers should be trained to use current and create new linguistic and methodical forms and subject teaching methods through interim language. The teachers should not make the students focus on the foreign language but make them use interim language to focus on the subject and comprehend the content of science from doing science through organizing science and explaining science to arguing science (Airey, 2012; Cimermanova, 2017; Kunioshi et al., 2015; Mcdougald, 2016; Meyer et al., 2018; Perez, 2019).

CLIL science teachers should also be (1) flexible to changes in professional competence requirements in a changing educational situation (Bier, 2016; Rodríguez & Saray, 2020), (2) ready for interactions not only with students but also with foreign language teachers and other subject teachers, evaluate in content-specified terminology, etc. (Airey, 2012; Bicaku, 2011; Cimermanova, 2017; Gustafsson, 2018; Mcdougald, 2016; Tarasenkova et al., 2020). In addition to the humanitarian component of the training CLIL science teachers, let us point that CLIL study is mainly based on three different types of languages:

- Dialogic (content non-specific);
- Descriptive (content semi-specific, implies identification, definition, classification, etc.);
- Argumentative (content-specific, implies proof, argumentation, examples, development, etc.) (Tarasenkova et al., 2020).

Since researchers note that one of limiting factors of students' learning is teachers' ability to mediate the knowledge of science (Airey & Linder, 2006), then CLIL science teacher has to be able to simplify, elaborate, and discuss the text with science content (Cabezuelo & Pavón, 2019; Kewara, 2017). Also, CLIL science teachers should teach the language of science through a non-native language of instruction, bearing in mind the negative effects of teaching a subject through a foreign language, including the "surface"- a study of the subject (Airey, 2012). While teaching science in a non-native language, CLIL teacher has to create conditions and develop students' cognitive processes from remembering, understanding, and applying to analyze (including deconstruction and differentiating), evaluating (including checking and critiquing), and creating (including generating, planning, producing) (Campillo-Ferrer et al., 2020). Thus, a great effort should be made to train and improve the professional skills of CLIL science teachers (Macaro et al., 2018), because not all relevant didactic conditions and procedures have been defined in sufficient detail or have not yet been elaborated and developed (Gustafsson, 2018).

MATERIALS AND METHODS

The research aims to study the humanitarian components of the CLIL science teachers' training, considering the peculiarities of the language and subject of students' preliminary preparedness. Thus, two tasks are set, namely:

- Analysis of theoretical researches and practical approaches presented in scientific papers;
- Analysis of experimental data obtained from the experiment of 2014–2019 to identify linguistic and methodical kinds of problems and clarify the requirements for training CLIL science teachers on the example of teaching physics to medical students using interim language.

In total, 758 international first-year medical students from 11 countries participated in the experiment of 2015–2019. Unfortunately, the experiment did not take place in the 2019–2020 and 2020-2021 academic years due to COVID-19 events because international medical students usually start studying

physics and pass entrance tests when the self-isolation in Russia in 2020 began. It was considered useless to conduct testing in a distant format where the student may have uncontrolled access to the Internet due to the evident inaccuracy of the data.

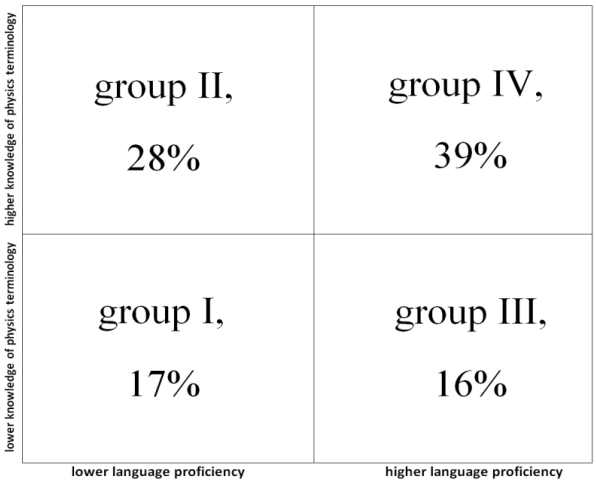
The results of research conducted with first-year international medical students are used to (1) assess the range of problems caused by the peculiarities of students' training and (2) evaluate the existing communicative differences in the physics content among students in an interim language that CLIL science teacher will face. The students have been passing entrance and final tests with four parts in each test. The entrance test was based on the content of the pre-university course of physics, the final test – on the content of a physics course at a medical university. In the first part of the test, the students had to write terms of physics concepts whose interpretations are presented in verbal form. In the second part of the test, they gave verbal descriptions of the notions of given physics concepts. In the third part, the students had to title a small text with the physics content (usually a description of the physics phenomenon). In the fourth part of the tests, it is necessary to record the words missed in the text with the physics content. This way, the preparedness of the international students for physics study and the effectiveness of the physics course in the interim language are evaluated, compared by analyzing quantitative indicators of knowledge of English physics terminology, skills of written monologue speech on the content of physics, and understanding the description and properties of physical phenomena and objects.

Such tests allow us to receive an integral assessment of both physics knowledge and language of instruction proficiency in the content of physics, where the tasks of the first and second parts of the test are aimed to check the productive knowledge and skills, and the third and fourth – receptive. The results of the third and fourth parts of the test describe receptive types of speech activity on the material of the studied discipline by the example of reading skills. They allow evaluating the understanding of the content read by students in a Physics textbook or manual for physics laboratory experiments. Students' proficiency in a non-native language of instruction is a necessary and compulsory condition for learning the content through an interim language that impacts the efficiency of study using interim language (Macaro et al., 2018). However, the results of the experiments (Kovrizhnykh, 2020) showed that knowledge of a foreign language is not a sufficient condition of effective study of a subject in a non-native language, as well as students' proficiency in interim language and their knowledge of physics terminology in the language of instruction are independent variables from each other. Students' interim language proficiency was assessed on the English entrance exam score.

RESULTS

The obtained results were divided into four groups according to the levels of physics terms knowledge in the foreign language and the results of the English entrance exam (Fig.1). Group I (17%) consisted of experimental data of students with lower levels of English proficiency and knowledge of physics terminology. Group II (28%) contains data of students with a better knowledge of physics terms and with lower levels of English proficiency. Group III (16%) contains data of students with the best results of the entrance exam in English, but lower rates of knowledge of physics terminology, and group IV (39%) contains data of representatives with the best knowledge of both English language and physics terminology. Thus, 55% of students have good knowledge of physics terminology, and 67% have good English language proficiency. But at the same time, less than half of students have good preparedness in both subject and language, and about 60% of students have a lower level in one or another component of training through an interim language. It shows insufficient training in interim language, which (Vilkancienė & Rozgienė, 2017) is a fairly common phenomenon.

FIGURE 1
THE DISTRIBUTION OF EXPERIMENTAL DATA DUE TO STUDENTS' FOREIGN LANGUAGE PROFICIENCY AND THEIR KNOWLEDGE OF PHYSICS TERMINOLOGY



It is unexpected and remarkable that in groups I and II, the English language scores, on average, do not have significant differences, as well as in groups III and IV. At the same time, groups II and IV have 1.56 times different scores for the entrance exam in English. Their knowledge of physics terminology is equal, as well as in groups I and III. Considering that the average knowledge of physics terminology in groups II and IV is 2.5 times higher than in groups I and III, I can assume that I obtained four groups in which the knowledge of physical terminology and foreign language proficiency have significant differences. It confirms the thesis about the need to differentiate the CLIL due to students' preparedness.

The quantitative expressions of students performing the entrance and final tests are analyzed below.

FIGURE 2
THE RESULTS OF THE ENTRANCE TEST BY GROUPS

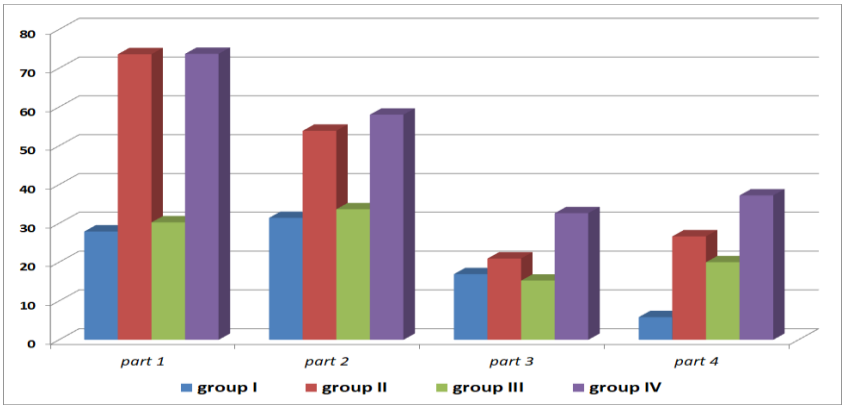


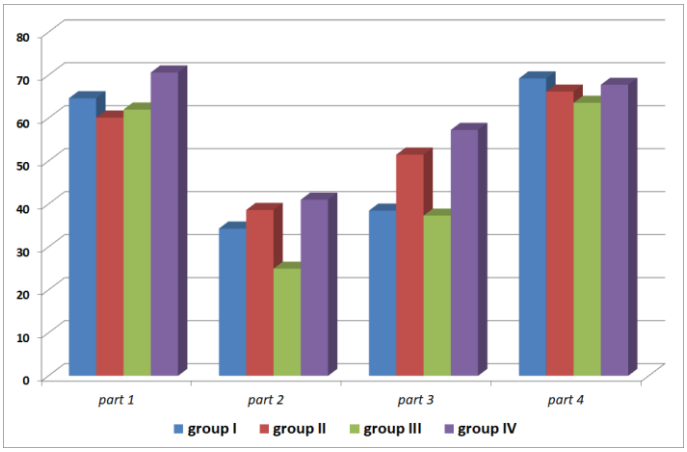
Fig. 2 shows the results of the input test. The general analysis allows identifying the presence of noticeable differences in the representatives of each group, which should be considered when training CLIL science teachers. Teachers will be most comfortable to teach representatives of group IV since they have (1) the highest indicators of proficiency in the conceptual and terminological apparatus of physics, and (2) an understanding of texts with physics content compared to other groups. When teaching representatives of group II, a teacher can rely on a good knowledge of physics concepts and terminology, but at the same time provide scaffolding when presenting new educational material due to lower

performance of third and fourth parts of the entrance test. Conceptual and especially terminological support is most needed when teaching representatives of groups I and III, which leads to noticeable variations in the presentation of new educational material concerning representatives of groups II and IV with possible differences in the depth and accuracy of the subject study. This implies that CLIL science teachers have humanitarian training in terms of teaching vocabulary, particularly scientific terminology, through various methods of word formation (prefixing and affixation, word composition, and conversion, etc.). To reduce the influence of the differences described above, using the flipped classroom method will help with the application of scaffolding exercises to develop knowledge and skills on the subject on the material of a topic in the condition of study through non-native language.

Comparing the entrance test results for representatives of groups II and III illustrates a more significant impact of physics terminology knowledge on communication skills and the physics material than the possession of a non-native language of instruction within the range acceptable for teaching international medical students. The above does not mean that there is no need to develop scaffolding exercises for group IV as it is necessary to pay attention that the average performance of tasks three and four of the entrance test in that group is below 40%, which cannot guarantee an accurate and deep understanding of the studied content in written and to a greater extent oral form. Thus, representatives of all four groups described above need help and support from the CLIL science teacher, but in different amounts and various forms. Besides, group IV may need assistance and scaffolding in a slightly different way which is associated with the fact that representatives of this group could be engaged in a more complex type of educational activity, including solving more complicated physics problems, students' educational researches, students' scientific research, etc. Evidently, the academic results of the CLIL study, in the end, can hardly be the same. However, they must be at least not less than satisfactory for the representatives of group I. Probably, representatives of other groups can expect higher results concerning group I due to better initial subject and language knowledge. However, the task of the CLIL science teacher is to provide representatives of each group with the opportunity for cognitive and language development considering their initial conditions. CLIL science teachers must have sufficient subject and language knowledge and methodical skills, as well as humanitarian training to not only select and, if necessary, create a variety of integrated linguistic and methodical scaffoldings for a student from any of the abovementioned groups considering the subject and language components of the student's training.

Let us analyze the results of the final testing of the same students without applying any differentiated approach. It is necessary to note that there was no division to the described above groups during the study; the division was made during the data analysis while preparing the current paper.

FIGURE 3
THE RESULTS OF THE FINAL TEST BY GROUPS



As seen from Fig. 3, the increase of all indicators is observed in group I. On the one hand, it illustrates the orientation of the educational process to a greater extent on "weaker" students (which in some sense could be justified). On the other hand, it is an example of insufficient linguistic and methodical training of the teachers who were not ready to teach students with different preliminary language and subject training levels. Remarkably, group IV showed a slight increase of indicators in tasks three and four of the final test compared to the entrance test, but the indicators of the performance of tasks one and two showed a different degree of reduction. Besides, representatives of group III who speak English well but have insufficient knowledge of physical terminology were found to have the lowest scores on the final test. Thus, the relative alignment of indicators in groups for different parts of the test tasks observed by the results of the final test is the result of the fact that the linguistic, organizational, and content conditions created by teachers for physics were more focused on students who are "weaker" in the language and subject, which is not the best expectable result of teaching physics in English. Thus, we have got confirmation of the existence of noticeable differences in the preliminary language and subject training of students for study in a non-native language, as well as the assumption that the reason for some negative manifestations about better-trained students was the absence of a differentiated approach to the educational process in a non-native language. The insufficiently effective teaching of physics through the interim language of international medical students with high preliminary subject training in the language of instruction obtained in the described experiment may be due to lacking language training of their teachers or incomplete competence to teach science through interim language (Macaro et al., 2018). This issue and the analysis of the dependence of efficiency of teaching science through a foreign language on the level of teachers' language proficiency will be researched in future studies.

DISCUSSION

Teaching academic subjects through a non-native language began its active development more than half a century ago. In recent decades, it received new types of approaches, including CLIL. Due to more intensive global expansion of learning through interim language, the role of CLIL science teachers became more significant and required a revision of views on the language and subject components of teachers' training. There is also the absence of linguistic components in the subject curriculum in an interim language. There are reasons to suppose that the latter is because the CLIL science teacher and the current education system are not always ready to address this issue. It proves the necessity of reflection of this aspect in the design of the CLIL science teacher training program as a humanitarian component. It is noted that the best academic results are achieved in educational groups with the same level of student preparedness, which in current conditions is not always possible and almost unbelievable about physics in medical universities due to the different levels of students' subject and language training in various academic subjects. It follows that when training CLIL science teachers in the student-centered approach, special attention should be paid to the elaboration and development of a differentiated approach to teaching science through a non-native language, including teaching students of different levels of language and subject complexity, differentiated linguistic and methodical scaffoldings due to the preparedness of CLIL students, and providing them the individual educational trajectories in studying science through interim language.

In pedagogical and methodical research, diverse views reflect various educational situations while there is no unified approach and structure of training CLIL science teachers (including its humanitarian component). The linguistic and methodical approach can become a unified integrating system for (1) describing various issues and problems of educational nature in a non-native language, (2) presenting the content of an additional component in the CLIL study, and (3) structuring the design of CLIL science teachers' training.

From the presented experiment, it is clear that in case of such distribution of students by levels of their subject knowledge and language proficiency, there may be quite a large number of combinations, wherein the methodically best situation among the 11 educational groups four will contain the representatives of a high level of interim language proficiency and basic subject knowledge, in other three

educational groups - students with good basic subject knowledge but relatively weak interim language proficiency. There will be students with a comparatively low level of basic subject knowledge in the four remaining groups, while two of them also have a relatively low level of language proficiency. Thus, when studying one scientific discipline, the teacher conducting classes with various groups will need to apply different linguistic and methodical teaching methods in different groups, and CLIL science teachers should be trained.

As another example, the worst-case represents a situation with one group of eleven students, four of which will be good both in language proficiency and subject knowledge, two students - with a comparatively low level of subject knowledge and language proficiency, two students - with insufficient subject knowledge but with good language proficiency, and last three students - with good subject knowledge but relatively low language proficiency. In this case, the CLIL science teachers combine different teaching methods through interim language in every lesson. The described cases represent subjects of two separate scientific studies.

CONCLUSION

Experimental data indicate that the subject component of students' training in a subject in a non-native language is more significant than its language component; therefore, the main emphasis should be placed on the development of the student's terminological and conceptual apparatus as scaffolding for further content study through interim language. Due to the assumption that language of science, especially with its symbolic, graphical, schematic, and other components, can be leading support in teaching scientific disciplines through a non-native language, then it is possible to conclude that the didactic potential of the science language is a noticeable gap in methodical researches, which becomes especially evident in CLIL education.

Speaking about the difficulties that await future CLIL science teachers, we can refer to the practical problems that arise from teaching physics through interim language to international medical students. Some of these problems may be related to the fact that representatives of different countries and, consequently, different systems and programs of high-school and pre-university education are often present in the same educational group. The latter confirms the need to include country-specific information in the content of future CLIL science teachers' training, covering the main features of educational systems in different countries and other important information. For future CLIL science teachers, such information can also be classified as humanitarian and may involve various teaching methods.

The research novelty is substantiating the necessity to rely on integrated linguistic and methodical techniques in training the future CLIL science teacher for the elaboration and development of a differentiated approach to teaching science through a non-native language which takes into account both the content and language components of students' preparedness for CLIL education.

The main finding of this research is the detection and the description of significantly heterogeneities among the CLIL students related to the subject and language components of the preliminary students' preparedness which should be reflected in the CLIL science teachers training and later in the organization of the differentiated approach of the educational process in a non-native language based on linguistic and methodical techniques.

The research results can be applied for training the CLIL science teachers for conducting the educational process in a non-native language with the application of differentiated approach and relying on linguistic and methodical techniques, and also for analyzing the composition of students in their preliminary preparation for CLIL education on the example of teaching physics in English.

ACKNOWLEDGMENT

The author expresses his deep gratitude to D. N. Yemelyanov, Dean for International Students of Volgograd State Medical University, for the help and support in organizing and performing the experiment.

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