

Mechanical engineering lexis and CLIL principles in acquisition of content-based lexical competence in English

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Abstract

The effectiveness of CLIL methodology in teaching Mechanics as an academic subject was examined through a pedagogical experiment at a secondary vocational school of mechanical engineering. In Slovakia, CLIL (Content and Language Integrated Learning) is considered one of the bilingual forms of education that enables students to learn both the subject-based content and the content-based foreign language simultaneously. Closer cooperation between language and academic subject teachers was assumed in planning the school curricula with a focus on specialist lexical competence acquisition. Higher vocational secondary schools in Slovakia are showing increasing interest in CLIL. In the dual-focused educational approach, language is considered both a tool for communication and a subject for teaching and learning. CLIL balances foreign language skills acquisition and vocational education, thereby significantly supporting personal development, responsibility, and motivation in students.

Key words: content, language, integration, acquisition, competence, principles

Introduction

Overcoming traditional boundaries of teaching foreign languages and specialist content of particular technical subjects in secondary vocational schools was the primary motivation for the application of CLIL principles.

Content and Language Integrated Learning (CLIL) has been regarded as an effective symbiotic fusion of studying particular academic subject matter content through, not in, a foreign language. Didactics of both the foreign language and academic subjects, are integrated within the specific type of education, characterized by the application of various organizational forms and teaching methods, including different types of teaching and learning strategies.

In this paper, insights into historical factors and CLIL principles with a focus on integrating of L2 and academic subject teaching are described with respect to both the potential employers' and students' needs investigation outcomes.

The objective of this paper is to clarify how content and language integrated learning approach differs from L2 teaching in language classes with no integration into an academic subject. Based on the results obtained in the pedagogical experiment, the rate of CLIL effectiveness in dual-focused teaching, motivation for content-based studying of the foreign language, and increase in lexical competence were measured and compared between CLIL and control groups of students.

In the last few years, progress and improvement have been achieved in lexical and communication competence acquisition by application of the CLIL-type approach. However, many important questions remain. There is still little, though growing, CLIL research evidence available in vocational-technical education showing an impact of CLIL on students' performance. Some recommendations for future research in practice are provided in conclusion as a result of the pedagogical experiment experience.

Insights into history: the most important facts about CLIL methodology development

During the 1990s, CLIL became one of the most frequently used terms indicating teaching languages in such a way that the focus is not on the form but on the subject matter content. The concept has quite a long history, and over many years specific methodological and organizational approaches have been developed. David Marsh was one of the first promoters of content and language integrated learning, coining the acronym CLIL in his publication *Content and Language Integrated Learning at School in Europe* (1994).

The variety of approach models is the consequence of cultural, social, political, and historical factors typical for a particular region. To a large extent, bilingualism or multilingualism in countries with several official languages in which bilingual education has developed, implementation of learning foreign languages in a real, meaningful subject context emerged.

It is worth mentioning that the concept even dates back to history in the work of a significant pedagogue of Czech origin J. A. Komenský (1592 – 1670). He emphasized the need for effective language education (*Orbis Pictus, Janua Linguarum Reserata*). Before 1970, programs focusing on language and content integration emerged as a result of different geographic, demographic, social, and economic developments. Mainly in frontier areas, it was essential to enable pupils to study in a bilingual environment to increase their communication skills in everyday situations with other people in the area.

In countries with several official languages, *immersion education* programs are applied. Canadian Immersion Programmes, focusing on giving instruction in the target language from kindergarten or starting during elementary school (Naves, 2009) prove efficient. The concern about how much content through the students' second language was learned led to the demand for the immersion program evaluation by parents, school boards, and administrators (Naves, 2009). Immersion education has extended from Canada to the USA and Europe. The term *immersion* became a synonym for bilingual education in the 1970s and 1980s.

European bilingual education was influenced to a large extent by the Canadian immersion education program. CLIL is considered a bilingual approach. The pupils acquire their language skills simultaneously with the subject matter acquisition, and no initial language preparation is required. The use of L1 is allowed, too, for a proper understanding of special subject-based terminology both in L1 and L2.

Language diversity has always been one of the main objectives encouraged by the European Union. In the 1990s, debates on language education in Europe led to the investigation and support of innovative methods within the Lingua program (1990), which declared the importance of supporting innovations in foreign language education. Thus the EU started initiatives in the area of content and language integrated learning (CLIL).

Council Resolution of 31 March 1995, one of the first legislative documents of the Council of the European Union that puts focus on the promotion of linguistic diversity, highlights one of the major issues in education. It aims to make language teaching and learning more effective by introducing a range of innovative methods at schools and universities. In light of the above, the Council emphasizes the need to enhance communication skills with particular attention to methods that develop reading comprehension, writing, listening comprehension, and speaking, as well as the teaching of classes in a foreign language for disciplines other than languages, providing bilingual teaching. According to the Resolution, the promotion of learning of languages in technical and vocational teaching results from a growing number of enterprises that need employees mastering several languages of the Union. The pupils in technical and vocational education must have an opportunity to acquire the

language skills necessary to find work and to progress through their careers (Council Resolution, 1995). One of the ways to achieve the objectives is to implement language learning methods adapted to technical and vocational teaching.

In the same year, in the White Paper focusing on teaching and learning towards the learning society, the EU Commission came up with guidelines for action in the fields of education and training. "Training and apprenticeship policies, which are fundamental for improving employment and competitiveness, must be strengthened, especially continuing training" (White Paper. Teaching and Learning. Towards the Learning Society., 1995). Article 127 of the Treaty establishing the European Community stipulates that "the Community shall implement a vocational training policy which shall support and supplement the action of the Member States." This is the basis upon which the EU Commission stated its objectives in the White Paper that the development of proficiency in three foreign languages is one of the main EU priorities. Along with this, the Commission stated that "...it could even be argued that secondary school pupils should study certain subjects in the first foreign language learned, as is the case in the European schools" (Eurydice, 2006). The acronym CLIL is used to describe all educational models in which L2 is used to teach certain subjects in the curriculum other than language lessons. The methodological principles in CLIL promote subject-based lexical competence acquisition by exposing learners to situations promoting genuine communication.

CLIL in vocational secondary education as the means to enhance professional skills in students

Secondary vocational school of mechanical engineering in Bratislava (the capital of Slovakia) provides study programs preparing students either for their immediate involvement in a labor market after completing their studies or prepares students for their entry at technical universities, thus providing continual education in technical sciences. Most of the secondary vocational schools' students in Slovakia decide to continue studying at the Slovak University of Technology in Bratislava, directly at the Faculty of Mechanical Engineering. In order to ensure the vocational-technical education meets the demands of potential employers, the documents, emphasizing integration of language, general and professional skills, were accepted in the Slovak Republic in compliance with the EU document: White Paper. Teaching and Learning. Towards the Learning Society (1995). The EU Commission stated its objectives in the White Paper that the development of proficiency in three foreign languages is one of the main EU priorities. Along with this, the Commission stated that "...it could even be argued that secondary school pupils should study certain subjects in the first foreign language learned, as is the case in the European schools" (Eurydice, 2006).

Knowledge, skills, and competences are measured according to eight qualification levels within the National Qualifications Framework of the Slovak Republic (approved by the Government Resolution no. 105/2009 of 4 February 2009) along with a particular formal level of education. The structure of the framework was approved as a reaction to the recommendations of the European Parliament and the Council of 23 April 2008 about the creation of the European Qualifications Framework for lifelong learning. Consequently, the National System of Occupations was created as a result of cooperation between the Ministry of Labour, Social Affairs and Family of the SR, public administration authorities, local self-government bodies, employers, representatives of employers and representatives of trade unions. The main objective of the system is to enable access to detailed information on the labor market, considering the current needs of employers with the aim to improve and interlink between the employers' demands, education, and training for the labor market (Eurydice, 2019).

Data about the graduates' level of foreign language proficiency and the measure to which they use foreign languages at their workplaces were obtained in a survey

carried out by the Department of Foreign Languages at the Faculty of Mechanical Engineering of the Slovak University of Technology in Bratislava, within which 20 companies in the tech industry were surveyed. 45% of the companies confirmed that language skills mastered by the graduates they employ are sufficient, 25% of the overall number of the companies show neutral attitude, and 20% of them confirmed an insufficient level of foreign language proficiency. 45% of the companies confirmed that their employees use English as a foreign language every day, 30% partially, and 25% not every day. 80% of employers strongly confirmed the importance of communication competence in English in their employees.

Based on the initiatives and the facts mentioned above, the fusion of academic subject matter and specialist language communication competence is thought of as the supreme importance in education.

The acronym CLIL is used to describe all educational models in which L2 is used to teach certain subjects in the curriculum other than language lessons. The methodological principles in CLIL promote subject-based lexical competence acquisition by exposing learners to situations promoting genuine communication.

Research method

The effectiveness of the CLIL principles, introduced into the academic subject *mechanics: strength and elasticity*, was studied by the experiment at the secondary vocational-technical school of mechanical engineering. An increase in the technical subject-based lexical acquisition was the main assumption to be proved by the experiment, along with an increase in motivation in students for studying professional subject-based L2.

Two groups of students were involved in the experiment to compare the outcomes, as well as the students' attitude towards studying L2 by this approach. English, the target language, is the L2 studied by the students in language classes with the amount of weekly 5 hours.

In both the CLIL and control groups, 32 students were required first to write a comprehension test consisting of grammar and reading comprehension parts. The students' outcomes from both groups displayed various proficiency levels of the English language as a target L2. Even though the statistical results do not show a significant difference between the groups, the data collected at the end of the experiment displayed the difference in the progress of the subject-based lexical competence acquisition when the proficiency levels at the beginning and the end of the experiment were compared in students in each of the groups.

Procedures and analyses

The main question positioned at the start of the experiment was that the score in CLIL students would be better than in non-CLIL students in the technical subject-based lexical acquisition. English as a target language was integrated directly into the academic, technical subject.

Selected subject-related topics were, as follows:

- Mechanical properties of materials in engineering,
- Shear stress and shear strain,
- Hooke's law in shear,
- Torsion loading of circular and noncircular shafts.

Taking into account that no CLIL-type lessons have ever been introduced at the secondary vocational school, except language lessons including ESP combination of various topics with no reference to a particular academic subject, completely new teaching materials were prepared in cooperation of both the L2 and the subject teachers.

The lessons were conducted in the way of *soft CLIL* in which the teacher concentrates on the use of tools with a focus on linguistic objectives. It is usually planned for a shorter period over which the students acquire content knowledge though the focus lies on L2 lexical and communication acquisition (Ball et al., 2015).

The structure of the lessons involved academic language input introduced by the L2 teacher through which the content was delivered to students. Then practical tasks based on computing with reference to the studied content followed under the subject teacher's guidance. Content-based terminology and language structures were practiced at the end of the lessons by the use of activity-based tasks promoting cooperation of students in pair or group activities in CLIL group students.

Implementation of the research

Experimental verification of CLIL methodology consisted of:

- pre-test in the English language aimed at testing the students' proficiency level,
- pre-test result assessment,
- designing of studying, teaching and methodical materials,
- Post-test examining the students' cognitive knowledge achievement obtained in English as L2 with a focus on the assessment of the specialist terminology acquisition in a foreign language,
- evidence of CLIL-type teaching units, etc.

Quantitative research methods were applied to obtain results from data collected by questionnaires, as well as to provide the result analyses.

Within pilot research, a questionnaire was used to obtain information about the students' attitudes towards foreign language learning. It focused on what motivates students to study a foreign language, how often, and how much time they spend by studying L2 in the school, as well as within their extra-curricular activities, whether they use extra study materials and information communication technologies (ICT). Students were also asked to express their opinion about the types of activities which they think should be incorporated into classes. Long-term expectations in students with reference to using foreign languages in their future careers were investigated too. Based on the questionnaire data results, English as L2 has been taught by non-native teachers, i. e. Slovak teachers of English in both the CLIL and control groups of students.

The rate of students' interest in integrated learning of subject-based content and English as a target language is shown in Figures 1 and 2. In the CLIL group, 78% and in the control group 55% of students confirmed their interest in the type of education described above.

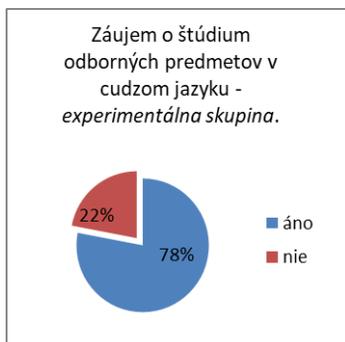


Figure 1: CLIL group

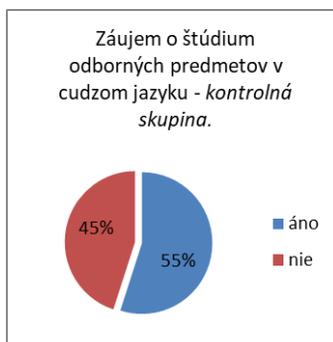


Figure 2: Control group

The types of resources for learning English in the school including extra-materials and ICT are shown in Figure 3.

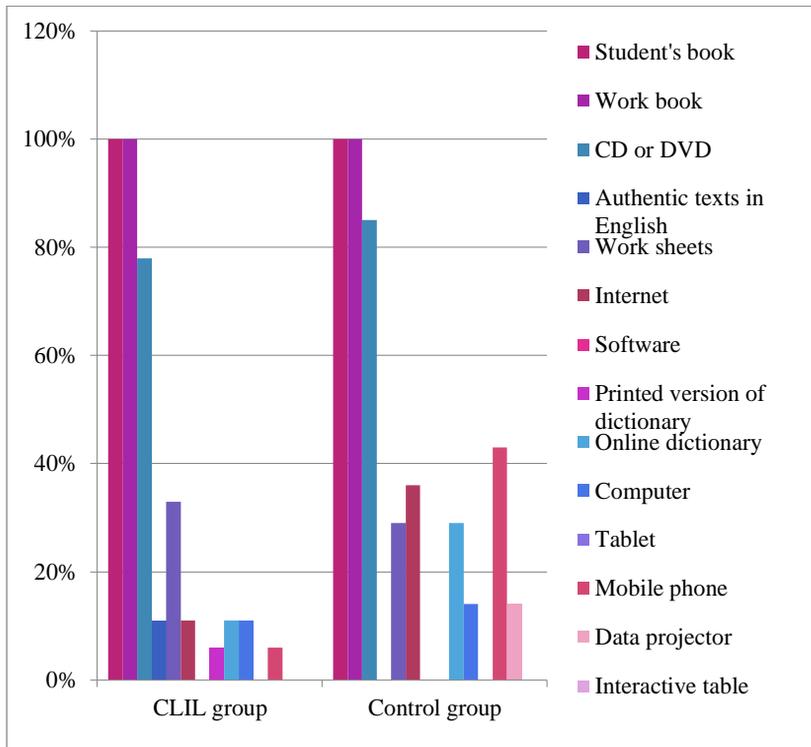


Figure 3: Resources for learning English as L2 in the secondary vocational school of mechanical engineering

What motivates students to study foreign languages with reference to their future plans is provided in Figure 4.

	CLIL group	Control group
Future occupation	83%	64%
Parents' recommendations	17%	36%
Because I enjoy English lessons in the school	22%	14%
Because I am successful in studying English	28%	7%
Travelling abroad	83%	64%
To be able to search for information in English	61%	64%
I enjoy English as L2	56%	29%

For further studying at a foreign university	44%	14%
Other reasons in a particular number of students	1) Compulsory subject 2) Sports activities 3) Conversation with English speaking persons	1) I use English as L2 more frequently than Slovak

Figure 4: Motivation for studying English as L2

Extra-curricular activities with the use of English above students' compulsory duties can be seen in Figure 5.

	CLIL group	Control group
I read English texts published in journals, books, on the internet, etc.	61%	50%
I watch English films / videos	78%	86%
I speak English regularly (with friends, family members, etc.)	28%	36%
I communicate in English in a written form regularly (with friends, family members, social networks, etc.)	33%	21%
I attend an English language course other from that in my home school	11%	14%
I am not interested in and I do not use English in my leisure time	17%	7%

Figure 5: English as a part of extra-curricular activities

Research results and discussion

Through instructional scaffolding, the teacher helped students to achieve mastery in the subject matter area. K-W-L charts helped the students organize knowledge in compliance with: what I know (K), what I want to find out (W), what I learned about the problem (L). Mind-mapping was one of the strategies applied to develop students' motivation and speaking skills while achieving both content and language objectives (Buzan, 1996). Collecting ideas around a particular topic was common for both K-W-L and mind-mapping methods, with an added value of clustering ideas and defining relationships in the latter one (Lipkova et al., 2019). An example of mind-mapping being gradually produced by students over the classes, through instructional scaffolding, is shown in Figure 6.

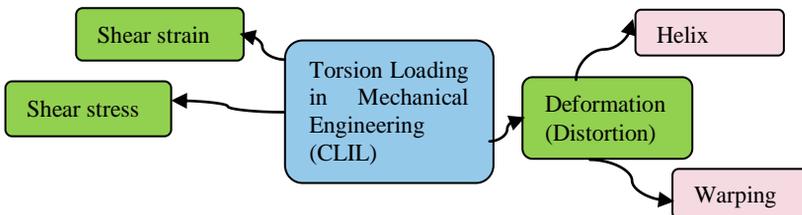


Figure 6: Mind-mapping in Mechanical Engineering

The objective of the research was to verify how effective are the applied CLIL principles in supporting learning specialist English as 2L integrated into a particular academic subject. Thanks to pedagogical experiment, we could compare the

performance of students in two groups with a different approach to learning L2, i. e. CLIL-type learning in one of the groups and traditional way of learning L2 in a control group, separately from the academic subject in the latter one. The main difference laid on the interaction of students and the measure of their involvement in the learning process.

In the research, we applied a pedagogical experiment as the main research method along with additional research methods: questionnaire survey at the beginning and the end of the research, pre-test, and post-test, statistical assessment of the research data, and discussion with the English language teachers.

As regards the academic language, it incorporates the discipline-specific terminology that allows students to acquire knowledge and academic skills. Competency in academic language often refers to a variety of non-linguistic skills that are integral to language mastery, including (The Glossary of Education Reform, 2013):

- academic skills (organizing, planning, researching),
- cognitive skills (critical thinking, problem-solving, interpreting, analyzing, memorizing, recalling),
- learning modes (questioning, discussing, observing, theorizing, experimenting),
- work habits (persistence, self-discipline, curiosity, conscientiousness, responsibility),
- other forms of literacy (technological, online, media, multicultural, etc.).

In that context, the CLIL approach incorporates a combination of principles to enhance communication competence with the use of technical terminology, in the case of this research, related to the academic subject of mechanics: strength and elasticity.

The incorporation of authentic technical texts adapted for teaching purposes provides a good opportunity for understanding the specific meaning of terms within a discourse (Fig. 7 and 8). Thus, authentic technical texts in a foreign language characterized by a high concentration of technical words with their explicit meaning, diagrams, charts, etc. represent valuable teaching materials. Working with text may be realized in the form of team-based activities working on a common project that requires looking up and sorting information related to the task. Interpretation and presentation of the students' findings with their attitude to a specific problem develop both critical thinking and motivation in students. They become more enthusiastic about learning an academic foreign language by discussing an issue and listening to the attempt to understand the utterances of other students.

Terms used to describe a) properties of materials, b) shear loading, c) torsion loading	
shape	Materials change their <i>shape</i> and size.
properties	Engineers have to take into account mechanical <i>properties</i> of materials.
load	Some materials resist deformation under the application of <i>loads</i> .
deformation	<i>Deformation</i> refers to changes in the shape or size of an object.
distortion	There's a small <i>distortion</i> in the shape of this orange.
wear & tear	Wear & tear is a damage that occurs naturally when an object is

	used; it is exposed to external forces.
rotation	The <i>rotation</i> of the cross section at the free end of the shaft is called the angle of twist.
torque	The <i>torque</i> refers to the twisting moment.
helix angle	We recognize that the <i>helix angle</i> is the shear strain of the element.
shear stress etc.	Maximum <i>shear stress</i> occurs at the surface of the shaft.

Figure 7: Specific subject-based terms within the discourse

high elastic modulus	A high elastic modulus is typical for materials that are hard to deform; in other words, materials that require a high load to achieve a significant strain; for example, a steel band.
low elastic modulus	A low elastic modulus is typical for materials that are easily deformed under a load; for example, a rubber band.
force	Force is a measure of the interaction between bodies. Force is known as a vector quantity, as it has both direction and magnitude.
stress	The stress applied to a material is the force per unit area applied to the material. The maximum stress a material can stand before it breaks is called the breaking stress .
strain	Strain is a measure of material deformation in response to an applied force (or stress).
load	Load is a term frequently used in engineering to mean the force exerted on a surface or body.
Hooke's Law etc.	Stress is directly proportional to strain.

Figure 8: Terms and their definitions within the discourse

The starting position of both these groups, tested in language proficiency by comprehension pre-test, indicated a homogeneous community with slightly worse results in the experimental group at the start of the research. Performance in each of the groups over the research period was compared by evaluating post-test outcomes in both groups. Figure 9 compares the distribution of two samples for the post-test in target technical language acquisition. The number of students in the experimental group with poor outcomes in comprehension pre-test decreased in comparison to post-test outcomes. More students demonstrated higher interest in learning L2 integrated into a technical academic subject. Findings in Figure 9 prove higher motivation in experimental students for learning language, as the distribution of two samples displays (Lipkova, 2019).

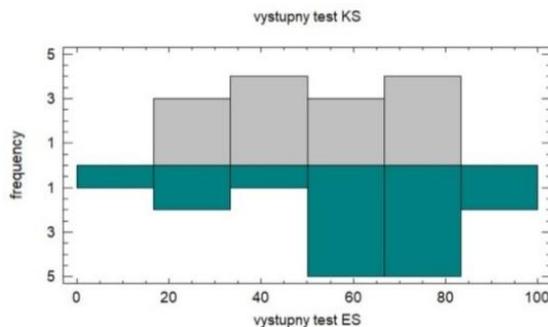


Figure 9: Kolmogorov-Smirnov Test for post-test in control and experimental groups. Legend: ■ Control group; ■ Experimental group

Conclusion

Requirements for quality education result from the need for companies to employ persons with mastery of communication in several foreign languages. Implementation of the CLIL principles into education proves to be a beneficial approach to fostering this tendency.

The research supports the hypothesis that CLIL classes are useful for secondary school learners, and the data collected from a short questionnaire revealed the motivation and interest in students to incorporate more technical subjects into curriculum implementing CLIL models of education.

However, planning and preparing for CLIL lessons is crucial. D. Coyle (2006) stated four basic principles (4Cs) the teacher should focus on when planning CLIL-type lessons: Content, Communication, Cognition, and Culture.

Language *of* learning (language skills, i. e. language related to subject matter content), Language *for* learning (learning skills, i. e. language needed to pursue activities of learning within-pair or group work, discussions, negotiating arguments, writing essays, etc.) and Language *through* learning (applying of what has been learned to provide opportunities for strengthening of knowledge and its extending) are the key elements in supporting of language and cognitive development (Coyle, Hood, Marsh, 2010).

With the CLIL-type lessons, some drawbacks may also be encountered. Designing of study materials and their further preparation prove as time-consuming. In some cases, the teachers do not have a relevant level of language knowledge or communication competence. Lack of enthusiasm and motivation for CLIL lessons is sometimes seen in teachers too. The experience shows that more training courses should be organized for CLIL teachers. Common online databases of CLIL lesson plans sorted according to different disciplines, and the level of education should be available with free access and the upload and download options.

On the other hand, the advantages of the CLIL approach involve high emphasis put on teamwork, an increase in intercultural awareness, acquisition of communicative and specialist lexical competence, enhancement of critical thinking in students, learning based on students' own experience, etc.

More complex research into CLIL has been needed to be carried out covering a wider range of different types of schools, including secondary vocational-technical schools. These types of schools represent a high potential for developing CLIL strategies with more general application into education. The feasibility of effective CLIL lessons can

be guaranteed by closer cooperation between both the subject teachers and the teachers of foreign languages.

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