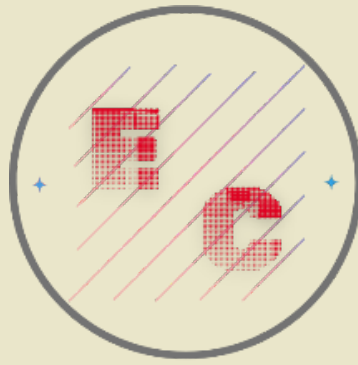




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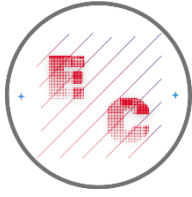
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Ecuador

Use of the CLIL approach to strengthen reading skills in Ecuadorian technical high school students through computer science-related materials.

Using the CLIL approach to strengthen reading skills in Ecuadorian technical high school students through computer science–related materials

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ABSTRACT

Learning English as a foreign language represents a major challenge for high school students in Ecuador, particularly in the development of reading comprehension. This study analyzed the relationship between the application of the Content and Language Integrated Learning (CLIL) approach, mediated by Informatics-related material, and the development of English reading skills. A quantitative, quasi-experimental, comparative–correlational design was used, complemented by a qualitative component. The participants were 121 technical high school students majoring in Informatics: an experimental group (n = 60) that worked with the CLIL methodology through technical vocabulary, specialized readings, the Informatics Dictionary project, and interactive

activities, and a control group ($n = 61$) that followed traditional language instruction. A ten-point reading proficiency test assessed five sub-skills (skimming, scanning, vocabulary in context, making inferences, and structure and purpose), together with a Likert-scale perception questionnaire and an open-ended question. The experimental group obtained a higher mean score ($M = 8.17$; $SD = 2.10$) than the control group ($M = 7.61$; $SD = 2.30$), with a statistically significant difference in the skimming sub-skill ($p = .033$) and a small overall effect size ($d = 0.25$). More than 72% of the respondents valued the methodology positively across all dimensions, and the qualitative analysis highlighted technical vocabulary acquisition, motivation, and the connection with students' future professional life. It is concluded that CLIL with Informatics-related material is a relevant pedagogical alternative to strengthen English reading skills in Ecuadorian technical high school education.

Keywords: CLIL; reading comprehension; English as a foreign language; Informatics; secondary education.

RESUMEN:

El aprendizaje del inglés como lengua extranjera representa un desafío importante para los estudiantes de bachillerato en Ecuador, especialmente en el desarrollo de la comprensión lectora. El presente estudio analizó la relación entre la aplicación del enfoque Content and Language Integrated Learning (CLIL), mediado por material relacionado con la Informática, y el desarrollo de las habilidades de lectura en inglés. Se empleó un diseño cuantitativo, cuasiexperimental y de alcance comparativo–correlacional, complementado con un componente cualitativo. Participaron 121 estudiantes de bachillerato técnico en Informática: un grupo experimental ($n = 60$) que trabajó con la metodología CLIL a través de vocabulario

técnico, lecturas especializadas, el proyecto Informatics dictionary y actividades interactivas, y un grupo de control ($n = 61$) que siguió la enseñanza tradicional del idioma. Se aplicó un test de suficiencia lectora sobre diez puntos que evaluó cinco subhabilidades (skimming, scanning, vocabulario en contexto, inferencias, y estructura y propósito), junto con un cuestionario de percepción en escala de Likert y una pregunta abierta. El grupo experimental obtuvo un promedio superior ($M = 8.17$; $DE = 2.10$) frente al grupo de control ($M = 7.61$; $DE = 2.30$), con una diferencia estadísticamente significativa en la subhabilidad de skimming ($p = .033$) y un tamaño del efecto global pequeño ($d = 0.25$). Más del 72 % de los encuestados valoró positivamente la metodología en todas las dimensiones, y el análisis cualitativo destacó la adquisición de vocabulario técnico, la motivación y la conexión con la futura vida profesional. Se concluye que CLIL con material informático constituye una alternativa pedagógica pertinente para fortalecer la lectura en inglés en el bachillerato técnico ecuatoriano.

Palabras clave: CLIL; comprensión lectora; inglés como lengua extranjera; educación secundaria; metodologías de enseñanza.

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INTRODUCTION

The learning of English as a foreign language (EFL) has become a priority within contemporary educational systems due to its relevance for access to scientific knowledge, international communication, and academic and professional opportunities in a globalized world (Cenoz & Gorter, 2020; Macaro, Curle, Pun, An, & Dearden, 2018). In this context, secondary education represents a key stage for the development of linguistic competencies that enable students to interact with academic texts and develop higher cognitive skills associated with the comprehension of complex information (Grabe & Stoller, 2020).

Among the four fundamental language skills, reading comprehension occupies a central role in foreign language learning, as it facilitates access to disciplinary knowledge, the development of academic vocabulary, and the construction of meaning from written texts (Nation, 2013; Jeon & Yamashita, 2014). Recent studies have shown that difficulties in English reading comprehension continue to be a significant challenge for students who learn the language in contexts where it is not used as an everyday communication language (Pérez-Cañado, 2018; Teng, 2020). These difficulties are usually associated with factors such as limited exposure to the language, the scarcity of academic reading strategies, and the use of traditional teaching methodologies centered on the memorization of grammatical structures (Macaro et al., 2018; Nation, 2013).

In response to these pedagogical limitations, the Content and Language Integrated Learning (CLIL) approach has emerged as one of the most relevant methodologies in the teaching of English as a foreign language. CLIL is characterized by integrating academic content learning with the development of language skills, using the target language as the medium of instruction to address topics from different areas of knowledge.

Recent research has shown that educational programs based on CLIL can generate significant improvements in the development of language skills, particularly in reading comprehension and the acquisition of academic vocabulary (Pérez-Cañado, 2018; Nikula, Dalton-Puffer, & Llinares, 2013). This is largely due to the fact that the approach promotes interaction with authentic materials and relevant thematic content that allows language learning to be contextualized (Dalton-Puffer, 2011). Likewise, empirical studies have shown that students participating in CLIL programs tend to demonstrate higher levels of motivation, autonomy, and engagement compared to those following traditional language teaching methodologies (Teng, 2020; Lasagabaster, 2008).

From a pedagogical perspective, the implementation of the CLIL approach is usually organized through a methodological sequence that progressively integrates disciplinary content

and language learning. Several authors have proposed structured teaching models based on various stages or phases that guide the learning process (Meyer et al., 2015; Meyer & Coyle, 2017). In this context, the application of CLIL can be understood through six main teaching phases.

The first phase corresponds to the activation of prior knowledge, in which the teacher introduces the topic and stimulates students' initial reflection through questions, discussions, or exploratory activities. The second phase involves the presentation of content and key vocabulary, providing linguistic scaffolding that enables students to understand the fundamental concepts of the topic. Subsequently, in the third phase, the exploration and comprehension of content is developed, generally through the reading of specialized texts, the analysis of information, or the solving of problems related to the topic being studied (Llinares, Morton, & Whittaker, 2012).

The fourth phase focuses on cognitive development and communicative interaction, where students use the language to discuss ideas, interpret information, and collaboratively construct knowledge. In the fifth phase, language production is promoted, either through written or oral activities that allow students to apply the vocabulary and concepts learned. Finally, the sixth phase corresponds to the evaluation and reflection of learning, where both the results of disciplinary content and the progress in language development are analyzed (Meyer et al., 2015; Meyer & Coyle, 2017).

Despite the widely documented benefits of the CLIL approach, recent studies have identified some challenges in its implementation. Among the most common pitfalls are the lack of balance between content learning and language development, the insufficient use of linguistic scaffolding strategies, and the limited teacher preparation to effectively integrate both components within the educational process (Pérez-Cañado, 2012; Morton & Llinares, 2017). Likewise, some researchers have noted that in certain educational contexts teachers tend to prioritize disciplinary content over linguistic interaction, which can limit the language practice

opportunities necessary for the development of communicative and reading comprehension skills (Dalton-Puffer, 2011; Cenoz & Gorter, 2020).

In contexts where English is learned as a foreign language, as occurs in many Latin American educational systems, these challenges can be amplified by factors such as limited exposure to the language, the lack of specialized teaching resources, and differences in the level of linguistic competence among students (Macaro et al., 2018). For this reason, it is necessary to analyze the real impact of methodologies such as CLIL on the development of specific language skills within concrete educational contexts.

In the literature, two modalities of implementation of the approach are distinguished. The so-called hard CLIL is content-driven, so that the disciplinary subject is taught through the foreign language; on the other hand, soft CLIL is language-driven, as topics in the area of knowledge are incorporated into the language class with the main purpose of promoting language development (Ball, Kelly, & Clegg, 2015; Marsh, 2002). The subject of Computer Science has been identified as a particularly suitable area for working with CLIL, given that English functions as a language of great impact on computing: that is, programming languages, technical documentation, interfaces and a large part of the digital resources are in that language, which guarantees permanent contact with authentic inputs (Kussaiynkyzy and Dringó-Horváth, 2021). The use of computer-related materials, in addition to increasing motivation, favors the development of specialized vocabulary and comprehension of technical texts (Mehisto, 2012; Ball, 2018).

In Latin America, and particularly in Ecuador, research on CLIL is still at an early stage, as noted by Banegas (2022) and Hemmi and Banegas (2021); the available studies have focused primarily on university teacher training and pilot experiences (Argudo, Abad, Fajardo-Dack, & Cabrera, 2018; Barre & Villafuerte, 2021; Andrade Mendoza, Padilla, & Padilla, 2020), so that a gap in empirical evidence regarding its application with Informatics-related materials in

technical high school education persists. The present study seeks to contribute to bridging that gap.

In this regard, the study aims to analyze the relationship between the application of the CLIL approach and the development of English reading skills in Technical High School students in the area of Informatics, compared with those following traditional teaching methods. Through a correlational approach based on data collection in the current educational context, this research seeks to identify possible differences in performance between students to whom this teaching methodology was applied, relative to students who use traditional methodologies in the learning of English.

METHODOLOGY

Study Design

The research adopted a quantitative approach with a quasi-experimental, comparative–correlational, cross-sectional design, complemented by a qualitative component derived from an open-ended question, yielding a mixed-methods approach with a predominantly quantitative emphasis. Two groups of students from the Colegio de Bachillerato Ricaurte, majoring in Informatics, participated in the study: an experimental group that received English instruction through the CLIL approach using topics and materials exclusively related to Informatics throughout the academic year, and a control group that continued with the traditional language teaching methodology centered on grammar, using materials developed exclusively by the teachers, with mixed topics only minimally related to the Informatics area. The independent variable was the teaching methodology (CLIL vs. traditional method) and the dependent variable was the level of development of English reading skills, measured through five sub-skills.

Population and Sample

The population consisted of students from the technical area with an Informatics specialization at the Colegio de Bachillerato Ricaurte, an Ecuadorian educational institution. The sample, selected through non-probability convenience sampling with intact groups, comprised 121 students: 60 in the experimental group and 61 in the control group, ranging in age from 15 to 18 years. The perception questionnaire on the methodology was completed by 60 students ($N = 60$). Participation was voluntary and had no bearing on the participants' academic grades.

Procedures

Implementation of the CLIL Intervention

During the academic period, the experimental group worked on English content using Informatics topics under a soft CLIL orientation, that is, language-driven. The instructional sequence followed six phases: activation of prior knowledge; presentation of content and key vocabulary with linguistic scaffolding; exploration and comprehension of technical texts; communicative interaction and cognitive development; oral and written language production; and evaluation and reflection on learning. The materials and activities included readings on hardware, software, computer parts, and programming fundamentals; the Informatics Dictionary project, consisting in the creation of an illustrated glossary of 40 technical terms; dialogues, games, and interactive activities aimed at applying vocabulary in communicative situations such as Role Plays based on real-life contexts that future Informatics professionals would face. The control group pursued the same English curricular objectives through activities on diverse topics with a primary emphasis on developing grammatical knowledge and conventional activities, with sporadic integration of Informatics-related topics.

Administration of the Reading Proficiency Test

At the end of the intervention, both groups took a reading proficiency test scored out of ten points, structured around five sub-skills: skimming (global reading), scanning (locating specific information), vocabulary in context, making inferences, and recognizing text structure and purpose. Each sub-skill was scored out of ten points and the overall score corresponded to the student's overall performance on the test.

Administration of the Questionnaire

At the end of the reading test, the group that participated in the experience was administered a perception questionnaire consisting of 20 items on a four-point Likert scale (1= Agree, 2= Strongly agree, 3= Disagree, 4= Strongly disagree), organized into six dimensions: (1) interest and motivation, (2) reading comprehension, (3) vocabulary and language skills, (4) application and relevance, (5) overall effectiveness, and (6) evaluation of reading strategies. The instrument also included an open question: "What do you like most about learning English through topics related to Computer Science?", whose answers were subjected to a thematic analysis.

Instruments

The questionnaire comprised three main data collection dimensions: the reading proficiency test, the Likert-type perception scale, and the open-ended qualitative question. Quantitative data were processed using descriptive statistics (means, standard deviations, and percentages) and inferential statistics: Welch's t-test for independent samples, the Mann-Whitney U test as a non-parametric contrast, and Cohen's d as a measure of effect size, with a significance level of $\alpha = .05$. Table 1 presents the research variables.

Table 1*Research Variables*

Variable	Operational definition	Indicadores	Instrument / scale
Teaching methodology (independent)	Application of the CLIL approach with Informatics material vs. traditional method	Experimental group (CLIL); control group (traditional)	Record of the instructional intervention
English reading skills (dependent)	Performance in English text comprehension	Skimming; scanning; vocabulary in context; inferences; structure and purpose	Reading proficiency test scored out of 10
Perception of the methodology	Student assessment of the CLIL experience	Interest and motivation; reading comprehension; vocabulary; application and relevance; effectiveness; reading strategies	5-point Likert scale (17 items) and open-ended question

Note: A correlation was performed between the study variables and the main indicators and scales used as analytical instruments.

Ethical Statement

The research was conducted with the authorization of the educational institution's authorities and with the informed consent of the participants and their legal guardians. Confidentiality and anonymity of the information were guaranteed: results are reported in aggregate form using participant codes, with no data that would allow individual identification. The study did not involve risks for students nor did it affect their academic evaluation, and it was conducted in accordance with the ethical principles of educational research.

RESULTS

Table 2

Comparison of Reading Performance between the Experimental (CLIL) and Control Groups

Measurement	GE (n = 60) M (DE)	GC (n = 61) M (DE)	t	p
Overall score (/10)	8.17 (2.10)	7.61 (2.30)	1.40	.165
Skimming	8.25 (2.89)	7.05 (3.21)	2.16	.033*
Scanning	8.83 (2.50)	8.36 (2.70)	1.00	.319
Vocabulary in context	7.20 (3.38)	6.39 (3.78)	1.24	.218
Inferences	8.33 (2.86)	7.87 (3.35)	0.82	.414
Structure and purpose	8.14 (3.20)	7.62 (3.49)	0.84	.403

Note: EG = experimental group; CG = control group; M = mean; SD = standard deviation. Welch's t-test for independent samples. * $p < .05$. The effect size for the overall score was $d = 0.25$; the Mann-Whitney U test confirmed the result ($U = 2092.5$; $p = .164$).

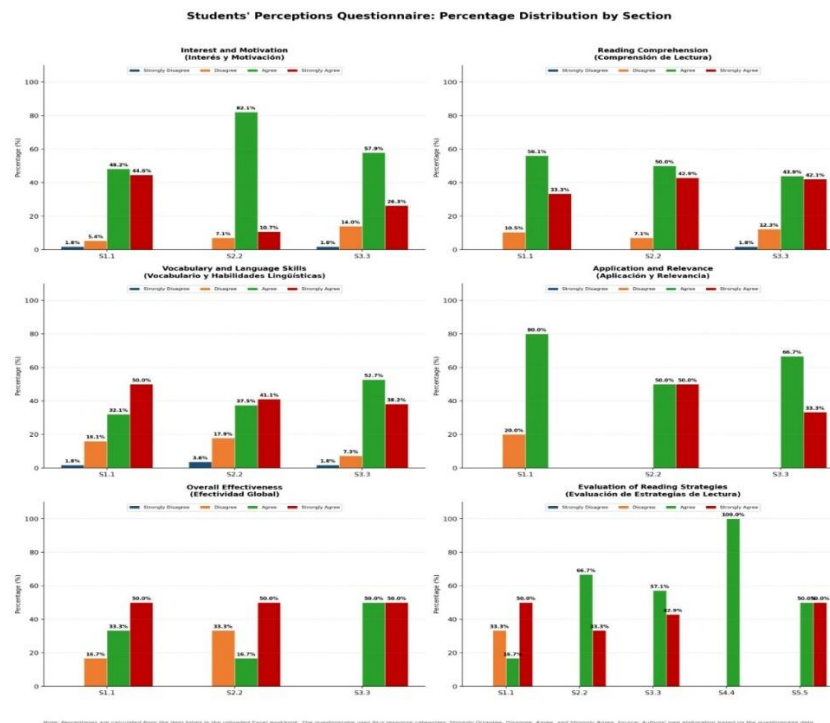
The experimental group outperformed the control group both in the overall score (8.17 vs. 7.61 points) and across all five sub-skills evaluated. The overall difference did not reach statistical significance ($p = .165$) and corresponds to a small effect size ($d = 0.25$); however, in the skimming sub-skill the experimental group's advantage was statistically significant ($p = .033$), with a difference of more than one point (8.25 vs. 7.05). The largest descriptive gaps were recorded, in addition to skimming, in vocabulary in context (7.20 vs. 6.39), which is consistent with the intervention's emphasis on technical vocabulary and the global reading of Informatics texts. In both groups, the sub-skill with the lowest performance was vocabulary in context, while scanning had the highest averages.

Results According to the Likert Scale

Figure 1 summarizes the percentage distribution of responses to the perception questionnaire (N = 60) across the six dimensions evaluated.

Figure 1

Percentage distribution of students' responses by section.



Note: Percentages are calculated over the total number of participants (N = 60).

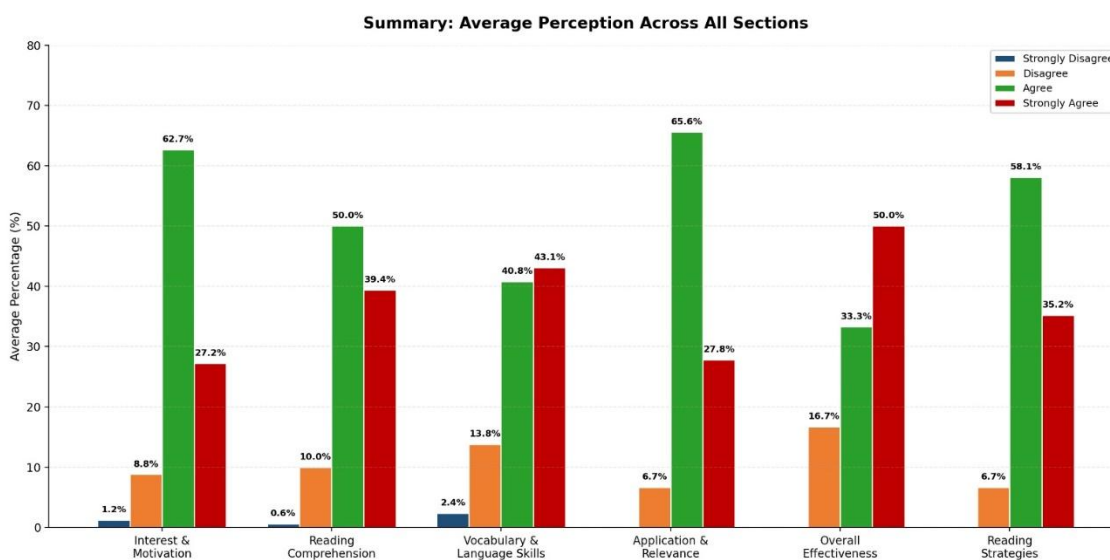
Responses were measured on a four-point Likert scale (1 = strongly disagree; 5 = strongly agree). Authors' own elaboration.

All six dimensions recorded agreement levels (agree plus strongly agree) above 71%. The overall effectiveness dimension concentrated the highest rating, with an average agreement of close to 79% (for example, item 5.3 reached 47.5% agree and 32.5% strongly agree), followed by application and relevance (approximately 76%) and evaluation of reading

strategies (approximately 76%). Interest and motivation (72%), reading comprehension (74%), and vocabulary and language skills (73%) likewise showed a clearly favorable trend. Neutral responses ranged between 13.8% and 18.8%, while cumulative disagreement (disagree plus strongly disagree) did not exceed 12% for any item.

Figure 2

Percentage distribution of responses to the perception questionnaire by dimension and item.



Nota: The interpretation of the results is the authors' own.

These results indicate that students perceive that learning English through Informatics content increases their motivation, enhances their text comprehension, and is relevant to their technical training.

Open-Ended Question Results

The thematic analysis of the responses to the open-ended question made it possible to identify six emerging themes, which are presented in Table 3 along with their frequency and the participants' representative ideas.

Table 3*Emerging Themes from the Open-Ended Questionnaire Question.*

Emerging theme (n)	Frequency	Representative ideas
Technical vocabulary and Informatics concepts	15	Learning technical vocabulary, computer parts, programming terms, and hardware and software terminology.
Improvement of English language skills	11	Improvement of vocabulary, pronunciation, oral expression, reading comprehension, and overall English proficiency.
Connection with career and professional development	9	English as preparation for employment, technical studies, and future professional practice.
Motivation through engaging activities	8	Games, interactive activities, dialogues, and dynamic classes that make learning enjoyable.
Practical application to real situations	6	Use of English in daily life, comprehension of real texts, and authentic communication.
CLIL and integrated learning	4	Learning English and Informatics simultaneously, making learning faster and more meaningful.

Note: Frequency of occurrence of each theme in students' responses. Authors' own elaboration.

The most frequent themes — technical vocabulary ($n = 15$) and overall language improvement ($n = 11$) — converge with the quantitative results, particularly with the experimental group's descriptive advantage in vocabulary in context and the high rating of the vocabulary dimension on the Likert scale. Likewise, the connection with the future career ($n = 9$) and the motivation generated by the activities ($n = 8$) partly explain the high levels of agreement in the application and relevance and interest and motivation dimensions.

DISCUSSION

The results of this study show that students who learned English through the CLIL approach with Informatics-related material obtained better reading performance than their peers instructed with the traditional methodology, in which topics of various kinds — with an emphasis on grammatical aspects and only sporadically on Informatics — were used as the guiding thread for language development, with a statistically significant advantage in global reading (skimming) and favorable descriptive differences across all five sub-skills evaluated. This pattern is consistent with European evidence attributing improvements in receptive skills, especially reading, to CLIL programs (Lasagabaster, 2008; Ruiz de Zarobe & Jiménez Catalán, 2009; Pérez-Cañado, 2018), and with findings linking exposure to authentic materials with the development of academic vocabulary and the comprehension of complex texts (Nation, 2013; Grabe, 2009; Koda, 2005).

The small overall effect size ($d = 0.25$) and the absence of significance in the total score, however, call for a cautious interpretation. As Sylvén (2013) warns, CLIL results are strongly conditioned by context: the intensity of exposure, teacher training, and the availability of materials. In this case, the intervention was concentrated in one academic period and in a soft CLIL orientation, so it is reasonable that the clearest gains are observed in the sub-skill most practiced during the experience — global reading of technical texts — and in specialized vocabulary, in line with what Kussaiynkyzy and Dringó-Horváth (2021) noted regarding the suitability of Informatics as CLIL content due to the role of English as the lingua franca of computing. Table 4 summarizes the comparison of the main authors with the findings of the present study.

Table 4*Comparative Table of Main Authors in Relation to the Study Findings*

Autor(es) y año	Contexto	Main finding	Relation to the present study
Coyle, Hood y Marsh (2010)	Theoretical framework (Europe)	The 4Cs model (content, communication, cognition, and culture) guides the integration of language and content.	Supported the design of the six-phase instructional sequence with Informatics material.
Ruiz de Zarobe y Jiménez Catalán (2009)	Europe, various levels	Consistent evidence of CLIL benefits for receptive skills.	Consistent with the favorable differences across all five reading sub-skills.
Sylvén (2013)	Sweden, secondary level	CLIL outcomes depend on context, exposure, and teacher preparation.	Explains the small effect size obtained after a limited-duration intervention.
Pérez-Cañado (2018)	Spain, monolingual contexts	CLIL produces positive effects without detriment to the L1 or disciplinary content.	Consistent with reading improvement without affecting Informatics subject learning.
Kussaiynkyzy y Dringó-Horváth (2021)	Systematic review, computer science	Informatics is an ideal area for CLIL due to the role of English as the lingua franca of computing.	Consistent with the centrality of technical vocabulary in the qualitative results (n = 15).
Mehisto (2012); Ball (2018)	CLIL materials design	The quality and relevance of materials determines the outcomes of the approach.	Authentic Informatics material fostered motivation and perceived relevance (76% agreement).
Teng (2020)	Young English learners	Instruction in metacognitive reading strategies improves comprehension.	Supports the high rating of the reading strategies dimension ($\approx$ 76% agreement).
Argudo, Abad, Fajardo-Dack y Cabrera (2018)	Ecuador, teacher training	The implementation of CLIL in Ecuador requires methodological strengthening.	The study provides Ecuadorian empirical classroom evidence from technical high school education.
Barre y Villafuerte (2021)	Ecuador, secondary education	The adoption of CLIL in Ecuador is still incipient and poorly documented.	Contributes to bridging the local research gap identified in the literature.

Note: Authors' own elaboration based on the literature review and results obtained.

At the attitudinal level, the high agreement levels in all six dimensions of the Likert scale (above 71%) and the emerging themes from the open-ended question confirm what the literature reports regarding the motivational effect of CLIL and materials relevant to students' interests and aspirations (Mehisto, 2012; Coyle & Meyer, 2021). The perceived connection between English and students' future professional life, the third most frequent theme, reinforces the argument that integrated content and language learning becomes meaningful when it is anchored in the student's technical specialization (Meyer & Coyle, 2017; Lin, 2016). Likewise, the linguistic scaffolding applied during the intervention phases is grounded in the notion of the zone of proximal development (Vygotsky, 1978) and in the evidence on the role of classroom discourse in CLIL settings (Llinares et al., 2012; Nikula et al., 2013).

This study has limitations that must be considered. Intact groups were used without a prior measurement (pretest), so it is not possible to rule out initial differences between groups; the test showed a possible ceiling effect, as a significant number of students achieved the maximum score; and the perception questionnaire was administered only to the students who participated in the experience, which prevents contrasting perceptions between groups. Future research should incorporate pre- and post-test designs, instruments with a greater difficulty range, scale reliability analyses, and longer intervention periods, as well as extend the experience to other professional tracks in Ecuadorian technical high school education (Banegas, 2022; Macaro et al., 2018).

CONCLUSIONS

The comparative analysis showed that the application of the CLIL approach with Informatics-related material is associated with a better development of English reading skills in Ecuadorian technical high school students. The experimental group outperformed the control group in the overall score of the reading proficiency test (8.17 vs. 7.61 points) and in all five sub-skills evaluated, with a statistically significant difference in global reading (skimming) and a small overall effect size, attributable in part to the limited duration of the intervention.

Students' perception was consistently favorable: more than 71% expressed agreement with the methodology across all six dimensions evaluated, with the highest ratings for overall effectiveness and the application and relevance of the content. The qualitative analysis showed that students value, above all, the acquisition of technical vocabulary from their specialization, the overall improvement of the language, the connection with their future professional life, and the motivating nature of the activities, which confirms the relevance of Informatics material as a vehicle for English learning.

It is concluded that the CLIL approach, in its language-driven modality and mediated by Informatics content, constitutes a viable and relevant pedagogical alternative to strengthen English reading comprehension in Ecuadorian technical high school education. Its progressive implementation is recommended, accompanied by specific teacher training, the design of authentic materials linked to professional tracks, and assessments with pretest–posttest designs that allow for a more precise estimation of the methodology's effect.

Declaration of conflict of interest

The author declares no conflict of interest related to this research.

Declaration of authorship contribution

The author carried out the conceptualization of the study, the methodological design, the data collection and analysis, as well as the writing, review, and editing of the manuscript.

Artificial Intelligence Usage Statement

The authors declare that they used artificial intelligence as support for this article, and also that this tool does not in any way replace the intellectual task or process. After rigorous reviews with different tools that confirmed the absence of plagiarism, as evidenced in the supporting documentation, the authors state and acknowledge that this work is the product of their own intellectual effort and has not been written or published on any electronic or AI platform.

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