Asesorías y Tutorías para la Investigación Científica en la Educación Puig-Salabarría S.C.
José María Pino Suárez 400-2 esq a Lerdo de Tejada. Toluca, Estado de México. 7223893475
RFC: ATI120618V12

Revista Dilemas Contemporáneos: Educación, Política y Valores.
http://www.dilemascontemporaneoseducacionpoliticayvalores.com/
Año: VII Número: Edición Especial Artículo no.:68 Período: Noviembre, 2019.

TÍTULO: La formación del conocimiento de lenguas extranjeras de los estudiantes-ingenieros mediante el método AICLE.

AUTORES:

1. Ed. Dr. K.V. Vlasenko.
2. Ed. Dr. I.V. Lovyanova.
3. Cand. Ph.D. O.O. Chumak.
4. Cand Ph.D. I.V. Sitak.
5. T.S. Kalashnykova.

RESUMEN: El artículo busca formas de desarrollar el conocimiento intercultural de los estudiantes de ingeniería, formando su competencia en idiomas extranjeros. La investigación mostró la influencia del aprendizaje integrado de contenido y lenguaje (AICL), contribuyendo a la integración social activa de los estudiantes y mejorando su motivación para dominar el inglés. El estudio determinó el principio del enfoque AICL, su modelo y postulados. Este documento también describe la introducción del curso electivo "Matemática elemental en inglés" para estudiantes de ingeniería, eligiendo el método modelo C3 AICL. Los resultados confirman la dinámica positiva de formar la competencia en idiomas extranjeros de los estudiantes de ingeniería, así como mejorar su motivación para estudiar a través del desarrollo y la implementación del curso electivo integrado mencionado bajo ciertas condiciones educativas.

PALABRAS CLAVES: Enfoque AICLE, competencia en lengua extranjera, motivación, matemática elemental, curso electivo para estudiantes ingenieros.

TITLE: The formation of foreign language competence of engineering students through CLIL-method.

AUTHORS:

1. Ed.D. K.V. Vlasenko.
2. Ed.D. I.V. Lovyanova.
3. Cand. Ph.D. O.O. Chumak.
4. Cand. Ph.D. I.V. Sitak.
5. T.S. Kalashnykova.

ABSTRACT: The article looks into ways to develop intercultural knowledge of engineering students, forming their foreign language competence. The research displayed the influence of the Content-Language Integrated Learning (CLIL), contributing to students' active social integration, and improving their motivation for mastering English. The study determined the CLIL approach principle, its model and postulates. This paper also describes the introduction of the "Elementary Mathematics in English" elective course for engineering students, choosing the model C3 CLIL method. The results confirm the positive dynamics of forming engineering students' foreign language competence, as well as improving their motivation to study through the development and implementation of the integrated elective course mentioned under certain educational conditions.

KEY WORDS: CLIL, foreign language competence, motivation, Elementary Mathematics, elective course, engineering students.

INTRODUCTION.

Multilingualism and social integration are the key tasks for Ukrainian higher education. This idea came to the fore in the reports of INCLUDE (2016) that consider language learning as a priority in terms of mobility and intercultural understanding. In this regard, there is a need to use modern foreign language teaching forms and methods, which ensure the most effective implementation of specialists training programs, in particular, for technical speciality students.

The analysis of the works of such scientists as Chostelidou & Griva (2014), Dallinger et al. (2018), Kashiwagia & Tomecsek (2015), Surmont et al. (2015) helps come to the conclusion that one of the highly successful ways of students' active social integration is Content Language Integrated Learning (CLIL), which enables the formation of students' intercultural knowledge, and the development of their competences. Moreover, the scientists point to the significant influence of these methods on the increase in students' motivation, expansion of their cultural consciousness and development of their intercultural communication skills.

In this way, Gimeno et al. (2010) consider CLIL as a step forward compared to the traditional ESP (English for Specific Purposes) teaching methods, as, this method activates both professional and personal skills of the students. Kashiwagia & Tomecsek (2015) agree that CLIL improves students' overall ability to speak English. In his research Wenhsien (2017) shows how CLIL develops students' cognitive flexibility and communication skills.

The previously mentioned method, according to Martín Del Pozo (2015), helps to provide conditions for forming students' foreign language competence. We consider the specified competence as the ability of individuals to use a foreign language successfully in professional, scientific activities and social communication (Stavytska, 2017).

According to Kontio & Sylvén (2015), the carefully selected teaching materials for reading special texts encouraged the students to develop their foreign language skills. The scientists point out that such texts can be used not only to study a particular subject but also to learn a language. Among the important recommendations of scientists there is the collaborative work of the teachers of both disciplines, one of which is a foreign language. While agreeing with the scientists' research findings, we propose to integrate the skills and competencies of both disciplines when working out the curriculum with account for the foreign teachers' recommendations on the selection of language means.

Surmont et al. (2015) confirm our reasoning on the positive impact of CLIL on students' acquisition of lexical and grammatical units and structures, as well as, on their progress in all types of language activities (reading, speaking, writing and listening). The scientists also found the positive impact of CLIL coming from the integration of English and Maths. This is confirmed by the fact that Mathematics provides a significant amount of linguistic material that students master in the process of work. Additionally, the enrichment of students' vocabulary is provided through the use of the required subject terminology. The studies by Jiménez Catalán et al. (2017) also demonstrate the positive impact of CLIL on the language competence of those students who study English while learning Mathematics.

The analysis of the scientific research and our personal experience (Vlasenko, 2018) helped us to choose an Elementary Mathematics course to be integrated with English language learning. During this, it was also taken into account that the course chosen was to be at the core of any mathematical or special discipline. While choosing the form of educational organization, Honcharenko's opinion, according to which a young person acquires competence not only in the study of a subject or a group of subjects but also through non-formal education, was also taken into consideration. The informal

approach can be achieved through an elective course (Honcharenko, 2011). While agreeing on this, we worked out the "Elementary Mathematics in English" elective course for engineering students.

The purpose of the article is to study the formation of the foreign language competence of engineering students by means of CLIL method. We set the following objectives: to determine the model of the CLIL approach; to work out the goals and subject content of the elective course; to design types of tasks with the emphasis on the subject content, its understanding, checking and active discussing; to test experimentally the introduction of the elective course, designed on the basis of the C3 CLIL approach.

The hypothesis of the study is that the development and introduction of an integrated elective course of English and Elementary Mathematics influence the positive aspects of forming foreign language competence of engineering students, as well as on the improvement of their motivation to study.

DEVELOPMENT.

Methods.

Taking into account the purpose of the study, we chose the following methods:

1) Theoretical: the analysis of domestic and foreign scientific literature, which presents the use of the method of Content-Language Integrated Learning; modelling of the educational process;

2) Empirical: the observation of the educational process; performing poll and questionnaire for teachers of English and Mathematics; a questionnaire for students of engineering specialties to find out the levels of motivation by the method of Dubovitskaya (2002); conducting an experiment to verify the effectiveness of the proposed methods for teaching "Elementary Mathematics in English" elective course for students of engineering specialties; checking the results of experimental learning using a distribution-free test of fit χ^2.

The pedagogical experiment consists of the preparatory, main and final stages.

In the preparatory stage of the experiment (2015 – 2016), we analyzed scientists' experience considering the integration of the English language and fundamental or professional disciplines while training technical students. Also, we examined the methodological support of the Elementary Mathematics course with the materials provided in English. At the beginning of the experiment we determined the initial level of foreign language competence of the technical students.

During the pedagogical experiment, 124 students of the first and second years of study at a higher technical educational institutions were involved, in particular, the students of Donbas State Engineering Academy (63 students), the Institute of Chemical Technologies (the town of Rubizhne) of the East Ukrainian Volodymyr Dahl National University (29 students) and Donbas National Academy of Civil Engineering and Architecture (32 students).

Surveying the students with the help of Dubovitskaya 's method (2002), which has no restrictions regarding the respondents' educational, social and professional characteristics, we determined the initial level of the students' motivation for forming foreign language competence. An evaluation scale of this method has four levels: high, sufficient, satisfactory, low. The method for diagnosing the students' motivation to study in the chosen field consisted of 20 judgments and suggested answer options. Each student had to express his/her attitude to every statement following the 12-point scale. The answer in the range between 10 and 12 points is considered positive. Also, we found out if teachers want to improve their students' English. We checked whether they are ready to work together with mathematics teachers and use innovation in the learning process.

Processing the results was done by analyzing the answers. All the teachers confirmed that they are self-confident and ready to face the challenge. Thus, we confirmed the feasibility of developing the "Elementary Mathematics in English" elective course for engineering students.

To show the effectiveness of the implementation of the elective course through means of CLIL method we checked on the improvement of the students' foreign language competence. The criteria were motivation, reflective, cognitive activity, practical and technological skills. Each criterion has its indicators (table 1).

Table 1. The indicators of formation of foreign language competence of engineering students.

Motivation	Reflective	Cognitive activity	Practical and technological skills
The importance of foreign language training, interest in learning both the foreign language and Elementary Mathematics, assess the feasibility to study professionally and scientifically oriented foreign language based on individual abilities	The ability to estimate, analyze and evaluate your knowledge of a foreign language, capacity for self-study of foreign languages	Reading and translation of mathematical texts, discussion of topics of professional issues; speech perception; knowledge of business correspondence, knowledge of terminology	The ability of self-study, the ability to help classmates with learning

Experimental (EG, 61 students) and control group (CG, 63 students) were formed at the beginning of the preparatory stage (2016 – 2017).

During the pedagogical experiment, reliability of the obtained results was insured by the following factors: observation in groups was conducted in the conditions of the natural educational process; the students in the control and experimental groups studied identical content of the educational material; tests were carried out simultaneously in the experimental and control groups; all the evaluations were made on the basis of the same questionnaires, tests and control papers; the teachers involved in the experiment had been previously introduced to the elective course.

In order to study the initial level of the students' foreign language competence, there was conducted a placement test, which determined the level of the groups as B1 according to the scale of the Common European Framework of Reference for Languages (CEFR). On this basis, it was recognized that it is expedient to hold the elective course in Elementary Mathematics in English.

During the main stage of the experiment, we chose the integrated training methodology and the C3 CLIL model, called Language-embedded content courses, "content programmes are designed from the outset with language development objectives. Teaching is carried out by content and language specialists" (Coyle et al., 2010). The choice of the model stemmed from the fact that its use allows us to provide the students with ongoing support during the whole course.

Elementary Mathematics course was selected for the development of the elective classes. It was due to the fact that, according to the teachers of Mathematics, the concepts and procedures of Elementary Mathematics are the basis for students' mastery of all fundamental and special disciplines. In addition, the course aimed to form the students' language competence, mastering mathematical terminology in English and revision of Elementary Mathematics. Mathematicians and language specialists worked out the syllabus that had seven tutorials of 45 minutes each. We chose seven topics. They were arithmetic operations, fractions, the real numbers, the number raised to a power, quadratic roots, equations and inequations, quadratic equations.

While designing the syllabus, mathematics teachers figured out how long it would take students to solve tasks or to understand the instructions. The teachers of English considered what type of support the students needed. To ensure the corresponding support during the solution of the tasks, the students' answer to the following question was taken into account: What helps them to learn English? Some of the answers were: more vocabulary and more diagrams on the worksheets, receiving more explanations, using easy words and vocabulary for the explanations, more pictures, adding a list of vocabulary and illustrations, providing the most difficult words with translation.

Using the elective course as a form of organizing English language training simplifies the analysis of the lesson, and problem-solving, including language issues. There is also the possibility of constant correction of the work program, types of tasks, and organization of feedback from the students. Feedback from the students can be received through a short questionnaire, which reflects the characteristics of the lessons important for the teacher. The questionnaire can be offered in two languages (English and Ukrainian). Here is an example of a questionnaire received by students after one of the classes. It was proposed to choose the correct estimation, from the student's point of view.

1. How was the training session organized? (excellent / good / satisfactory / unsatisfactory).
2. How did you understand new information? (excellent / good / satisfactory / unsatisfactory).
3. How was the information presented? (excellent / good / satisfactory / unsatisfactory).
4. Estimate the complexity of the assignments from 1 to 5 (1 – very simple, 5 – very difficult).
5. Estimate the clarity of the teacher’s instructions from 1 to 5 (1 – completely incomprehensible, 5 – very understandable).
6. Assess the content from 1 to 5 (1 – failed to improve professional skills, 5 – skills have significantly improved).

The analysis of students' answers in the informal environment of the elective course helped to introduce changes to the content and language parts of the course, as well as to change the teaching tactics, learn to give simple instructions during the class, and use other forms of student interaction. The elective classes were given by Mathematics teachers whose level of English was corresponded to B2. English teachers consulted with their colleagues on preparing for classes and developing educational materials. In addition, the English teachers participated in carrying out control activities and checking the written assignments. While evaluating the level of English teachers' responsiveness to innovations, the optimal level of readiness was confirmed. The joint activities of the teachers of

Mathematics and English helped to develop the elective programme and tasks that were fulfilled during the classes.

The results of the student survey, about the factors that usually help them learn English, influenced the choice of the task types. What is more, the analysis of the results of the respondent survey reaffirmed the need for using interactive types of tasks. Exploiting them was intended to provide support for the students through the use of individual, pair and group forms of organizational activity. Here are some examples of task types (table 2) that were used.

Table 2. The types of tasks used during the elective course.

Circle/underline	Describe and guess	Information transfer	Odd one out
Classify	Domino games	Jigsaw	PowerPoint presentation
Compare and contrast	Find the mistake	Label match	True/false
Complete the diagram	Gap fill	Multiply choice	Word searches and web searchers
Crossword	Identification keys – e. g. a flow diagram with questions which help learners identify 3-D shape	Sequence	Yes/no – e.g. an elimination game ‘Determine the Angle Type’

The topics of the lessons were offered to the students in advance. In addition to that, the students had a plan for each class.

The organization of teaching was carried out through the involvement of multimedia technologies. The use of multimedia support while doing the system of exercises enabled the visual and auditory perception of the material and its better memorizing by the students. This was achieved through the dynamic simulation of learning situations, in which students, for example, were asked to form a

hypothesis and then provide the proof for it. The learners had to do with cognitively challenging materials from the beginning of the course. Therefore, the teachers of Mathematics implemented the strategies for both content support and language support. For example, the teacher demonstrated some sentence starters to the students in order to support their skills of reasoning.

We found that the	graph equation	is _____because_____.
We found that the graph is linear because the coordinates make a straight line. We found that the equation $y = x^2$ is non-linear because the coordinates make a curved graph.		

This approach contributed to the students' awareness of learning the material through training the abilities and skills that can be mastered in the process of learning in an already known or a new situation. The versatile presentation of the educational information through multimedia technologies helped the students come to realize that this meaning had various content interpretations.

While solving the tasks in Elementary Mathematics, the students focused their attention on the content obligatory language (the subject-specific vocabulary, grammatical structures and functional expressions) and content compatible language. The tasks of International Baccalaureate were also used for the development of the educational material (Fannon et al., 2012; Urban et al., 2008).

Summarizing the results of the experiment, the English teachers studied the improvement dynamics for the results of training the foreign language competence of the engineering specialties students. To evaluate this, the method of diagnosing foreign language competence formation was applied. The evaluation was carried out by means of the questionnaires and tasks developed by Stavytska (2015).

We were guided by the criteria and indicators developed by the above-mentioned researcher and related to motivation, reflexivity, cognitive activity, practical and technological activity. The following performance levels were selected: high, sufficient, average, low.

The final stage of the experiment (2017 - 2018 years) was aimed at the implementation, testing and refinement of the developed training method. The experimental data were worked out and analyzed and conclusions were formulated. The purpose of this stage was to determine the effectiveness of the proposed elective course.

Results.

Summarizing the results of the experiment, the English teachers studied the improvement dynamics for the results of training the foreign language competence of the engineering students To evaluate this, the method of diagnosing foreign language competence formation was applied. The evaluation was carried out using the questionnaires and tasks developed by Stavytska (2015). We chose the criteria and indicators developed by the above-mentioned researcher and related to motivation, reflexivity, cognitive activity, practical and technological activity. We selected the following performance levels: high, sufficient, average, low.

We shall now consider how the level of the formation of the students' motivation was determined during the preparatory and main stages of the experiment. The results of the tests conducted are presented in table 3, where the number of students (in %) in the experimental and control groups who offered a positive answer was put into compliance for each judgment.

Table 3. The formation of the students' educational motivation in the experimental and control groups.

Statement	Level of the students' attitude to the statement			
	At the beginning of the experiment (%)		At the end of the experiment (%)	
	EG (61)	CG (63)	EG (61)	CG (63)
1	2	3	4	5
1. I am more interested in my success in English than in other disciplines	20	24	32	23
2. I like speaking English with teachers during classes	49	48	60	45
3. I like doing grammatical tasks	45	42	53	43
4. I always look for additional material for the class	18	19	25	20
5. I always look for transcription of words while preparing for classes	48	46	59	47
6. I would like to know English better than my groupmates	28	29	37	31
7. I like reading aloud in English	27	24	38	29
8. I would like to have a profession related to English	17	19	45	28
9. I like answering questions in English	17	15	28	20
10. I would like to communicate with my group mates in English fluently	34	35	59	45
11. I try to write notes in my notebook during the class	13	15	35	26
12. I like learning grammar rules	5	8	24	10
13. I agree that English is no less important than professional discipline	12	18	56	22
14. I try to watch films and programs in English at home	13	15	46	33
15. I try to find additional literature on professional subjects in English	6	6	12	8
16. I try to communicate with my group mates in English during breaks	24	22	39	24
17. I would like some of the disciplines to be taught in English	9	8	19	9
18. I do not feel tense during the classroom, which is taught in English	11	10	38	21
19. I would like to study mathematics in English	12	15	38	25
20. I listen to records in English	24	26	61	30

For clarity, we shall give the dynamics of changes in the form of the relative frequencies range (Fig. 1), where the numbers of statements are presented on the horizontal axis, and the frequency of students' positive responses are on the vertically one (in percentage).

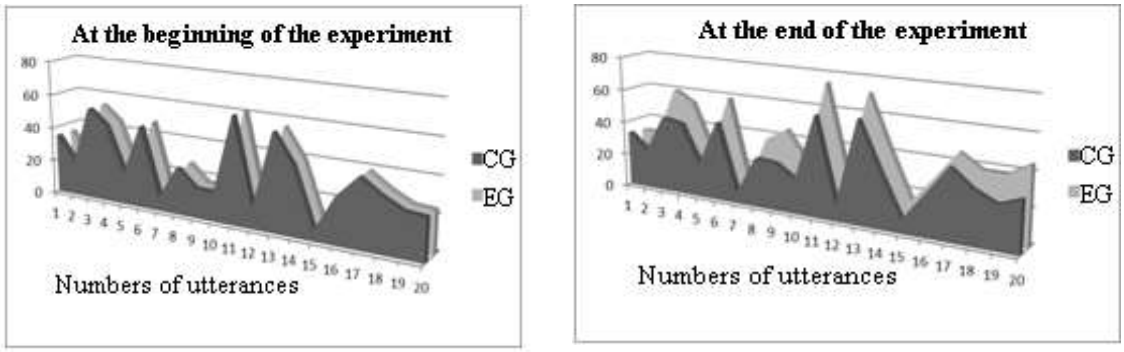

Fig. 1. Comparison of the results of the formation of the educational motivation of students in EG and CG.

The analysis of students' scores revealed positive changes in the levels of forming foreign language competence of the EG compared with the control one. It was found that the number of students in EG with high levels of motivation, reflective, cognitive activity, practical and technological skills increased. The comparative analysis of the experimental results showed the increasing levels of formation of foreign language competence of EG students after the experiment, while the results of the CG did not change significantly (table 4).

Table 4. Levels of formation of foreign language competence of students after the formative experiment, %.

Criteria	Levels							
	High		Sufficient		Average		Low	
	EG	CG	EG	CG	EG	CG	EG	CG
Motivation	46,5	27,8	34,4	35,4	13,5	23,3	5,6	13,5
Reflective	50,3	29,8	31,4	26,1	15,2	36,5	3,1	7,6
Cognitive activity	34,6	15,1	39,7	36,4	21,3	40,2	4,4	8,3
Practical and technological skills	51,8	13,2	25,1	19,9	18,7	49,3	4,4	17,6

Accordingly, the high level of formation of the motivational criterion is 39.2 %, sufficient – 31.8 % in EG and the students of the CG have 31.1 % and 33.5 % respectively. 39.7 % of students of the EG show the high level of formation of reflective criterion, sufficient – 29%, average – 26.4 %, 4.5 % – low level. The results of the reflexive criterion in CG are: high – 31.8%, sufficient – 23.9 %, average – 38 %, low – 6.2 %. The indicators of the cognitive activity criterion of the CG at a high level are 15.1%.

It served as ground to make a conclusion that the conducted elective course, which was developed on the basis of C3 CLIL-approach model, had a positive effect on the students' foreign language competency at technical higher educational institutions.

Discussion.

We agree with Velázquez Guerrero (2013) and Lo & Macaro (2015) that the formation of foreign language competence in the students of technical higher educational institutions is an extremely important problem. The studies by Coyle et al. (2010), Chostelidou & Griva (2014) have helped us to take the CLIL method into notice.

The empirical results obtained by such scientists as Dallinger et al. (2016) also show significant progress observed in students that were trained using CLIL. Namely, the scientists confirmed the improvement of students' verbal cognitive skills, their practical and technological skills and motivation.

We view the CLIL, following Mehisto et al. (2008, p.11-12), as an approach that involves the development of social, cultural, cognitive, linguistic, academic and other learning skills, which in their turn contribute to learning both the subject and the language. Agreeing with Ioannou Georgiou & Pavlu (2015), some of the features of the CLIL method can be used. As a feature of CLIL practice, Somers & Llinares (2018) highlight that its application stimulates students' motivation for a foreign

language study. We also rely on the studies by Jiménez Catalán & Pilar Agustín Llach (2017) which demonstrate the positive impact of CLIL on English learners' linguistic competence.

Researching the effect of the approach on improving students' foreign language competence, Vollmer et al. (2016), Bystray et al. (2018) discovered the impact of integrated technology combining English with geography and history. To fill this gap, we introduce CLIL in the teaching of Elementary Mathematics to engineering students.

We also take into account that learning a foreign language, integrated into the content of mathematics, is made possible by simplifying the content of the subject. In addition, the creation of an elective course corresponds to the requirements of the teaching method of the discipline within the framework of C3 CLIL model. According to Sandra Attard Montalto's opinion, it does not require the strict use of language material (as opposed to learning a foreign language) (Montalto et al., 2015). Therefore, an instructor during an elective course has the opportunity to select linguistic resources, and tasks which, from the instructor's point of view, are the best way to implement at a given part of an Elementary Mathematics class.

We agree with Stavytska's opinion (2015) carrying out the organization of solving the system of educational tasks through the usage of multimedia technologies. Such technologies enable the presentation of the material through text, video, animation and sound, help to create models of objects or processes of cognition, implement the principle of simulation of learning situations during the organization of task solving. In this approach, it is possible to combine the use of active organizational methods, forms, and means of training.

CONCLUSIONS.

Experimental testing of the effectiveness of introducing elective courses based on the CLIL-method confirmed the conclusion about the potency of its implementation in the process of language training of students in technical universities.

It was found that the use of the integrated learning method should be considered as a way of teaching a foreign language by means of Mathematics (teaching a foreign language through content) and the way of improving the teaching of mathematical disciplines by means of a foreign language.

It was confirmed that the use of the CLIL approach based on a C3-model at a Higher Technical School is a means of motivating students to study and a tool for multi-lingual education. The implementation of the method by engaging both teachers of Mathematics and English specialists can be done via an elective course.

The introduction of the method involving both teachers of Mathematics and English specialists can be done with the help of an elective course. The creation of the elective course provides for the development of its program, the selection of special mathematical texts and tasks submitted to students in a foreign language. An informal approach to teaching an elective course (use of questionnaires) helps the teacher to introduce changes in the learning process. Compliance with this approach helps to form students' foreign language competence.

Taking into account the main results of the study, practical recommendations can be given on the use of the approach.

– Mathematics is a suitable basis for using the CLIL method. There is a need for creative cooperation between teachers of Mathematics and the English language teachers when compiling the program of elective courses. This requires continuous improvement of the Maths teachers language competence and the professional development of the English language teachers.

– The use of multimedia technologies in elective courses enables the transition to activity ways of organizing the learning process through multimedia learning support. This approach involves the development and display of demonstration materials to present learning information. The engagement of multimedia technologies requires from teachers to master modern teaching technologies, plan the use of the multimedia learning support with regard to the topic and aims of training, the functions and

duration of the use of various local digital information reproduction devices.

– It is important to select and to use constantly a sufficient number of different independent and creative tasks in describing, comparing, expressing a personal point of view, giving a presentation, as well as developing the students' skills of verbal and written communication during the class work and using problem-based assignments (based on special texts), for which students are forced to use actively interdisciplinary knowledge.

– The creation of support for students throughout the learning process, the engagement of students with all levels of linguistic competence development significantly influences the effectiveness of the classes.

As a direction for further inquiries, we are also currently studying the impact of this methodology on boosting students' motivation to improve their mathematical skills.

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DATA OF THE AUTHORS.

1. Kateryna Vlasenko. Ed.D., Donbass State Engineering Academy, Kramatorsk, Ukraine. Email: vlasenkokv@ukr.net
2. Iryna Lovyanova. Ed.D., Kryvyj Rih State Pedagogical University Kryvyj Rih, Ukraine. Email: lovira22@i.ua
3. Iryna Sitak. Ph.D., The Institute of Chemical Technologies (the town of Rubizhne) of the East Ukrainian Volodymyr Dahl National University, Rubizhne, Ukraine. Email: sitakirina@gmail.com
4. Olena Chumak. Ph.D., Donbas National Academy of Civil Engineering and Architecture, Kramatorsk, Ukraine. Email: chumakelena17@gmail.com

5. Tetiana Kalashnikova. Donbas National Academy of Civil Engineering and Architecture, Kramatorsk, Ukraine. Email: t.s.kalashnikova@donnaba.edu.ua

RECIBIDO: 8 de octubre del 2019. **APROBADO:** 22 de octubre del 2019.