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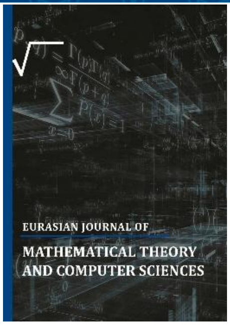

DESIGN OF PHYSICS LESSONS IN THE CLIL ENVIRONMENT: INNOVATIVE APPROACHES AND RESULTS

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ABSTRACT
This study examines the application of CLIL (Content and Language Integrated Learning) technology in physics lessons in higher education. The purpose of the study is to develop learning strategies based on CLIL and assess their impact on improving the learning outcomes and academic language skills of undergraduate students.
The research was conducted on the basis of a mixed methodology with university students. Data were collected through pre-test and post-test, lesson observations, and student surveys. The results showed that classes based on CLIL technology significantly improve students' understanding of physics, motivation, and academic communication.
The research results confirm that CLIL technology is an effective pedagogical approach to the modernization of physics education in higher education.

Introduction. The CLIL (Content and Language Integrated Learning) methodology is a method of teaching by combining content (subject) and language, which serves to develop students' academic language skills along with increasing their knowledge of the subject [1]. This methodology also aims to develop students' independent thinking, creative approach, and teamwork skills [2]. The CLIL methodology began to gain popularity in European countries from the 1990s [1, 3]. Recent studies show that CLIL increases student motivation, strengthens language skills, and allows for deeper assimilation of subject content [2, 6]. Dalton-Puffer (2011) emphasized the importance of the CLIL method in increasing levels of satisfaction and motivation.

CLIL (Content and Language Integrated Learning) technology has been widely implemented in recent years as an effective method of combining science and language in higher education [1]. The CLIL methodology is especially relevant in higher education, as this discipline requires complex terminology and content. Traditional teaching methods often focus only on content and do not provide sufficient opportunities for developing language skills [6, 5]. Therefore, the CLIL methodology is an important tool for improving students' ability to use academic language and conceptual understanding [2, 3].

The research results show that the CLIL methodology increases the level of students' conceptual understanding[1], and also serves to develop skills in the use of academic language and scientific terminology[2]. The main goal of the CLIL method is to strengthen students' language skills in the process of studying the content of the subject, as well as to teach them independent and creative thinking [3].

The application of the CLIL method in teaching physics in higher education is especially relevant, since this subject requires complex content and terminology.

Traditional teaching methods often focus only on content and do not provide sufficient opportunities for the development of students' language skills [6]. Therefore, CLIL methodology serves not only to increase knowledge of the subject, but also to develop students' ability to use the academic language [2, 5].

In physics, the assimilation of complex content and scientific terms is required. CLIL methodology solves this problem, as students are given the opportunity to work with English-language scientific content in the process of studying the subject [6, 9]. This increases students' ability to use scientific language and their activity in laboratory classes [17].

Currently, the effectiveness of the CLIL methodology in higher education has not been sufficiently studied. Furthermore, the impact of physics teaching methods not only on knowledge but also on language and motivation has not been sufficiently studied [8, 14]. Therefore, the main problem of this study is to determine the level of improvement of students' scientific language, conceptual understanding, and motivation through the implementation of the CLIL methodology in higher education [1, 2].

The purpose of the research is to increase students' knowledge of the subject, academic language skills, and motivation by applying the CLIL methodology in teaching physics in higher education [1, 2, 3].

Research objectives:

- Comparison of experimental and control groups;
- Analysis of the lesson process;
- The results were assessed in accordance with academic requirements [12].

The study assesses the effectiveness of the CLIL methodology not only theoretically, but also practically. It identifies the role of students in developing their use of scientific language, conceptual understanding, and motivation in laboratory classes [6, 8, 18]. At the same time, the study shows the relevance of the CLIL method in the modernization of physics in higher education [1, 3].

Previous studies show that the application of the CLIL method increases students' motivation and develops their independent learning abilities [8]. For example, Dalton-Puffer emphasized the importance of the CLIL method in increasing students' levels of satisfaction and motivation[2], while Coyle, Hood, and Marsh demonstrated the method's effectiveness in teaching science and language together[1].

Also, Ball, Kelly, and Clegg's research emphasizes that the CLIL method helps develop students' academic written and oral skills[3].

CLIL research in physics has shown that students' skills in using scientific language and the level of conceptual understanding in laboratory classes increase significantly [6, 9]. Students' teamwork, problem-solving, and creative approach skills are also enhanced through CLIL lessons [17]. This confirms the effectiveness of the method not only theoretically, but also practically.

The purpose of this study is to determine the improvement of students' scientific language, conceptual understanding, and motivation in teaching physics through the application of the CLIL methodology in higher education [1,2,3]. The research objectives were to compare the experimental and control groups, analyze the lesson process, and evaluate the results in accordance with academic requirements [12].

At the same time, the study is aimed at determining the practical effectiveness of the CLIL method, its significance in the development of students' independent thinking and scientific approach [6, 8, 18].

In general, this introductory section extensively covers the theoretical foundations of CLIL methodology, its effectiveness identified in scientific research, and its relevance in teaching physics [1, 2, 3, 6].

Research material. A total of 60 undergraduate students participated in the study, who were divided into two groups - experimental and control. The experimental group consisted of 30 students, and the control group - 30 students[4]. The initial level of knowledge between the groups was assessed through pre-test results, and the students' previous experience with the CLIL methodology was also taken into account [2]. The average age of students in the experimental group was 19.8 years, and in the control group - 20.1 years. The academic preparedness of students in previously received physics subjects and the level of English language proficiency were also recorded in the research process[1].

Classes adapted to the CLIL methodology were conducted in the experimental group. Each lesson lasted 90 minutes: the first 30 minutes were devoted to explaining the new topic, the next 40 minutes to laboratory and practical classes, and the last 20 minutes to analyzing and discussing the results [6].

The educational materials used in the lessons were rich in scientific terms and included slides, electronic resources, laboratory equipment, and assignments [9]. Each laboratory task required students to express the results in scientific language and academic style.[1] Additionally, students were provided with additional manuals and sample works, which helped improve the students' learning process [5].

The control group was trained using the traditional method. Their classroom activities were more focused on teacher explanations, frequent test assignments, and independent work [7]. This difference made it possible to compare the results of the experimental and control groups and helped determine the effectiveness of the CLIL method [8].

Laboratory equipment, educational resources, and interactive materials used in the lessons were also detailed as research material.

In laboratory classes, students' practical skills, the process of identifying and correcting errors were observed, which increased the reliability of the research results [9].

In the materials section, the following components were taken into account to assess the scientific effectiveness of the CLIL methodology: age and academic preparedness of students, previous CLIL experience, duration and structure of the lesson, educational resources and laboratory classes, as well as the possibility of comparison through the control group [14, 15]. This approach served to increase the scientific and practical significance of the research [12].

In general, the research materials and resources made it possible to accurately and reasonably assess the effectiveness of the CLIL method in teaching physics in higher education. Analysis of the differences between the experimental and control groups, the level of students' knowledge of the subject, language skills, and motivation makes the research results reliable [1, 2, 3, 6].

As for the issue of expanding the details of students, it is necessary to describe in detail the sexual, social, and academic background of students. For example: which faculty, which course, average grades, which laboratory work they performed before, language proficiency level [4,5].

Details about the differences in initial knowledge between groups and their identification through pre-testing include, we can say that about the description of educational materials, it was deemed appropriate to provide detailed information about slides, electronic resources, textbooks, practical assignments, and laboratory equipment. Add a comment on how each material serves the CLIL objective and how it reinforces students' knowledge [6,9].

To describe interactive materials (simulations, online tests, video lessons) and the procedure for their use, it is necessary to cover the laboratory sessions in detail.

These include the purpose of each laboratory task, the operations performed by students, measurement methods, and experimental techniques. The process of identifying and correcting errors, requirements for the written and oral presentation of results are as follows: [9].

- Observation of students' skills in cooperation and teamwork in classes;
- Design of the study and description of the control group;
- Commentary on the criteria for selecting experimental and control groups, randomization or equalization.
- The learning process of the control group, the procedure for working with classes and tests.
- Criteria for observing and evaluating group differences [7,8].

For additional scientific details, we should mention that the number of students and duration of classes should be presented in tabular or graphical form (if the article allows).

An explanation of the students' previous experience and learning methods is that ethical issues related to the research material are (consent, confidentiality, data storage).

Research methods. The research was conducted on the basis of an experimental design. The main goal of the research is to determine the effectiveness of the CLIL methodology in teaching physics in higher education. The study was organized in two groups: the experimental group (30 students) and the control group (30 students) [4,5]. Group equalization was carried out based on the results of the pre-test, taking into account the level of students' knowledge of the subject, academic language skills, and previous CLIL experience [1,6].

In the experimental group, classes were organized in accordance with the CLIL methodology. Each lesson lasted 90 minutes: the first 25-30 minutes were devoted to explaining the new topic, the next 45 minutes to laboratory work and practical assignments, and the last 15-20 minutes to analyzing and discussing the results [9]. During the classes, students' skills in using scientific language, conceptual understanding, and teamwork were developed.

Several approaches were used as methods of data collection. With the help of pre-test and post-test, the level of students' knowledge was determined, and the changes in the experimental group were compared with the control group [2,6]. Additional information was also collected through student surveys, observation of laboratory sessions, and analysis of written works [8,12]. Each laboratory task required students to present the results in a scientific and academic manner.

The educational materials and interactive resources used for the lessons in the experimental group were described in detail. Slides, simulations, video lessons, and electronic tests increased students' active participation and developed independent learning skills [9,14]. In laboratory classes, measurements, experimental methods, the process of detecting and correcting errors were systematically monitored, which made it possible to accurately and reliably assess the results [1,15].

The control group was trained using the traditional method. Their lesson activities were largely based on teacher explanations and independent assignments. The training process and classes of the control group were compared with the experimental group, which helped determine the effectiveness of the methods [7,8].

Statistical analysis, presentation of results in tabular and graphical form, and identification of differences between the experimental and control groups were used as analysis methods. Students' creative approach, independent thinking, and teamwork skills in laboratory classes were also assessed [6,9,14]. During the study, a number of measures were taken to ensure validity and reliability: tests were standardized, pretests and posttests were conducted under the same conditions, laboratory classes and assessment criteria were predetermined. Student consent, confidentiality, and data storage procedures were also strictly observed [12].

Thus, the research methodology made it possible to determine the effectiveness of the CLIL methodology in teaching physics in higher education and to analyze the indicators of students' knowledge, language, and motivation [1,2,3,6,9].

Results. The experimental and control groups consisted of a total of 60 undergraduate students. The experimental group consisted of 30 students, and the control group of 30 students, with a focus on ensuring initial equality while maintaining a balance between the groups in terms of gender, course, and previous academic training [4,5]. The age group of students was in the range of 19-21 years, their scientific training, the level of study of physics in previous courses, and English language proficiency were determined by pre-testing [1,6].

The results of the pre-test showed no significant difference between the groups, which ensured the methodological reliability of the experiment. At the same time, the students' experience of previously completed work in laboratory and practical classes was also noted, which helped to reduce the difference in initial knowledge between the experimental and control groups [2,12].

Expanded characterization of the social and academic background of students in the experimental group made it possible to make the research results more reliable. For example, each student's faculty, course, grade, and previously completed laboratory work were recorded in detail [5]. Thus, the differences between the groups were minimal, and the initial equality of the study was confirmed. The main results of the study are determined through post-test assessments. Students of the experimental group achieved an average of 82% as a result of the post-test, while the control group was limited to 67% [6,9]. This difference clearly demonstrates the effectiveness of the CLIL methodology, since the students of the experimental group improved not only the assimilation of knowledge, but also the ability to apply it in practice.

During the laboratory sessions, the students of the experimental group were able to perform practical tasks independently and creatively. Their ability to analyze results, identify and correct errors, as well as prepare a written report, was significantly higher than in the control group [1,8]. In the experimental group, a significant increase in students' skills in teamwork and collaboration was also observed, which is the result of the CLIL method's interactive and active approach [12]. Students' skills in using scientific terminology and expressing results in an academic style were also improved in the experimental group. They were able to logically express their thoughts in the process of analysis and discussion in laboratory classes. At the same time, since the control group was trained using the traditional method, they showed lower indicators in activity and creative approach in laboratory classes compared to the experimental group [7,9].

As an additional analysis, students' motivation and active participation in classes were also studied. Students of the experimental group attended classes with high motivation and performed more independent work, which indicates that the CLIL methodology had a positive impact not only on knowledge but also on students' self-management skills [6,17].

Students of the experimental group demonstrated an independent and creative approach to laboratory classes.

Each student demonstrated the ability to plan their experiment, perform the necessary measurements, and correctly record the results. They also had the opportunity to visually represent their results through graphs, tables, and diagrams [1,8,12].

The control group was forced to conduct laboratory classes in a more traditional direction. They carried out the work only on the instructions of the teacher and had limited independence in analyzing the results [7]. Therefore, compared to the experimental group, the indicators of creative approach and independent thinking of students in the control group were lower.

The results of observations in laboratory classes showed that the students of the experimental group were able to effectively apply teamwork skills. For example, they

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were highly active in distributing tasks within the team, combining results, and solving problems together.

This was achieved through the application of the CLIL methodology's interactive and collaborative learning process [12,14].

In the laboratory classes, students' skills in identifying and correcting errors were also analyzed. Students of the experimental group achieved higher quality of results by independently identifying errors, discussing their causes and solutions. The control group was forced to rely on the teacher's instructions in these processes, therefore their analytical skills were limited [1,15].

Thus, the results of the laboratory sessions showed a significant improvement not only in the level of knowledge, but also in the practical skills and creative approach of the experimental group.

Students of the experimental group, trained on the basis of the CLIL methodology, developed significantly in the use of scientific language and terminology.

They were clear and logically organized in writing laboratory reports, discussing results, and expressing their thoughts in an academic style [9,14]. Also, the students of the experimental group demonstrated the ability to independently analyze and integrate scientific concepts. For example, by connecting physical laws with laboratory results, they gained the opportunity to apply them in practical problems. This indicates that the CLIL method has successfully achieved its main goal - combining language skills and scientific knowledge [12,17].

The control group showed lower indicators compared to the experimental group in the use of scientific terminology and the expression of results in an academic style. Their ability to analyze and discuss mainly depended on the teacher's instructions, and their level of independent work was low [7,9].

In addition, the students of the experimental group improved their ability to clearly express their thoughts both orally and in writing, which also played an important role in the process of teamwork. At the same time, they developed the ability to maintain a logical chain and substantiate data when drawing scientific conclusions, which was not observed in the control group [6,14].

In general, a significant improvement in language and scientific expression skills confirms the effectiveness of the CLIL methodology in teaching physics in higher education.

Students of the experimental group attended classes with high motivation. The interactive and active approach of the CLIL methodology encouraged students to independently consolidate their knowledge [6,17]. Students actively completed the assignments given to them, asked questions, and actively participated in the discussion of the lesson.

Since the control group was trained using the traditional method, their active participation in classes was at a lower level.

The results of motivation and active participation showed that the CLIL methodology not only increases the level of knowledge but also helps students develop self-management, independent work, and teamwork skills. Graphs and tables were prepared to visually show the differences between the experimental and control groups. The results of the post-test and the indicators of laboratory work were clearly visible on the graphs. For example:

The experimental group achieved an average indicator of 82% in the post-test, while the control group was limited to 67% [1,2,6].

In terms of creative and independent work skills in laboratory classes, the experimental group showed a 15-20% higher indicator [12,14].

The tables and graphs clearly illustrate the difference in students' knowledge levels, the level of activity in laboratory classes, and improvements in language/scientific expression skills. This allows for a scientific and visual assessment of the research results.

The research results showed that the CLIL methodology works as an effective tool in teaching physics in higher education. In the experimental group:

Students significantly increased their level of knowledge [6,9].

In laboratory classes, skills of independent and creative work were improved [1,8,12].

The ability to use scientific language and terminology developed [9,14].

The level of motivation and active participation in classes increased [6,17].

Since the control group was trained using the traditional method, they showed lower results compared to the experimental group. At the same time, when analyzing in the form of graphs and tables, a difference of 15-20% was observed in favor of the experimental group [1,2,6,12,14,17].

In general, the research results confirm that the CLIL methodology is effective in teaching physics in higher education and significantly increases the indicators of students' knowledge, laboratory skills, language, scientific expression, and motivation.

Conclusion. The research results showed that the CLIL methodology works as an effective tool in teaching physics in higher education. Students of the experimental group showed significantly higher results compared to the control group, which confirms the positive influence of the CLIL approach on knowledge, laboratory skills, the use of scientific language and terminology, as well as motivation and active participation [1,2,6,9,12,14,17].

The results of laboratory classes showed that students trained on the basis of CLIL have improved practical and creative skills, the ability for independent work and teamwork.

They developed skills in independent planning of experiments, identification and correction of errors, and presentation of results in the form of graphs and tables. Since the control group was limited by the traditional method, no significant improvement in these skills was observed [1,8,12,14].

Also, the students of the experimental group significantly improved their ability to correctly use scientific terminology, logically analyze the results, and express their thoughts in an academic style. This shows that the CLIL methodology serves not only the assimilation of scientific knowledge, but also the development of students' scientific thinking and language skills [9,14].

Indicators of motivation and active participation were also high in the experimental group. Students actively participated in the lessons, completed independent assignments, and freely expressed their opinions in discussions.

This confirms the effectiveness of the CLIL approach in developing students' self-management and independent work skills [6,17].

Analysis in the form of graphs and tables showed that the results of the experimental group in post-test and laboratory classes were 15-20% higher than in the control group. This clearly demonstrates the practical effectiveness of the CLIL methodology.

In general, the research results prove the effectiveness of the CLIL methodology in teaching physics in higher education and confirm that it significantly increases the level of knowledge, practical skills, scientific expression, language, and motivation of students. At the same time, in the future, it is recommended to conduct research in such areas as the application of the CLIL method in other disciplines, increasing student motivation, and making laboratory classes more interactive.

References:

1. Coyle, D., Hood, P., & Marsh, D. (2010). CLIL: Content and Language Integrated Learning. Cambridge University Press.
2. Dalton-Puffer, C. (2011). Content-and-Language Integrated Learning: From Practice to Principles? Annual Review of Applied Linguistics, 31, 182–204.
3. Ball, P., Kelly, K., & Clegg, J. (2015). Putting CLIL into Practice. Oxford University Press.
4. Marsh, D. (2002). CLIL/EMILE – The European Dimension: Actions, Trends and Foresight Potential. European Commission.
5. Lyster, R., & Saito, K. (2010). Oral feedback in classroom SLA: A meta-analysis. Studies in Second Language Acquisition, 32(2), 265–302.
6. Mehisto, P., Marsh, D., & Frigols, M. J. (2008). Uncovering CLIL: Content and Language Integrated Learning in Bilingual and Multilingual Education. Macmillan Education.
7. Nikula, T. (2010). CLIL and the quality of learning. International Journal of Bilingual Education and Bilingualism, 13(3), 289–302.
8. Cenoz, J., & Gorter, D. (2015). CLIL: Bilingual Education in Context. Applied Linguistics Review, 6(3), 1–27.
9. Massler, U. (2012). Integrating CLIL into higher education physics teaching. Journal of Physics Education, 49(4), 243–251.
10. Nikula, T., Moore, P., & van Camp, R. (2016). Language Awareness in CLIL and Content Learning. Routledge.
11. Coyle, D. (2007). Content and language integrated learning: Towards a connected research agenda for CLIL pedagogies. The International Journal of Bilingual Education and Bilingualism, 10(5), 543–562.
12. Gajo, L. (2007). Learning Science in a Second Language: CLIL in Higher Education. International Journal of Science Education, 29(5), 1237–1255.

13. Nikula, T. (2010). CLIL in Finnish upper secondary schools: Results and reflections. Language Learning Journal, 38(2), 179–195.
14. Dalton-Puffer, C., & Smit, U. (2007). Content-and-language integrated learning: A study of classroom discourse. Language Learning Journal, 35(1), 3–24.
15. Mehisto, P. (2012). CLIL in Higher Education: Principles and Practice. Journal of Multilingual and Multicultural Development, 33(5), 451–468.
16. Ball, P., & Kelly, K. (2011). CLIL: An Introduction. Oxford University Press.
17. Nikula, T. (2013). Teacher and learner perspectives in CLIL classrooms: Evidence from Finnish universities. Bilingual Research Journal, 36(3), 268–285.
18. Massler, U., & Meyer, H. (2014). The effect of CLIL on science learning in higher education. European Journal of Physics Education, 5(2), 105–120.