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Assessing the Success of Content and Language Integrated Learning (CLIL) in Tertiary Engineering Department

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Abstract: Content and Language Integrated Learning (CLIL) is a style of teaching where language skills and content knowledge of a subject are taught together in order to help learners become successful in the global marketplace of academic and professional workplaces. This research looks into the impact of teaching using CLIL to tertiary engineering students in terms of educational attainment, learning a language, and students' satisfaction. To carry out this research, a combination of qualitative and quantitative data collection and analysis in the form of standardized tests and student grades, as well as completion of surveys, interviews, and direct classroom observations, was performed. The results show that students in the CLIL program achieved greater academic success, obtaining an average score of 82.5, compared to a score of 75.3 in the traditional courses. The CLIL participants also registered a 15% improvement in language proficiency, compared to the traditional program participants' 6% improvement. Classroom observations and student surveys also showed that 80 students were actively engaged in the classroom learning activities, and that 78 students were motivated to learn. Regarding the cognitive learning experiences and the lack of teaching materials and training for teachers, the students also mentioned that the CLIL was successful in integrating content and language. The results of this study indicate that in order to strengthen CLIL, a commitment to the redesign of the curriculum, in combination with the development of training courses for faculty to increase their knowledge of teaching and languages, is paramount to achieve success. This study also suggests that CLIL is a highly effective model for engineering educators to teach their students in order to prepare them for the global job market.

Key Words: content and language integrated learning (CLIL), tertiary engineering education, academic achievement, language proficiency improvement, educational models, student motivation, mixed-methods research

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Introduction

In the Content and Language Integrated Learning (CLIL) approach, learners gain subject and language knowledge, promoting multilingualism and cognitive skills. This form of teaching was first developed in Europe in the 1990s. Unlike traditional language education that isolates language acquisition, CLIL involves the acquisition of subject discipline and language skills. With the focus on International Education, CLIL is becoming even more popular across the globe. Unlike CLIL, which includes both discipline and language components of learning, English Medium Instruction (EMI) is focused more on the functional aspect of learning content. As such, CLIL is more appropriate for the discipline of engineering as it concerns the improvement of a student's language skills and the communication of engineering content.

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The rapid expansion of CLIL in different universities is tied to the globalization of education. With the growing number of international students, universities find themselves in competition to attract and retain these students while also meeting the standards of linguistic inclusion. This is particularly true for engineering courses where communication skills and technical language are important.

Regarding the place of CLIL in higher education engineering, the need of the hour is that engineers graduating today need to work in the global domain where English is the language of communication, in both the spoken and written forms, as is the language of scientific research and publications. The focus of CLIL in higher education engineering is that the students of engineering benefit from gaining the technical knowledge and developing the associated linguistic skills as well. This focus is useful in the preparation of engineers for the profession.

Along with that, the increasing frequency with which engineering faculties are partnering with engineering faculties of other countries as well as with engineering firms and research institutes abroad is also evident. Students learn foreign languages in order to be able to read English engineering documents, give English presentations, and work with researchers in foreign countries. This is essential for global engineering education. With the globalization of engineering education, the students of engineering education abroad are also expected to publish papers in foreign journals, participate in foreign conferences, and join international research projects. In the context of the above, the incorporation of foreign languages in engineering education becomes important.

The main purpose of research on these objectives is to;

- Assess the impact of CLIL on engineering education and specifically on academic achievement.
- Measure CLIL with regard to foreign language improvement over other models.
- Assess and evaluate the level of satisfaction and engagement of students in integrated learning environments.
- Identify and/or explain the support systems needed for the successful institutional implementation of CLIL.

The paper has seven major sections. Section II reviews the related literature and draws some conclusions about the themes of the application of CLIL. Mixed methods designs and a preview of the STEP method are narrated in Section III. Section IV uses statistical charts and diagrams to report findings. Section V explains the interpretative dimensions. A summary is found in Section VI, which also includes future practice suggestions.

Literature Review

Different implementers of CLIL across European and Asian contexts found a boost in content understanding and second-language learning via the application of CLIL (Yang, 2015; Tsou, 2018). An engineered CLIL program for students appears to be a better-performing program in comparison to the conventional training seminars on the same subject (Thi et al., 2023). In addition, the CLIL structuring of courses appears to elevate the confidence level of students, as seen in several Asian universities, as learners of the CLIL model tend to demonstrate a better engagement with the English language (Yang, 2015; Ping & Ahmad, 2022). Enhanced motivation and proficiency in language are positive correlates of integrating language and content as opposed to the standard form of English Medium Instruction (EMI) (Thi et al., 2023; Aguilar, 2017). This method effectively boosts students' ability to cognitively absorb language at a higher level by requiring them to process the subject matter in the target language (Dalton-Puffer & Bauer-Marschallinger, 2019; Alonso-Belmonte & Fernández-Agüero, 2018).

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The other main advantage of the CLIL approach is the development of intercultural skills (Coyle, 2018). Exposure to international case studies and collaboration with a diverse peer group fosters the development of transversal skills and emotional intelligence, which is a key component of the modern engineering profession (Nogales-Delgado et al., 2023; Rubtcova & Kaisarova, 2016; Jiang et al., 2022).

The CLIL method has several advantages, such as increased knowledge and skills in different languages (Pérez Cañado, 2023; Yang, 2015), heightened interest and deeper understanding of the different fields of study (Alonso-Belmonte & Fernández-Agüero, 2018; Thi et al., 2023), and higher chances of employment in an international workplace (Ping & Ahmad, 2022; Rubtcova & Kaisarova, 2016). Students report an increased feeling of joy and motivation for mastering complex thoughts and concepts in a foreign language (Thi et al., 2023; Jiang et al., 2022). Since CLIL fully embodies cooperation, students take part in working together to overcome the problems faced in the lessons (Coyle, 2018).

On the other side of the argument, even though the advantages of the CLIL method are many, the challenges can be numerous in such an approach. Teachers lack proper training for lessons in foreign languages, as they may have to teach using a language that they are not fully fluent in (Alonso-Belmonte & Fernández-Agüero, 2018; Aguilar, 2017). There may be a high level of adjustment of the current syllabus to accommodate the CLIL framework (Coyle, 2018; Yang, 2015), and students may experience increased difficulty in the understanding of information that is of a technical nature while they are expected to process such information in a foreign language (Tsou, 2018). As a result, plenty of institutional support and guidance are needed. The ways in which the students are evaluated also have to be improved so as to assess the students' mastery of the different subjects and the foreign languages in a more meaningful way (Zafiri & Zouganeli, 2017). Some students even perceive the CLIL framework to be a heavy load, especially if they do not feel self-assured of their language skills (Rubtcova & Kaisarova, 2016). Therefore, using the right supportive and gradual tools, including technology, to help students adjust to this practice is important for the success of the institution (Chen et al., 2024).

There is a rich body of literature establishing the link between integrated learning and workplace preparedness. The evolution of educational practices from the approach of English Medium Instruction (EMI)-fused CLIL (Content and Language Integrated Learning) represents a more balanced approach to the pedagogical dilemma of achieving technological and communicative developed. There are obstacles, such as a lack of training for many teachers, but the cognitive and affective advantages of CLIL make it an important means of updating engineering curricula at the tertiary education level.

Methodology

In the study, a mixed-method approach was employed to understand the extent and impact of CLIL (Content and Language Integrated Learning) on learning. In this sense, the study was strengthened, and its findings were made more reliable / validated in the sense that qualitative and quantitative research were employed. Quantitative research provided the measurable aspect of learning, and qualitative research of the learning experience from the students' perspective, as well as their perceptions of CLIL. The longitudinal aspect of the study was the tracking of learning every few semesters, which is more accurate than a single retrospective measure of what is learned and also provides a fuller picture of the CLIL experience and its effectiveness, along with a cross-sectional measure of learning at points in time.

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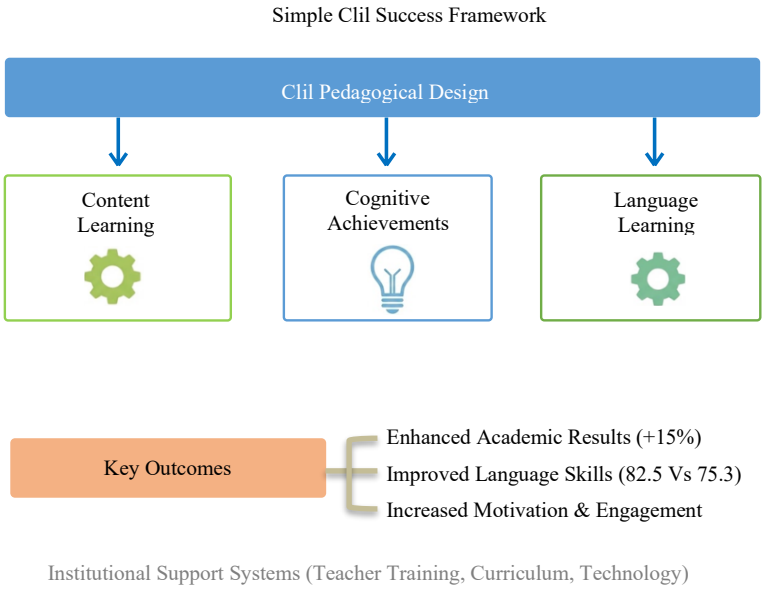

Figure 1: Conceptual Framework for Green Human Resource Management (GHRM) and Environmental Sustainability

Figure 1 shows that in tertiary education, engineering divided into sections shows that the foundational CLIL Pedagogical Design moves the whole framework. The success of this Pedagogical Design is assessed in relation to four firmly established Workplace Support Systems: Learner and Teacher guide training for linguistic and pedagogical work, Curriculum Redesign & Adaptation that incorporates technical engineering work and training, Adaptation of Technical Tools & Adjustments to the Learning Environment, and the Use of CLIL Assessment Methods. Each of these systems supports and influences the structure of pedagogical design, which influences the activation of the other CLIL Pedagogical Design Components, and the remaining Core Components. This learning structure leads to the framework's primary Objective, Key Outcomes, Elevated Educated Attainment (created through Elevated Grades and Pass Outcomes), Improved Student Involvement and Enthusiasm, and Elevated and Improved Student Language Attainment (in Teaching Outcomes of +15% from an Average of 82.5 to 75.3). The entire framework holds an Engineering Discipline & Industry Context, with the intention that graduates have the necessary communication and technical skills for the Global Workplace Context.

The participant pool for this study was comprised of undergraduates in the CLIL engineering courses of several higher learning institutions. Standardized assessments of language ability, transcripts, and surveys of student satisfaction were the empirical data sources. Additionally, semi-structured interviews were held with students and teachers, and interviews were complemented by data taken from participant observations to provide additional detail to teachers' data.

The faculty were part of the research study and were asked to share the difficulties faced in teaching and planning courses, and the extent of support the administration provided. Including all the stakeholders enhances the understanding of the effectiveness of CLIL. With the selection of the sample of students ensuring representation from all the different engineering areas, the findings can be generalized to all the other engineering areas, namely, electrical, civil, and even computer engineering. This will enable the study to address various other engineering technical fields in addition to mechanical engineering in evaluating the effectiveness of CLIL.

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For the analysis of the quantitative data, the main statistical methods used were the comparison of students' grades and their performance in standardized tests, while the qualitative data were thematically analyzed to capture students' perceptions of the experience they had with CLIL and the various challenges they faced while implementing it, and the advantages they gained from the process. The findings from the two analyses showed the effectiveness of CLIL.

The study used triangulation to show the reliability of the results, while the findings were said to be valid because of the cross-checking of findings using various data sources, including the statistical method of regression analysis that examined the association of the students' level of skills and academic performance, while thematic analysis provided the similarities and differences in the experiences of the students with CLIL.

Results

Table 1 compares the average grades of students who took CLIL-based engineering courses with those of students who took the traditional courses. The data suggests that CLIL students not only earned better average grades, but also exhibited better average performance. This is indicated by the lower standard deviation. The CLIL courses also had higher pass rates, indicating that students achieved better outcomes due to the integrated approach.

Table 1: Average Academic Performance (Grades out of 100)

Course Type	Standard Deviation	Average Grade	Pass Rate (%)
CLIL Courses	6.2	82.5	96
Traditional Courses	8.1	75.3	89

Figure 2 shows the average results of students in the provisions of CLIL (Content and Language Integrated Learning) and the average results of students in the traditional provisions of engineering. The students in CLIL not only performed better, but also had a better understanding of the subject (82.5 compared with 75.3) and of the technical English.

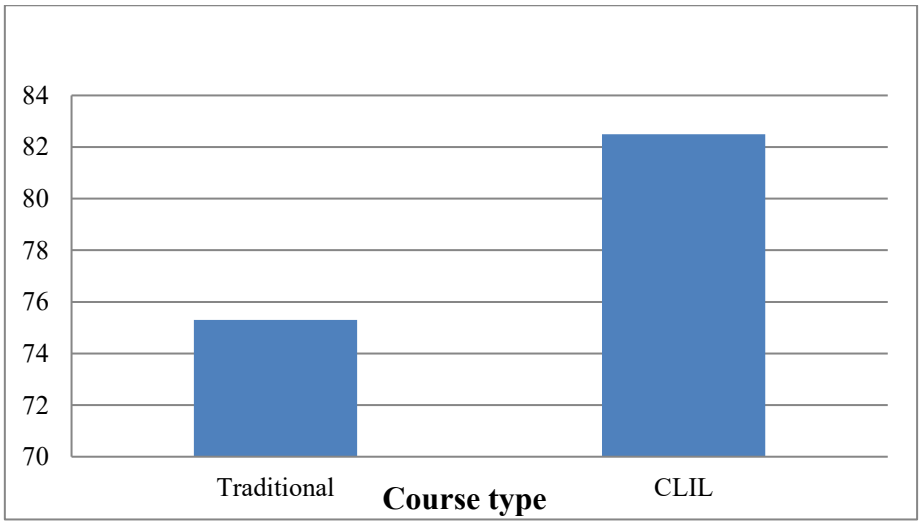

Figure 2: Average Grades in CLIL vs Traditional Courses

Clearly, the performance of CLIL-based learners is better than that of students in a traditional engineering course. The integration of the two models of learning boosts the learners' cognitive processing, critical thinking, and retention. Also, CLIL learners had less deviation in their individual scores to a lower extent, showing that CLIL had a more pronounced effect in the performance of all its participants than the

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traditional models of learning. This illustrates that CLIL is beneficial to a higher number of learners other than the normally highest achievers. The information shows that CLIL has a constructive effect on learners in engineering programs, and advocates that... more effectively.

One clearly definable advantage of CLIL is the improvement in the learning of students' language combined with learner/technical content in order to prepare them for challenges of global learning and to begin lifelong learning.

Table 2 summarizes the data collected from the surveys. The table lists the satisfaction with CLIL courses

Table 2: Student Satisfaction with CLIL Courses (Survey Results)

Satisfaction Dimension	High (%)	Moderate (%)	Low (%)
Motivation to Learn	78	18	4
Confidence in English Usage	72	21	7
Engagement in Class	80	15	5
Overall Satisfaction	76	19	5

Most students reflected on the survey as being highly satisfied with motivation and engagement, while the challenges of CLIL reflected there was a need to improve their confidence in English.

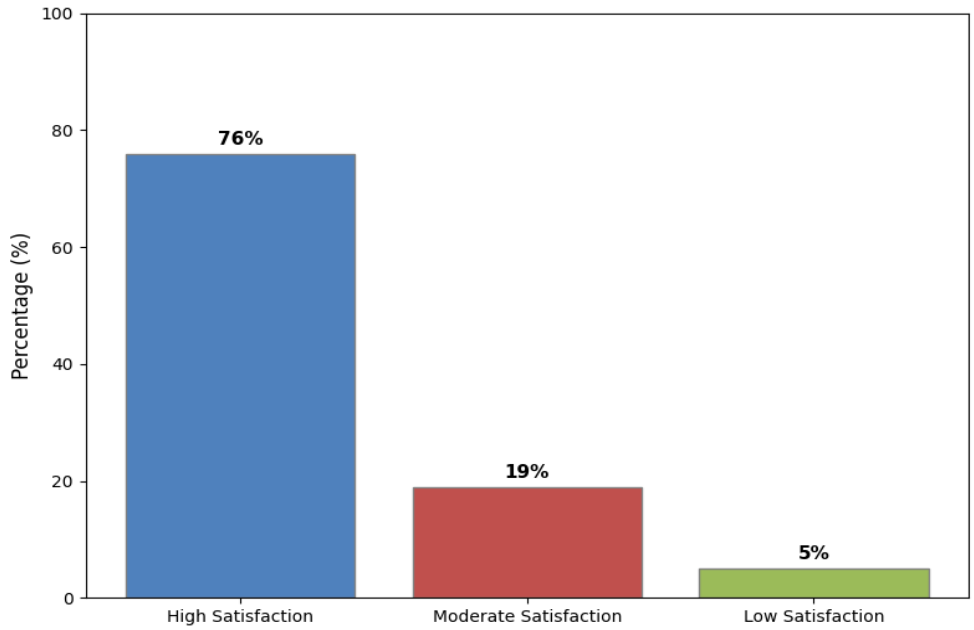

Figure 3: Overall Satisfaction with CLIL Courses

Figure 3 shows the grade point average and the level of satisfaction perceived by the students suggest that CLIL students scored higher on language proficiency tests compared to students from conventional learning (CLIL students had 15% higher average score, whereas students from the traditional program had only 6% higher average score).

Table 3: Language Proficiency Improvement (Test Scores)

Course Type	Pre-Test Average	Post-Test Average	Improvement (%)
Traditional Courses	70	76	+6
CLIL Courses	68	83	+15

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CLIL courses not only enhance the learning of subjects but also brush up the language learning, as shown by these stats from table 3.

Discussion

Research indicates that adopting the Content and Language Integrated Learning (CLIL) method leads to enhanced educational and linguistic accomplishments across the tertiary engineering disciplines. As seen in IV, those in CLIL courses tended to outperform those within the traditional coursework structures. The average grade differences (CLIL average = 82.5 and traditional average = 75.3) coupled with minimal variances in performance and higher pass rates depict the robust and positive effects observed. Development in academics and linguistics corroborates various primary literature in this field (Coyle, 2018; Tsou, 2018). As a holistic dual focus pedagogy, CLIL substantiates the pedagogy of CLIL, as well as the importance of cognitive activities and processes in adults (Alonso-Belmonte & Fernández-Agüero, 2018).

Remarkable performance in the CLIL courses can be accredited to the CLIL environment's incorporation of active learning styles (Thi et al., 2023; Jiang et al., 2022). Constructing and processing complex and technical materials in English requires of students to think of and conceptualize comprehensive and technical materials. This need enhances apprehension and thinking of the students (Alonso-Belmonte & Fernández-Agüero, 2018; Thi et al., 2023). These students, particularly due to the nature of CLIL as a collaborative environment, experience parallel growth in their presentation and requisite activities that CLIL incorporates and as such, see a substantial and positive impact to the development of their confidence. The growth of these transversal skills will benefit today's engineers as they to collaborate in the global work environment. The balance between the challenges of functioning with the initial cognitive load, focusing CLIL courses and technical content in a foreign language, in this case English, and the rise in overall satisfaction is notable given that (CLIL courses (76%) reported high satisfaction respectively) (Tsou, 2018).

Still, the study argues for the consideration of significant institutional challenges necessary for the proper medium- to long-term adoption of the model. The main challenges include students' high initial cognitive load, and more importantly, the absence of extended relevant experience and training of CLIL teachers (Alonso-Belmonte & Fernández-Agüero, 2018; Aguilar, 2017). It is necessary that instructors are domain experts as well as have the pedagogical skills to teach specialized content using a second language (Aguilar, 2017). To sustain the long-term integration of CLIL in teaching, an establishment should support its faculty through an organized redesign of their curriculum integrated with ample professional development (Yang, 2015; Tsou, 2018), and that are implemented with a great deal of patience in relation to the students (Coyle, 2018; Chen et al., 2024), to the greatest extent possible. It is important to eliminate these challenges, if CLIL is to be moved from a pilot practice to a model to educate im/migrated engineers.

Conclusion

Integrating language instruction along with technical skills increases the quality of engineering instruction at the undergraduate level. Data showed learners in these language and instruction programs had academic and technical skills beyond standard engineering learners. Students in the language and technical skills program had heightened motivation and engagement in the program, and had demonstrated proficiency in technical English skills for each aspect of listening, speaking, reading, and writing. By motivating learners to see and confront challenges, prepare learners to enter the world with practical and technical skills, along with necessary cultural skills for the global world. Furthermore, the cooperative

nature of CLIL motivates and supports learners to have the requisite confidence to work and to communicate effectively in the global scientific community. For CLIL to work successfully it relies on practice policy from the institution to innovate and remodel the curriculum and guide learners in pedagogy. Initially, the CLIL students may have challenges, such as a result of the lack of specialised teaching, but this should be managed with the support of the institution. The students should be prepared to have a dual position of role to focus on the technical skills of the subject and along with the linguistic skills of the subject. For further study, it is recommended that the impact of CLIL be evaluated on the student's outcome and that the CLIL be evaluated across the engineering discipline. To conclude, CLIL is a successful and vital educational model that helps integrate knowledge and skills in the field of engineering and language proficiency that is necessary in the context of global engineering.

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