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Impact of CLIL on Scientific English and Problem-Solving Skills: A Quasi-Experimental Study in Moroccan Middle Schools

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ABSTRACT

This study examines how CLIL (Content and Language Integrated Learning) can scaffold Moroccan school students to enhance their scientific English and problem-solving skills. This is important as it integrates language learning with subject mastery, a concept increasingly valued in academia and critical thinking development. The study employed a one-group pre-test and post-test design, with 25 middle school students participating in a science-oriented CLIL intervention. The results of a paired t-test revealed a significant improvement in scientific English proficiency and problem-solving ability following completion of the course. Compared to pre-test scores, post-test scores had increased considerably, concluding that the CLIL technique helped students acquire desirable academic skills (M difference = -5.640, SD = 3.303, SE = 0.661, t (24) = -8.539, p = 0.000), with a 95% confidence interval of [-7.003, -4.277]. This finding directly contributes to the ongoing efforts in Morocco to transform language and content instruction. It demonstrates that CLIL can significantly enhance learning outcomes, offering a pathway to improving the quality of teaching and learning in Moroccan schools.

INTRODUCTION

In the era of an increasingly interconnected world, communicating in English has become increasingly crucial, particularly in academic and professional settings. It is no longer restricted to having informal conversations; demand for them has dramatically increased in the scientific and technological fields. Educational systems worldwide are adopting new methods to teach English, not just for language proficiency but also to enhance subject learning. Since English is increasingly essential for academic and professional development, Morocco has a recognized gap in integrating practical language training with subject comprehension.

Moreover, Morocco has a distinct vision for language learning and developing critical thinking skills. Hence, English is introduced into public schools from the very first year of middle school. Moreover, the pilot phase has started in some primary schools that are considering a broad transition. This desire is to reduce the use of the French language in order to increase international competitiveness and align the education system with international standards. This leads to adjustments in the curriculum to ensure that English is taught and incorporated effectively, developing students into analytical thinkers for the global job market (Csefrs, 2015). In

addition to making a case for matching geography-based classes to an interconnected world, this initiative is part of a broader effort to modernize education. This will allow students adequate time to develop their English proficiency, which is essential in meeting the demands of the global economy.

In line with this vision, CLIL emerges as a powerful approach to achieving these educational goals. CLIL aims to provide a more effective learning experience for students by establishing a connection between language and content. That will lead to a more compelling and context-aware educational experience. This method of education is widely adopted in different parts of the world due to its impact on enhancing students' language skills while helping them understand academic concepts (Gulzar et al., 2023). Contextually speaking, within Moroccan private schools, CLIL offers a compelling model for promoting educational achievements in the context of a growing emphasis on English language skills.

Morocco's private education system is a vital component of the country's overall education system. Because they employ a different approach, private schools offer a more flexible and creative curriculum than public institutions. These institutions also have a significant advantage in implementing innovative teaching approaches and instructional practices, which enable them to meet the needs of their students more effectively. CLIL can enhance students' English language learning and their comprehension of scientific texts. This dual vision reflects the educational objectives of training students for a global workforce and fostering critical thinking abilities, which are vital for academic development and success.

Much of the research conducted on CLIL over the past few decades has focused on analysing the effects of this technique across various educational settings, including secondary and higher education. Research suggests that CLIL can enhance linguistic proficiency, cognitive abilities, and subject-specific knowledge. However, limited work considers its application in the context of middle schools, specifically public and private schools in Morocco. If such a disparity exists, it would necessitate specific research examining the effectiveness of content and language-integrated learning in these contexts and its potential benefits for younger children.

The fact that CLIL has the potential to address problems common to language learning and subject understanding makes it worthwhile to examine the influence of CLIL on private middle school students in Morocco. This project focuses on bridging the gap between language learning and the actual acquisition of the material, with an emphasis on the English scientific language itself. Including scientific material in English, these courses are designed to enhance students' understanding of scientific vocabulary and concepts while refining their analytical skills. This technique helps students achieve their academic goals with ease and simultaneously prepares them for their future educational and professional aspirations.

The key research question that this paper is addressing is: How does implementing CLIL impact the scientific English proficiency and analytical abilities of middle school students in Morocco?

Thus, this paper examines how CLIL promotes language and cognitive development, providing valuable insights into the teaching and learning process. It aims to add to the literature on CLIL with a detailed study of its impacts on students in private schools in Morocco. This quantitative study aims to fill this gap by investigating the relationship between the degree of implementation and the scientific proficiency of the English language among middle school students, with a statistical test for significance.

One of the most significant pedagogical trends in recent years is CLIL, which aims to integrate language instruction with content instruction (Olsson, 2021). This system is an innovative solution to the challenge of learning language skills in a foreign language while pursuing subject courses (Serra & Feijoo, 2022). Therefore, it is practiced in a specific context (Sheridan, Tanaka, & Hogg, 2019) and encourages students to use it meaningfully (Lázaro-Ibarrola & Azpilicueta-Martínez, 2021). When students are immersed in language and subject matter, deeper understanding and retention of both are promoted (Coyle, 2007). The second language also contributes to the development of critical thinking and the refinement of second language skills. Moreover, CLIL also enhances general academic performance and boosts motivation to study for students(Kruawong & Phoocharoensil, 2024).

The theory behind CLIL is that language learning is more effective when it occurs in meaningful contexts that engage students with real-world, relevant content (Coyle et al., 2010). This method has also been developed based on Vygotsky's sociocultural theory, which emphasizes the crucial role of social interaction and contextual learning in cognitive development (Zavershneva & van der Veer, 2021). CLIL aims to integrate language teaching with academic subject study, creating a dual educational context in which language and cognitive development are intertwined (Tai, Wei, & Loh, 2025).

CLIL has been proven effective in improving students' language competence, as evidenced by research synthesized from the CLIL literature (Lázaro-Ibarrola & Azpilicueta-Martínez, 2021). Several studies indicate that students engaged in CLIL programs (Olsson, 2021) tend to achieve higher language proficiency than students in traditional language instruction environments (Jafarigohar, Divsar, & Etemad, 2022). For instance, one study found that CLIL students significantly outperformed their non-CLIL peers in vocabulary knowledge, pronunciation, and overall language proficiency (Dalton-Puffer, 2008). In this regard, CLIL's focus on content and language provides a more practical approach to increasing foreign language knowledge (Lasagabaster & Sierra, 2009). Motivation and engagement have also increased, as CLIL offers the benefit of applying the language skills learned (Lázaro-Ibarrola & Azpilicueta-Martínez, 2021; Pladevall-Ballester, 2018). This suggests that CLIL effectively enhances language competence and provides high-quality language learning when implemented in textbooks (López-Medina, 2021).

In addition to language competence, it is already established that CLIL has a positive impact on academic achievement in language-specific fields (Dalton-Puffer, 2008). Research has shown that the dual-focused nature of CLIL not only enhances students' language skills but also positively affects their understanding of the content being taught to them (Huang, 2020). However, more and more investigations have shown that students who received instruction in formal CLIL programs outperformed their classmates by teaching their home language in other subjects, as well as science and mathematics (Nashaat-Sobhy, Mestre-Mestre, & MacDonald, 2024). Together, they demonstrate that CLIL is a valuable tool in making excellent progress towards mastering both language and content.

Despite the increasing amount of literature on the subject, studies on CLIL have primarily focused on secondary and tertiary education contexts (Fernandez-Fontecha, O'Halloran, Wignell, & Tan, 2020). Recent findings indicate that CLIL is still being studied in terms of its applicability in a middle school context (Lo & Lin, 2019). These studies suggest that CLIL may be particularly

advantageous at this educational stage, given the developmental needs and cognitive abilities of younger learners.

To develop scientific English competence, it is particularly relevant that an element of CLIL is using scientific facts in English language teaching (Piacentini, 2021). CLIL enables students to acquire and produce scientific language better (Coyle, 2007). It achieves this by introducing relevant terms and concepts to students in a context that is meaningful to them while they are engaged with the material (Mahan, Brevik, & Ødegaard, 2021). Studies by Llinares, Morton, and Whittaker show that CLIL is appropriate for teaching scientific content in English. This approach supports students in developing their language skills and better grasping science concepts (A Llinares, Morton, & Whittaker, 2012). CLIL refers to the integration of content and language, enabling learners in the science classroom to engage in meaningful and comprehensive learning (Tagnin & Ní Ríordáin, 2021). This study demonstrates a significant improvement in students' ability to comprehend and apply scientific language through the implementation of an integrated approach to teaching in a CLIL classroom (Piacentini, 2021).

Moreover, content-based learning helps develop analytical skills, e.g., critical thinking and problem-solving (Valverde Caravaca, 2019). These skills are crucial for academic success and future employment opportunities (Hemmi & Banegas, 2021). As a result, some studies have found that students who participated in the program exhibited improved analytical abilities (Sakamoto, 2022). This enhanced ability to analyze benefits greatly benefits students (Zhang et al., 2025), making them better equipped to tackle the challenges they will encounter in higher education and the workforce (Fernández-Costales, 2023). The CLIL enhances students' critical thinking and problem-solving skills, enabling them to tackle challenges in various academic and career contexts (Aiello et al., 2025). Not only does this improve their academic performance, but it also enhances their future employability.

The private sector in Morocco presents some interesting opportunities for implementing CLIL, alongside potential aspects of contention. Some challenges that need to be overcome to implement CLIL are the need for trained teacher specialists and the objective of producing suitable teaching materials. While CLIL offers numerous benefits, including enhanced language skills and improved academic achievement, it also presents challenges. On the other hand, the positive effect of CLIL on linguistic and subject-content learning outcomes provides strong motivation for addressing these challenges (Ana Llinares & Cross, 2022).

The current evidence indicates that CLIL is effective in enhancing academic achievement and language proficiency across various contexts (Nguyen, Nguyen, Gilanyi, Hoang, & Gao, 2025). However, further research is required to target Morocco's educational context and issues directly related to implementing CLIL. To address this gap, this study aims to investigate the impact of CLIL on the scientific English proficiency and analytical skills of Moroccan middle school students. The findings are valuable when tailoring courses to meet the unique needs of students in Morocco, a factor widely recognized as crucial for improving their academic journey and enhancing their mastery of the learning language. Through this study, educators can also gain insight into the subtle benefits of adopting a CLIL approach to teaching scientific English, developing analytical skills, and acquiring competencies for effective and meaningful learning in today's globalized educational landscape. In addition, this study’s findings could add to its relevance to CLIL and its applicability to the existing literature on CLIL. Such a foundation can serve as the basis for further CLIL studies in other disciplines or grade levels.

The grounded theory method was employed in a qualitative study conducted by Salah Ben Hammou and Abdelaziz Kesbi, who examined the views of Moroccan physics instructors on the use of English and French as the medium of instruction (Ben Hammou & Kesbi, 2021). Their findings suggest that instructors are generally satisfied with the bilingual curriculum that incorporates French; however, they are critical of the Ministry of Education for excluding them from the language reform process. The survey also reveals that Moroccan instructors do not believe Moroccan schools are prepared to teach students with English as the medium of instruction. This means that the state of the English language and the level of competency among teachers and pupils should be improved before these things are introduced. We need to examine the status of the English language and the proficiency of teachers and pupils in the language before implementing such policies. This study will also bridge a gap in the literature, as there is currently a lack of available information addressing Moroccan educational policies and practices. The successful implementation of English-medium instruction can also contribute to developing a more educated and skilled workforce, boosting the economy, and enhancing the quality of life for all Moroccans. This research can help policymakers design an effective reform to the education system.

METHODS

This study employs a one-group pre-test/post-test design, which is ideal for measuring change over time in a single group of subjects and controlling for individual differences that might confound the results. This design is beneficial for ethical educational research, where the effectiveness of an intervention is evaluated in a specific population (Cook, Campbell, & Day, 1979). Moreover, a one-group pre-test/post-test design offers a more economical and resource-friendly means of measuring the effectiveness of interventions than other research designs. This is important since it reflects the real-world context in which educational programs and interventions are delivered. Administering a pre-test to the participants before delivering the CLIL intervention provided a baseline for a better understanding of the students' analytical skills and scientific English knowledge. For example, the post-test, which measures what happens after something is done, allows one to directly compare how a person performed before treatment versus how they did afterward.

Moreover, this design is feasible and efficient in a classroom where time and resources are often limited (Shadish, Cook, & Campbell, 2002). This could even eliminate the need for a control group, which is not a trivial task in classrooms where each child requires individualized instruction. The design, in which the same students are mapped to their two different performances over time, provides an insightful approach for the researcher to determine if this CLIL intervention had any effect. In this situation, therefore, the best design is a one-group pre-test/post-test design. The design enables the direct comparison of students' performance before and after the intervention.

Additionally, eighteen first-grade students were selected to pilot the Test-Retest (Thabane et al., 2010). Pre and post-tests were given to them; these tests had a design similar to the primary test used in the study. The initial stage, which lasted three weeks, was critical for verifying that the testing instruments were accurate and reliable. Their representative sampling improved the consistency of assessments across time (Cohen, L., Manion, L., & Morrison, 2007). This method allowed the researcher to assess the reliability of the tests and adjust them, if

necessary, before applying the study on a larger scale. The researcher can validate that the test instrument was appropriate and effective for the specific population by conducting a test-retest pilot with a group of first-grade students. Cronbach's alpha was used to assess the reliability of the test, and a high level of internal consistency was observed. Pilot testing allowed for test validation. The high values of Cronbach's alpha indicate that the Test-Retest that was derived is consistent and accurate, as illustrated below:

Table 1. Case Processing Summary

		N	%
Cases	Valid	18	100,0
	Excluded[a]	0	,0
	Total	18	100,0

The Case Processing Summary indicates that all 18 cases evaluated are valid, accounting for 100% of the dataset. No instances were eliminated, ensuring data authenticity and reliability. This rigorous approach enhances the study's quality, resulting in more accurate and meaningful conclusions and ensuring informed decisions based on all available information.

Table 2. Reliability Statistics

Cronbach's Alpha	N of Items
,948	2

According to the results, the test-retest scores showed high internal reliability and consistency, with a Cronbach's alpha value of 0.948. Although the scale consists of only two items, the scores accurately reflect changes or stability in the examined variable. Due to the high dependability of the measuring equipment, its robustness in assessing Test-Retest findings is confirmed, which provides the opportunity for reliable data analysis regarding the effectiveness of the intervention. The strong Cronbach's alpha also suggests that the items on the scale are internally consistent, which contributes to the validity of the study's findings and conclusions about the intervention's effect on the variable being examined. The research results are more likely to be authentic due to this high reliability, which also enables the evaluation of the intervention's effectiveness with increasing confidence. The consistent and reliable data from the test-retest assessments give a solid foundation for acceptable conclusions.

The experience occurred at TAZI School in Casablanca, Morocco, focusing on a CLIL science intervention. The teacher-researcher who conducted this action research did so with the permission and guidance of the school and collected data concerning the privacy, identity, rights, and well-being of each participant. Professionalism and integrity were demonstrated in aspects of the study beyond data collection, storage, and analysis. The experimental group (n = 25; 16 females, nine males) participated in a science-oriented Content and Language Integrated Learning (CLIL) intervention designed to enhance their problem-solving skills and scientific knowledge. With a varied experimental group, the results were more generalizable to students across the population. The diversity of the experimental group ensured that the findings could be generalized to a broader population of students, providing findings with more generalizable conclusions. This approach enhanced the research's overall rigor and potential influence on instructional practices in science classrooms. Also, the group's composition differences might have provided insight into how different genders respond to CLIL interventions in science education.

This study involved assigning second-year students from Tazi Middle School in Casablanca, Morocco, to an experimental group. A pre-test was administered to each participant to assess their proficiency in scientific English and critical thinking (problem-solving skills) prior to the implementation of the intervention. The treatment administered to these students included physics, mathematics, and science tasks, as well as exposure to various activities, such as experiments, group projects, discussions, and presentations, to deepen their understanding of scientific concepts. As a result, a post-test was conducted following the intervention to assess their proficiency in scientific English and thinking skills. Pedagogical strategies that guided the treatment are shown in the following tables:

Table 3. Mathematics: Area and Perimeter

Content	Communication	Cognition	Materials
Area and Perimeter	Imperative vocabulary related to calculating area and perimeter	Developing reasoning skills to differentiate and calculate the area and perimeter by applying the proper formula, developing critical thinking skills, and creativity	Squared paper, coloured cards, scissors.

Source: Portal To English 2 (H.Q. Mitchell- Marileni Malkogianni, 2018)

The primary aim was to teach Maths in English (typically, students study it in French). The teacher draws students' attention to the word math " and asks them if they like the subject and are good at it as a warm-up. The teacher then draws a mind map and writes the word *"SHAPE" in the centre, allowing students to* deduce the word's meaning. The teacher also encourages students to think of any shapes they are familiar with. In the next step, the teacher elicits answers from students (square, triangle, rectangle, etc) to help them draw the shapes next to the corresponding word on the board; the teacher then explains that each shape has an area and a perimeter (draw a shape of an area and a perimeter on the board and ask students if they understand the difference), the teacher can refer students to page 110 students' book in Portal to English 2 and look at the (H.Q Mitchell- Marileni Malkogianni, 2018) graph paper on the right, after different stages, the teachers asks students to work in pairs or groups to the tasks including the last task on page 111: *Imagine your school wants to turn an old building into a student area. Examine the floor plan of the building below and determine its area and perimeter*. As displayed in the Table below:

Table 4. Teaching Physics through the English Language

Content	Communication	Cognition	Materials
The four forces of aerodynamics	Present simple vocabulary related to the four forces of aerodynamics	Using a dictionary, guessing the meaning of unknown words, extracting specific information, understanding procedures through visual prompts, developing problem-solving skills, developing critical thinking skills, and scientific inquiry skills	Paper, airplane, paper, ruler.

Source: Portal To English 2 (H.Q. Mitchell- Marileni Malkogianni, 2018)

The teacher draws a paper airplane on the board, and then a diagram explains to students the role of each force, according to the text, to help them better understand the four forces. It is a fun and engaging way to interact with students during the lesson. This hands-on approach can make complex concepts more accessible and memorable for students. By incorporating visual aids and interactive elements, the teacher can cater to different learning styles and enhance comprehension. Students can physically see how the forces interact, making it easier to grasp the concepts. This method also encourages active participation and critical thinking among students.

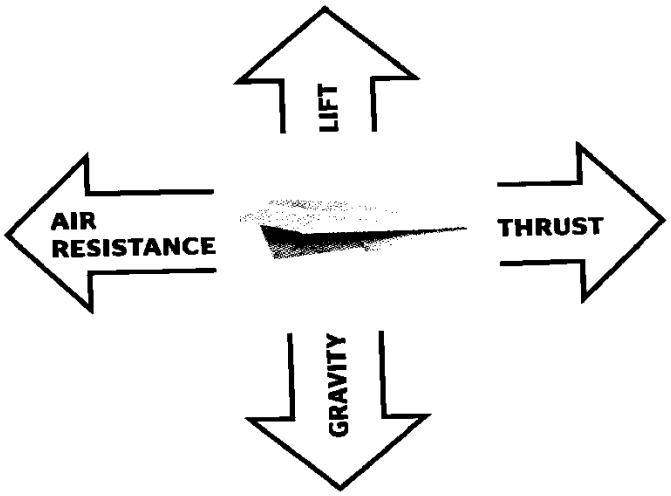

Figure 1. Diagram of Forces (H.Q. Mitchell- Marileni Malkogianni, 2018)

Table 5. Teaching Science through the English Language

Content	Communication	Cognition	Materials
The greenhouse effect and global warming	Present Simple, cause-and-effect structures, vocabulary related to the greenhouse effect, and global warming	Using a dictionary, understanding procedures through visual prompts, guessing the meaning of unknown words, extracting specific information, developing critical thinking skills, and scientific inquiry skills	Glass jar

Source: Portal To English 2 (H.Q. Mitchell- Marileni Malkogianni, 2018)

The lesson emphasizes the importance of communication skills by promoting the use of a dictionary, understanding processes through visual cues, and inferring the meaning of unfamiliar terms. Students can enhance their vocabulary and understanding by integrating various learning approaches. This method enhances students' confidence in expressing themselves effectively in both written and spoken formats. From a cognitive perspective, students are instructed to extract precise information, develop critical thinking skills, and actively engage in scientific investigation. The primary material used is a glass jar, most likely for a practical experiment demonstrating the greenhouse effect. This approach combines subject expertise, linguistic proficiency, and cognitive development to foster a comprehensive understanding of scientific concepts within an English language framework. Exercise promotes the development of critical thinking and problem-solving skills in young people. Through active engagement in the experiment, students can utilize their language skills in a tangible context and deepen their understanding of scientific concepts. This

interactive method promotes a comprehensive learning experience, integrating language learning with scientific investigation.

FINDINGS AND DISCUSSION

The study results are significant because they show the role of CLIL in developing critical thinking and problem-solving skills among Moroccan middle school learners. This study contributes to understanding the potential advantages of using CLIL as a pedagogical approach with implications for students' cognitive growth. It focuses on adding new approaches to enhance higher-order thinking skills among the students. To analyse the outcomes, the study conducted t-tests to compare the scores before and after the intervention. Descriptive statistics for the pre-test and post-test scores are presented in the tables below. Participants showed a statistically significant increase in post-test scores.

Table 6. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair data	**Pre-test**	10.36	25	3.053	,611
	Post-test	16,00	25	2,236	,447

The descriptive statistics of the experimental group's and post-test scores are presented in the table above. The average pre-test score is 10.36 ($STdd$=3.053), post-test score is 16.00 ($STdd$=2.236). The standard error means for the pre-test and post-test are 0.611 and 0.447, respectively. Regarding the mean score, these multiple comparisons revealed a significant increase from the pre-test to the post-test, indicating a more substantial improvement in the performance of critical thinking skills and scientific English, particularly in mathematics, physics, and science. It was a statistically significant performance improvement. This means that the treatment or intervention introduced had a beneficial effect on the academic capacity of the participating individuals. In summary, the findings show how targeted actions on specific CLIL competencies can enhance problem-solving and academic performance in mathematics, physics, and science.

Table 7. Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pre-test - Post-test	-5.640	3,303	,661	-7,003	-4,277	-8,539	24	0.000

The mean difference between the pre-test and post-test scores of the experimental group is -5.640, with a standard deviation of 3.303 and a standard error mean of 0.661. The difference is a 95%confidence interval of -7.003 to -4.277. T-value of -8.539, 24 df; p [0.000; > 0.05] — would suggest a statistically significant difference. This considerable change in the overall post-test results, in contrast to the pre-test score, suggests that the treatment given to the experimental group was helpful. These scores have shown significant improvement and serve as direct evidence of the intervention's effectiveness. The results indicate that the experimental group demonstrated considerable learning progress regarding mathematics, physics, and science.

This study's results confirm the current research findings on the benefits of content and language-integrated learning in improving critical thinking and language skills. The comparative analysis of pre-test and post-test data showed significant improvement in students' mastery of scientific English terminology, supporting Dalton-Puffer's (2008) assertion that CLIL enhances subject-specific language competencies. Llinares et al. (2012) suggest that integrating subject matter with language instruction is effective, and this enhancement demonstrates this. These findings align with Vygotsky's sociocultural theory (Zavershneva & van der Veer, 2021), highlighting the importance of mediated learning through interaction in supporting learning related to language and subject matter content.

CLIL is highlighted to develop analytical and critical thinking skills. The claims of Mehisto et al. (2008) were confirmed and supported by the fact that students demonstrated improved problem-solving skills and progressed through cognitive processes in the post-test. CLIL promotes a deeper level of cognitive engagement. This finding is particularly relevant in Moroccan education contexts where rote learning characterizes classroom experiences (Lo & Lin, 2019). In line with Fernandez-Fontecha et al. (2020), the study reaffirmed the transformative capacity of CLIL by directly engaging students with contemporary scientific disagreements through the medium of English.

A key finding relates to student motivation and engagement, which were superbly high during the intervention. This supports Tagnin and Ríordáin (2021), who argue that the multi-disciplinary approach of CLIL shows students increase engagement through teaching. Using authentic scientific tasks and practices in English appeared to bridge students' academic learning with real-world applications, adding meaning and enjoyment to the learning experience. According to research, students involved with CLIL tend to demonstrate a greater engagement with the subject and language (Coyle et al., 2010).

Still, the study also highlights issues that resonate with earlier studies. Teachers expressed concern about their preparedness to deliver CLIL instruction effectively, a sentiment that aligns with Eurydice's (2006) recommendation for the establishment of extensive teacher training programs. Without enough support, educators might struggle to balance subject and language demands, a challenge also noted by Lasagabaster and Sierra (2009). These challenges highlight the need to enhance professional development and establish gender-sensitive structures that support CLIL in Moroccan schools.

The findings of this study align with previous literature on the effectiveness of the CLIL strategy in integrating language competence, critical reflection, and student engagement, but highlight the need to address implementation issues. These findings contribute to the growing body of research supporting CLIL as a new and effective pedagogical strategy in bilingual and multilingual settings. Future research should investigate the long-term effects of CLIL interventions, with a focus on issues of scalability and sustainability, as well as addressing teacher preparedness and resource constraints.

This cross-analysis would be of utmost importance in providing policymakers with insight into how to leverage these findings to revise and amend Morocco's educational system. Policymakers must ensure that CLIL is centrally embedded in national curricula, providing adequate support for schools in terms of resourcing, professional development for educators, and adapting the approach to suit local needs. These steps involve providing tailored training in CLIL for teachers, fostering interdisciplinary collaboration, and integrating CLIL into mainstream

teacher preparation programs. To provide better integration of CLIL, schools need to create an environment that encourages the content-language teaching approach and incorporates material in a way that meets the needs of their students. However, the limitations of this investigation require a more explicit analysis. The results may not be generalizable due to the small sample size, the control group, and the potential for confounding factors, such as students' prior knowledge or individual differences in cognitive abilities. Moreover, these limitations should be acknowledged.

CONCLUSION

This study highlights the immense benefits of implementing Content and Language Integrated Learning methodologies in Science, Math, and Physics instruction, which ultimately facilitates the development of critical thinking, problem-solving skills, and scientific English proficiency, especially among middle school students in Morocco. A limitation of the generalization of the results is that the study relies on a single sample group, and the influence of CLIL on both public and private educational institutions is not considered. For further research, longitudinal studies should be conducted to assess the long-term effects of CLIL. Policymakers should consider institutionalizing CLIL teacher training as part of national professional development programs to ensure that teachers are well-equipped to deliver the approach successfully. Furthermore, private schools can collaborate with universities to design context-based CLIL courses, providing greater alignment with global academic standards and regional demands. These steps would help Moroccan pupils address the challenges of a globalized world and become more effective critical thinkers and problem solvers.

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