

FRANCESCA COSTA, VALENTINA MORGANA

Multimodal input for subject-specific vocabulary and cognates in CLIL

Abstract

Content and Language Integrated Learning (CLIL) is a growing methodological approach in Italian secondary schools. However, CLIL remains understudied within this educational context, particularly regarding subject-specific vocabulary (SSV), which is essential for helping learners understand, create meaning, and engage with content. The study used a mixed-method approach to compare a CLIL group (120 pre-intermediate learners) with a non-CLIL group (25 learners). The CLIL group completed an astronomy module in English with the support of captioned multimodal input, whereas the non-CLIL group covered the same module in Italian during science lessons and encountered the key SSV taught using traditional methods (wordlists, matching exercises) during English as a foreign language (EFL) lessons. A pre- and post-test design was employed to measure SSV. Data were complemented with an analysis of CLIL students' receptive SSV vocabulary gains in CLIL students' oral presentations. The results indicated that both groups demonstrated improvements in vocabulary gains in English.

Keywords

Content and Language Integrated Learning (CLIL), subject-specific vocabulary (SSV), lower secondary school

1. Introduction

Content and Language Integrated Learning (CLIL) is a fast-growing methodological approach in Europe, especially Italy, since CLIL is mandatory in upper secondary (ages 14-19) schools (Aiello, Di Martino, Di Sabato 2017; Costa, Pladevall-Ballester 2018; Mezzadri 2018; Gilardoni, Lo Presti 2023). In this climate of CLIL implementation in Italy, funds have been assigned to schools that provide courses in CLIL methodology for current pre-primary, primary, lower, and upper secondary teachers.

Even before these courses were introduced, there were many grassroots CLIL experiments at both the primary and lower secondary school levels in the Italian context. CLIL research in Italy has focused on the national context while situating Italian experiences within broader European developments (Coonan 2002; Cinganotto 2018; Lopriore, 2020; Menegale 2023; Aiello, Di Martino 2023).

A study by Macaro et al. (2019) reported that knowledge levels of lexis among CLIL upper secondary students and English-medium Instruction (EMI) university students are not sufficient to understand teachers' input. This is particularly problematic in CLIL contexts since, for example, subject-specific vocabulary (SSV) is fundamental (Dalton-Puffer 2007) because it helps learners understand and produce speech in disciplines taught through an L2 (Rieder-Bünemann, Hüttner, Smit 2019; 2022). In fact, "learning technical words is closely connected with learning the subject" (Nation 2001, 204), and lexis is crucial for both content and language learning (Heras, Lasagabaster 2014).

At the same time, the connection between CLIL and the use of multimodality is emerging as a growing area of research, particularly in science classrooms (Lin 2015; Liu, Lin 2021; Coyle, Roca de Larios 2024; Nikula, Jakonen, Kántä 2024). However, there is limited knowledge about how multimodal input impacts the learning of subject-specific vocabulary and cognates.

Given that no studies have explored SSV in the context of lower secondary (ages 11-14) schools in Italy, the aim of this study is to explore captioned multimodal input and SSV vocabulary gains in English among Italian lower secondary school students. Subject-specific receptive vocabulary gains were assessed through a pre-test/post-test design in both CLIL classes (where the subject was taught in English using multimodal input) and non-CLIL classes (where the same subject was taught in Italian, while the vocabulary was taught traditionally in EFL lessons without multimodal support). Data were complemented with an intragroup (CLIL group only) analysis of both receptive and productive SSV gains (see section 4).

2. *Literature review*

In light of the study's aims to explore multimodal input and SSV in CLIL contexts, the literature review will be structured along three main axes: multimodal input and, more broadly, multimodality in CLIL; vocabulary learning in CLIL; and SSV in CLIL.

2.1 The importance of multimodal input and multimodality in CLIL contexts

There is still a paucity of studies on the use of multimodality in CLIL contexts; in fact, the first research papers were published in the second half of the 2010s. Fernández-Fontecha et al. (2020) note that while the communicative approach to language teaching has led to a growing use of visual resources, the broader pedagogical significance of adopting a multimodal perspective, especially in CLIL contexts, still demands deeper investigation. Similarly, Coyle and Roca de Larios (2024, 633) highlight that: "multimodal disciplinary literacy development is also underexplored in CLIL contexts". Nikula, Jakonen, and Kántä (2024) investigated how a physics and a chemistry teacher in CLIL classrooms use a wide range of multimodal resources spoken and written language, gestures, objects, technology, and visual inscriptions to unpack (simplify and contextualise) and repack (abstract

and generalise) subject-specific knowledge. There seems to be a specific positive outcome of using multimodal semiotic systems specifically in science classes (Lin 2015; Forey, Polias 2017; Liu, Lin 2021; Fernández-Fontecha et al. 2020; Coyle, Roca de Larios 2024) and, in general, pedagogical affordances can act as scaffolding strategies (Salvador-García, Ruiz-Madrid 2024).

With the rise of easily accessible online platforms, learners now have unprecedented access to a range of screen media, such as TV shows, video documentaries, and films. Such resources are becoming indispensable tools for learning, not just because they offer a richer, more varied source of language exposure but also because they inherently engage and motivate students.

Unlike traditional text-based resources, screen media present language in a multimodal way, integrating visual and auditory elements. This complexity can sometimes pose challenges for learners, especially those just beginning their journey in acquiring a new language.

Recognising this challenge, many educators and platforms incorporate L2 captions to make the content more multimodally accessible. These captions not only help learners understand the spoken content but also provide a textual reference, allowing them to correlate spoken words with their written forms, thereby enhancing comprehension and retention (Caruana 2021), helping vocabulary development (Winke, Gass, Sydorenko 2010; Pujadas, Muñoz 2019; Zhang, Zhang 2024), and helping in segmenting speech into individual words (Bird, Williams 2002; Lee, Revesz 2020). The underpinning idea, as highlighted by Winke, Gass, and Sydorenko (2010), is that proficiency in one area (e.g. word recognition) can serve as a springboard to progress in other areas (such as vocabulary learning) by optimising the learner's attention to and engagement with new lexical items.

As highlighted by Taylor (2005), the efficacy of captioned videos for those at beginner or elementary level is a specific area of debate, as multimodal digital videos require learners to read quickly and decode complex language patterns (Vanderplank 2010). Selecting a multimodal input with a limited or specific range of vocabulary could help overcome this issue (Thomas, Morgana 2023). Additionally, from an operational and pedagogical perspective, exposing learners to long, authentic videos in the language classroom is problematic, so researchers have focused on the use of short clips (see, for example, Morgana 2023), which also contribute to lowering learners' cognitive load. This suggests that while the potential of captioned videos in L2 education is evident, further targeted research is essential to address existing gaps.

2.2 Studies on vocabulary learning in CLIL

This section focuses on learners' general vocabulary knowledge or overall vocabulary size, while the next section turns to subject-specific vocabulary. It is very difficult to compare studies on learning SSV in CLIL courses because they belong to very different contexts and use a variety of methodologies (Dalton-Puffer, Rieder-Marschallinger 2023), but above all, because they mostly analyse general vocabulary.

However, reviewing these studies remains important, given their focus on vocabulary learning within CLIL settings. Moreover, this part of the literature review is based on studies that compared CLIL groups and non-CLIL groups, as these would be more comparable to the present study. In addition to differences in context and methodology, the studies reviewed also vary in terms of the instructional programmes being compared. Most commonly, comparisons are drawn between CLIL and non-CLIL groups, where the latter typically follow traditional EFL instruction (e.g., Jiménez Catalán, Ruiz de Zarobe 2009; Agustín-Llach, Canga Alonso 2014; Canga Alonso 2015;). These studies will first be presented in chronological order and then summarised to highlight similarities and differences.

The initial research on vocabulary learning in CLIL courses dates to the second half of the 2000s. In their study on bilingual and non-bilingual cohorts in secondary schools in the Netherlands, Admiraal, Westhoff, and de Bor (2006) tested receptive vocabulary and found no significant differences in the two groups. Jiménez Catalán and Ruiz de Zarobe (2009) compared CLIL and non-CLIL learners for receptive vocabulary in primary school, using the 1,000-word receptive test and the 2,000-word frequency band in the receptive version of the Vocabulary Level Test (VLT). Their study shows that CLIL students performed better than non-CLIL students, keeping in mind that they had more hours of exposure. Ruiz de Zarobe (2011) further confirms that the greatest area of gains is receptive vocabulary. Similar results were obtained by Ojeda Alba (2009), who analysed primary school student essays to identify lexical fields. CLIL students demonstrated better performance in receptive vocabulary, lexical variation, and lexical richness.

The size of receptive and productive vocabulary in CLIL and non-CLIL classes was examined using the VLT and the Productive VLT, revealing that CLIL students possessed a larger vocabulary (Merikivi, Pietilä 2014). Similarly, a longitudinal investigation into lexicogrammatical skills demonstrated that while both CLIL and non-CLIL secondary school students improved their overall lexical and grammatical ability, the progress was notably faster among CLIL participants (Juan-Garau, Prieto-Arranz, Salazar-Noguera 2015).

Primary and secondary school students' receptive vocabulary knowledge was evaluated using the 2K VLT, with findings indicating that CLIL students performed better, especially in receptive skills (Canga Alonso 2015). A subsequent study assessing receptive vocabulary in Spanish secondary school students through the 2K and 3K VLT showed higher performance by CLIL students, although the differences were not statistically significant (Arribas 2016).

Further longitudinal research measured receptive vocabulary size in two cohorts, CLIL and EFL students demonstrating that CLIL students in higher grades achieved superior vocabulary scores (Agustín-Llach, Canga Alonso 2014). Vocabulary growth in Austrian lower secondary schools was explored through a mixed-method study employing the X-lex test. Results suggested that incidental learning alone in CLIL contexts may not suffice, as no significant advantage in receptive vocabulary growth was observed for CLIL students compared to controls

(Gierlinger, Wagner 2016). In an international school in Germany, longitudinal testing of 468 secondary students with the VLT highlighted varying rates of progress among cohorts (Coxhead, Boutorwick 2018).

Receptive and productive vocabulary outcomes were tested in a Turkish context using the Cambridge Key English Test, 2K VLT, and the Vocabulary Knowledge Scale, with CLIL students outperforming their non-CLIL counterparts (Bayram, Öztürk, Aray 2019). Testing receptive vocabulary in Swedish 10th and 12th graders showed that CLIL students, while already performing highly at the start, did not exhibit greater progress compared to their non-CLIL peers. This finding was complemented by an analysis of written assignments, where CLIL students' initial advantage in general and academic vocabulary did not significantly increase over time (Olsson, Sylén 2019; Sylén, Ohlander 2019).

An investigation into the receptive vocabulary size of Spanish secondary students revealed that CLIL students held an advantage in both non-academic and academic vocabulary, as measured by the Vocabulary Levels Test (Castellano-Risco, Alejo-Gonzalez, Piquer-Píriz 2020).

Finally, Navarro-Pablo (2021) tested 351 students from 7 bilingual and 1 non-bilingual school at primary and secondary levels in Spain on grammar and lexis skills. The comparison of the two approaches, conducted using a statistical test, revealed that the CLIL classes performed better.

A final overview of the studies reveals that most of them were conducted in Spain (Jiménez Catalán, Ruiz de Zarobe 2009; Ojeda Alba 2009; Agustín-Llach, Canga Alonso 2014; Juan-Garau et al. 2015; Arribas 2016; Canga Alonso 2016; Castellano-Risco, Alejo-Gonzalez, Piquer-Píriz 2020; Navarro-Pablo 2021) or in Europe between 2014 and 2016 (Agustín-Llach, Canga Alonso 2014; Merikivi, Pietilä 2014; Canga Alonso 2015; Juan-Garau, Prieto-Arranz, Salazar-Noguera 2015; Arribas 2016; Gierlinger, Wagner 2016). It is not possible to determine fully how much better the CLIL cohorts were since some surveys gave positive results (Jiménez Catalán, Ruiz de Zarobe 2009; Ojeda Alba 2009; Agustín-Llach, Canga Alonso 2014; Merikivi, Pietilä 2014; Canga Alonso 2015; Arribas 2016; Navarro-Pablo 2021) while others showed no advantage for the CLIL classes (Admiraal, Westhoff, de Bot 2006; Gierlinger, Wagner 2016). In addition, a variety of elements were analysed, with the majority addressing receptive vocabulary (Jiménez Catalán, Ruiz de Zarobe 2009; Ojeda Alba 2009; Agustín-Llach, Canga Alonso 2014; Merikivi, Pietilä 2014; Canga Alonso 2015; Gierlinger, Wagner 2016; Castellano-Risco, Alejo-Gonzalez, Piquer-Píriz 2020; Navarro-Pablo 2021), using standardised tests such as the VLT (Jiménez Catalán, Ruiz de Zarobe 2009; Agustín-Llach, Canga Alonso 2014; Merikivi, Pietilä 2014; Canga Alonso 2015; Arribas 2016; Castellano-Risco, Alejo-Gonzalez, Piquer-Píriz 2020; Coxhead, Boutorwick 2021). Finally, most of the studies focused on secondary schools (Admiraal, Westhoff, de Bot 2006; Agustín-Llach, Canga Alonso 2014; Canga Alonso 2015; Arribas 2016; Gierlinger, Wagner 2016; Castellano-Risco, Alejo-Gonzalez, Piquer-Píriz 2020; Coxhead, Boutorwick 2018; Navarro-Pablo 2021).

2.3 Studies on Subject-Specific Vocabulary in CLIL

Research on subject-specific vocabulary in CLIL contexts generally reveals positive outcomes for learners. Studies have shown that the CLIL methodological approach not only enhances receptive and productive knowledge of content-specific vocabulary but also fosters greater lexical diversity and sophistication (Vraciu, Marsol 2023). Learners in CLIL classrooms actively use SSV during classroom interactions, drawing on a variety of learning and communication strategies (Rieder-Bünemann, Hüttner, Smit 2022). Nikula (2017) further observed that the acquisition of subject-specific terminology in CLIL settings is a gradual process, with students progressing from initial confusion to confident use of specialised vocabulary through teacher scaffolding.

Adding to this body of research, Gablasova (2014) investigated the learning and retention of twelve subject-specific words among two groups of high school EFL students, comparing instruction in L1 and L2. Using pre- and post-tests with initially unfamiliar vocabulary items, the study found that L1 instruction supported better long-term retention, whereas students exposed to L2 input struggled to recall the terms over time.

Rieder-Bünemann, Hüttner, and Smit (2019) addressed the complexity of selecting topic-specific vocabulary by proposing a holistic model that integrated both single and multi-word lexical units through quantitative corpus analysis and qualitative evaluation. Gablasova's study similarly took a phased approach: Phase 1 included quantitative corpus analysis of relevant vocabulary, Phase 2 involved initial qualitative pre-selection by the research team, and Phase 3 entailed final selection by a subject expert. While effective, this model required extensive data, making implementation challenging. Both studies have informed, at least in part, the research design of the present study.

3. *Research questions*

This study is prompted by the current gap in the literature, as no research to date has examined SSV development in lower secondary (ages 11-14) CLIL settings in Italy. The study builds upon and elaborates on Thomas and Morgana's (2023) study, which piloted similar types of instruments and tasks. Among the limitations stated by Thomas and Morgana (2023) were the lack of inclusion of a non-CLIL control group in the design and the absence of students' speaking performances (output task). The current study significantly expanded the number of participants and included a control group that did not participate in the CLIL science programme but engaged in the same science programme in Italian (the students' L1) within the same school. Further, at the end of the experiment, we recorded and analysed CLIL students' use of SSV in oral performances in order to test their productive vocabulary.

The study has been designed to answer the following research questions:

1. Are there receptive subject-specific vocabulary gains in the CLIL and non-CLIL group?
2. Which receptive subject-specific vocabulary do CLIL learners recall more easily, and which present more challenges on the basis of frequency of occurrence and cognateness in the captioned multimodal input?
3. Which productive subject-specific vocabulary items do learners recall more easily, and which present more challenges in the CLIL group?

4. Methodology and procedure

The study adopts a mixed-method approach (Dörnyei 2007) involving a quantitative element that uses a pre- and post-test design to compare science-specific receptive vocabulary gains in a CLIL group ($N=120$ pre-intermediate learners) and in a non-CLIL group ($N=25$ pre-intermediate learners). A mixed-method approach was selected to provide both quantitative and qualitative insights into how learners acquire subject-specific vocabulary in an ecologically valid CLIL setting, allowing for comparison with non-CLIL peers while also examining the influence of input features and productive use. A further intragroup (CLIL only) quantitative analysis on receptive gains on the basis of frequency of occurrence and cognateness in the captioned multimodal input and a qualitative analysis of students' oral presentations ($N=5$) in order to test productive vocabulary gains was carried out. Over a period of ten weeks, participants in the CLIL group watched four 5-minute captioned videos and completed a series of input- and output-based tasks. The non-CLIL group participants completed the same pre- and post-tests but did not take part in the CLIL science program. Instead, they followed the same module in Italian and worked on SSV during their EFL lessons through traditional instructional methods (e.g., wordlists and matching exercises with definitions), without the support of multimodal input. The pre- and post-tests measured students' receptive vocabulary learning gains of the form and meaning of 27 subject-specific items, including cognates that appeared in the multimodal input.

As a further post-task, learners in the CLIL group delivered an oral presentation on the content of the science videos in order to test productive vocabulary. Data were recorded and statistically analysed for attempted and correct use of the subject-specific vocabulary.

This study involved data collection from student participants and was conducted in accordance with ethical research standards. Quality assurance was achieved according to the AHRC (Arts & Humanities Research Council) guidelines. Informed consent was obtained from all students, along with informed parental consent for each minor involved. To ensure confidentiality, all data were anonymised by assigning a numerical code to each participant. The anonymised data will be stored locally on a password-protected computer for a period of four years. Access to the data will be restricted to the two researchers involved in the study and will not be shared with third parties.

4.1 Participants

The participants in this study were 145 students in their third year of the same lower secondary school (eighth grade). All students were aged between 13 and 14 years old at the time of the study. All learners were at the pre-intermediate level of English (A2), as confirmed by the Oxford placement test taken two months prior to the experiment. The CLIL students participated in a CLIL school initiative that included a ten-week science module taught in English, whereas the non-CLIL group engaged in the same module in Italian. The non-CLIL group had three one-hour EFL sessions, during which they worked on vocabulary related to the science module. The EFL teacher introduced the SSV using traditional methods, such as wordlists and matching exercises. Those enrolled in the CLIL program had an additional hour of CLIL lesson each week for ten weeks. This was the students' second experience with CLIL, having completed a CLIL geography module the previous school year. Both the CLIL and non-CLIL groups were taught the subject-matter by the same science teacher, who had completed a 30-hour online CLIL training course and held a B2-level CEFR English certificate. The majority of the participants spoke Italian as their first language (N=129), while ten students were native Chinese speakers, four were native Spanish speakers, and two were Arabic speakers. They were all in the CLIL group, apart from two native Chinese speakers who belonged to the non-CLIL group. Four complete classes (N=120 students) were selected for the CLIL program, and one class (N=25 students) was assigned to the non-CLIL group condition. The unequal group sizes reflect the use of intact classes within an ecologically valid school setting and should be taken into account when interpreting between-group comparisons, which are complemented by intragroup analyses.

4.2 CLIL group captioned multimodal input description

The CLIL group was exposed to four videos with L2 captions from the Science 101 series by National Geographic. The non-CLIL group was not exposed to the videos but encountered the SSV in English during regular EFL lessons using traditional instruction methods. The videos from National Geographic's Earth Science and Astronomy collection covered subjects including the solar system, Mars, Mercury, and the Sun. Each of these videos lasted around five minutes, comprising approximately 600 spoken words. These were accompanied by audio narratives, music, visual footage, and additional graphics, including tables and textual content (Thomas, Morgana 2023). Following the guidelines provided by Rieder-Bünemann, Hüttner, and Smit (2019), 27 target items were chosen for examination based on specific criteria:

- a) They were specialised terms related to astronomy, encompassing semi-technical words that hold both general and topic-specific meanings and collocations.
- b) These terms appeared frequently in the videos (from a minimum of 1 to a maximum of 8 times).

- c) They spanned various linguistic categories, including nouns, verbs, and adjectives.

The selection process of these terms involved two phases: firstly, two academic researchers made the selections, as per the second phase of Rieder-Bünemann, Hüttner, and Smit's 2019 approach. This was followed by validation and approval by two experts on the subject, corresponding to the third phase of Rieder-Bünemann, Hüttner, and Smit (2019).

As Peters and Webb (2018) noted, vocabulary learning through videos can be influenced by various variables. Consequently, the study also considered the potential effects of two different variables on the learning of subject-specific vocabulary: frequency of occurrence and cognate status (Peters, Webb 2018). The frequency of occurrence has strong validity as the National Geographic channel produced the videos used for the project for L1 speakers. Cognateness was validated by two proficiency-level speakers of both Italian and English.

4.3 Cognate selection criteria

Cognateness was determined using a strict definition, focusing exclusively on full cognates, that is, lexical items that exhibit semantic, phonological, and orthographic similarity across languages (Valente et al. 2018; Abu-Rabiah 2025). This operational definition was deliberately chosen to ensure high cross-linguistic transparency, especially for lower secondary learners with A2-level proficiency, where partial or surface-level similarity might not lead to successful transfer (Frunza, Inkpen 2008; Otwinowska, Szewczyk 2019).

Words such as *surface*, *magnetic field*, *rocky*, *matter*, *nebula*, *lava flow*, and *force* were excluded from the "cognate" category because they either lack direct phonological equivalence in Italian (e.g., *rocky* vs. *roccioso*), are multi-word expressions or collocations (e.g., *magnetic field*, *lava flow*), or involve semantic ambiguity or partial cognate status that can hinder recognition (e.g., *matter* as "questione" vs. "materia") (Frunza, Inkpen 2008; Aguinaga Echeverría 2017). As demonstrated by both Otwinowska and Szewczyk (2019) and Aguinaga Echeverría (2017), not all cognates are equally recognisable: learners' ability to detect and use them varies significantly depending on factors such as transparency, regularity of form-meaning mapping, and input modality. Some formally similar words may not be noticed due to phonological irregularity or a lack of salience in spoken input.

Furthermore, as shown by Valente et al. (2018), phonological overlap plays a critical role in cognate acquisition, and when phonological similarity is low (e.g., between English and Italian), it is harder for learners to recognise them as cognates even if they look or mean the same.

In contrast, full cognates like *atmosphere*, *asteroid*, and *orbit* exhibit high phonological, semantic, and often orthographic alignment with their Italian equivalents (*atmosfera*, *asteroide*, *orbita*), which supports both accurate recognition and memory retention under incidental learning conditions (Otwinowska, Szewczyk 2019; Abu-Rabiah 2025).

While broader definitions of cognates exist, including partial cognates and interlingual homophones (Aguinaga Echeverría 2017; Abu-Rabiah 2025), we have adopted a more conservative and straightforward definition. Since our study did not involve detailed lexical coding, we preferred to focus only on clear cases of full cognates to avoid ambiguous classifications and ensure clarity in our analysis.

4.4 CLIL group productive vocabulary oral presentation task

At the end of each CLIL lesson, students were assigned individual tasks to be completed within a week and submitted online. These tasks, designed with a technology-mediated TBLT approach (Morgana 2023), encouraged learners to engage with input and apply context-specific vocabulary. For instance, students were asked to select a video segment and create either a brief summary or a voiceover presentation on a scientific topic. For their final project, each participant produced a five-minute oral and digital presentation on a planet in the solar system.

4.5 CLIL and non-CLIL groups' receptive vocabulary pre-test and post-test

The pre-test and post-test were designed to assess learners' prior knowledge of the 27 subject-specific target words in English. Both tests were identical, including form, meaning recall and meaning recognition items (multiple choice questions with four options: one correct item and three distractors). The tests were computer-based, delivered through Google Forms, and included written questions, visuals, and short audio files. Students were asked to recognise a word, provide its meaning, or guess it from context. To limit any test effects, the pre-test took place two weeks before the intervention. Learners had 45 minutes to complete the test. The post-test was delivered one week after the experiment.

5. *Data analysis*

The data analysis was structured into three phases, each aligned with a specific research question. Phase 1 compared the receptive SSV gains between the CLIL and non-CLIL groups. Phase 2 focused on an intragroup analysis (CLIL only) of receptive SSV gains. Phase 3 focused on an intragroup analysis (CLIL only) of productive SSV gains.

A descriptive statistical analysis of learners' scores was performed using JASP 0.18.3. In the pre- and post-tests, correct responses earned participants one point each. Words that participants answered correctly in both tests were labeled as familiar terms, while those initially unknown or answered incorrectly but later corrected were considered newly learned terms (Pujadas, Muñoz 2019). Absolute learning gains were calculated by measuring the difference between the pre-test and post-test number of known lexical items. Additionally, an intragroup analysis provided a detailed comparison and analysis of the CLIL group's scores to determine which words were recalled most easily, particularly in relation to two variables: frequency

of occurrence and cognateness. Cognate words were selected based on clear similarity in form, meaning, and pronunciation between English and the learners' first language, following a strict definition of full cognates. To evaluate learners' productive vocabulary, the CLIL group completed a follow-up oral presentation based on the science video content. The resulting data were analysed, examining subject-specific vocabulary use.

6. Findings

6.1 Receptive vocabulary learning gains

Descriptive statistics of the mean scores indicate a clear distinction between the CLIL and non-CLIL groups (Table 1). Both the CLIL and non-CLIL groups demonstrated improvement from the pre-test to the post-test in the meaning recall and recognition test. The CLIL group showed a substantial increase in mean score, rising from 14.47 (SD = 3.12) to 23.76 (SD = 2.76), with a notable absolute gain of 9.29 (SD = 2.57), indicating significant progress and greater consistency in performance. The non-CLIL group also improved, with their mean score increasing from 14.76 (SD = 3.11) to 15.68 (SD = 2.67), resulting in an absolute gain of 0.92 (SD = 0.90). Although this gain was more modest, it still reflects a positive learning outcome, especially considering that the module was delivered in Italian and cross-linguistic influences were observed.

Table 1 – *Descriptive statistics for meaning recall and recognition test.*

Group	Pre-test (Max=27) Mean (SD)	Post-test (Max=27) Mean (SD)	Absolute Gains Mean (SD)
CLIL (N = 120)	14.47 (3.12)	23.76 (2.76)	9.29 (2.57)
non-CLIL (N = 25)	14.76 (3.11)	15.68 (2.67)	0.90

In addition, we conducted a paired samples t-test comparing pre- and post-test results for the CLIL group ($t = -39.59$, $p < .001$), which showed a statistically significant improvement, supported by a large effect size (Cohen's $d = -3.61$).

6.2 The relationship between frequency of occurrence and cognate status (CLIL group)

The intragroup analysis within the CLIL group (Table 2) investigated the relationship between the frequency of occurrence and the cognate status of SSV words. Specifically, we explored how the frequency of occurrence (FoO) and the cognate status of SSV words influenced post-test scores, aiming to uncover patterns that shed light on the efficacy of vocabulary learning strategies in CLIL contexts.

Table 2 – *Target items with frequency of occurrence in input and cognate status*

Target item	FoO	Cognate	Target item	FoO	Cognate
Surface	8	No	Lava flow	2	No
Core	8	No	Asteroid	2	Yes
Atmosphere	6	Yes	Force	2	No
Magnetic field	6	No	Debris	2	No
Iron	5	No	Orbit	2	Yes
Gravity/gravitational	5	Yes	Galaxy	2	Yes
Degrees	5	No	Layer	2	No
Dust	4	No	Mantle	2	No
Rocky	4	No	Run out of	2	No
Collapse	3	Yes	Swirling object	2	No
Mass	3	Yes	Fuse	2	Yes
Matter	2	No	Revolve	2	No
Axis	1	Yes	Result in	1	No
Nebula	2	No			

Comparing the CLIL group test scores with the occurrences of the seven most frequent SSV words in the captioned multimodal input provided interesting results (see Table 3). Each video included around 600 words. The terms *surface* and *core* were the most frequent words in the corpus, with eight occurrences overall, followed by the terms *atmosphere* and *magnetic field*, each featuring six times. However, although these terms appeared with high frequency in the multimodal input, their post-test scores did not directly reflect this. For example, learners demonstrated a full understanding of the concept of *magnetic field*, which received the highest post-test score overall (120 correct answers). On the other hand, frequent terms such as *dust* and *degrees* received lower post-test scores (72 and 89), showing potential difficulties in grasping the associated concepts.

Interestingly, *iron*, which recurred five times in the multimodal input, resulted in a moderate post-test score of 99. This phenomenon could partly be attributed to it being a polysemous word i.e. a word with one or more meanings in general English and another specific to a particular field. In this study, for example, a word such as *iron* may have a general and frequent meaning in everyday English, but it also has a specific meaning and purpose in a scientific context. Thus, learners might have been familiar with the general English meaning of a word and relied on it to fully understand and retain scientific concepts. These findings unveil the complex

relationship between the frequency of SSV word occurrence and students' comprehension.

Table 3 – *Comparison between the seven most frequent SSV words and post-test scores (CLIL group).*

Most frequent SSV words	FoO	Cognate	Post-test Score (Max=120)
Surface	8	No	113
Core	8	No	111
Magnetic field	6	No	120
Iron	5	No	99
Degrees	5	No	89
Dust	4	No	72
Rocky	4	No	106

The analysis of the impact of the two variables, frequency of occurrence and cognateness, provided important insights into the factors that influence vocabulary learning. Specifically, we compared the frequency of occurrence of SSV, cognate words, and learners' post-test scores (see Table 4). Not surprisingly, cognate words consistently received high post-test scores, regardless of their frequency in the corpus. Terms with a relatively low frequency in the input (2 to 6 occurrences), such as *atmosphere*, *asteroid*, *gravity*, and *orbit*, resulted in high post-test scores of 120. This trend appears to be consistent across all test results. Cognate words such as *collapse*, *mass*, and *galaxy*, for example, also yielded high scores even though they occurred with lesser frequency. Moreover, terms such as *fuse* and *axis*, which only occurred once in the corpus, received positive post-test scores of 115 and 110. This trend indicates that cognates may simplify comprehension and retention for learners because of their linguistic similarity to the learners' L1, which could result in higher post-test scores.

Table 4 – *Comparison between cognate words, frequency of occurrence (FoO), and post-test scores (CLIL group).*

SSV cognate words	FoO	Cognate	Post-test Score (Max=120)
Atmosphere	6	Yes	120
Gravity (Gravitational)	5	Yes	120
Collapse	3	Yes	111
Mass	3	Yes	112
Asteroid	2	Yes	120

Orbit	2	Yes	120
Galaxy	2	Yes	120
Fuse	1	Yes	115
Axis	1	Yes	110

However, it is noteworthy that several non-cognate terms, such as *magnetic field*, *rocky*, and *surface*, also received relatively high scores in the post-test and demonstrated significant improvement from pre-test results. In fact, considering their lower initial scores at pre-test, the improvement observed for non-cognate items was often more pronounced than for cognates. This suggests that targeted teaching and captioned multimodal input may have particularly supported the learning of less transparent vocabulary, highlighting the potential for effective learning even when cognateness does not facilitate comprehension. Even when the frequency of cognate terms in the input data is relatively low, the consistency of the trend highlights the potential efficacy of using them in CLIL contexts to improve vocabulary development.

In the CLIL group, a t-test comparing gain scores between cognate and non-cognate items revealed a statistically significant difference ($t = -3.98$, $p = 0.0016$), indicating that cognate status had a meaningful impact on vocabulary learning gains. Specifically, non-cognate items showed significantly higher gains than cognate items. This suggests that while learners made notable progress with non-cognates, possibly due to the increased cognitive effort and focused attention required for unfamiliar words, they also relied on cognates as an essential resource for comprehension and retention. The consistently high scores for cognates across the dataset indicate that these familiar lexical items played a key role in supporting understanding of content and scaffolding the acquisition of more challenging vocabulary. Overall, the results highlight the complementary role of both cognate and non-cognate terms in CLIL vocabulary development.

Although it was not part of the original research questions, a complementary analysis of the non-CLIL group was conducted and will be presented below. The t-test comparing gain scores between cognate and non-cognate items in the non-CLIL group did not show any significant difference ($t = -0.072$, $p = 0.944$). In other words, whether the word was a cognate or not did not influence how much students improved. These results suggest that in the non-CLIL group, where teaching was likely more focused on content in the first language, vocabulary gains were generally low, and factors such as frequency and cognateness did not play a significant role in vocabulary learning.

6.3 Productive vocabulary oral presentations (CLIL group)

The post-task assessment phase focused on an output-based task. Students were asked to plan, prepare, and deliver a short presentation about one of the planets in the solar system. Each presentation lasted about five minutes and was performed

and assessed in class. Five presentations were transcribed and analysed to triangulate pre-and post-test results and gain further insights into learners' SSV vocabulary learning. All transcriptions were collected in a learner corpus and quantitatively analysed to investigate the frequency and the appropriate use of SSV in learners' performances. Students' discourse and elaboration varied significantly as presentations were of different lengths, from a minimum of approximately 170 words to a maximum of 350 words. With the exception of one student who chose to depend on her L1 to explain high values in numbers, pupils generally did not utilise their L1 to present their views.

Table 5 – *Target items used in students' presentations.*

Subject Specific Vocabulary Item	Occurrences in students' presentations
Surface	4
Core	3
Orbit	7
Dust	3
Atmosphere	2
Mass	2
Gravity (gravitational)	1
Debris	1
Layer	1
Matter	1

Despite the generally encouraging results of the post-test evaluations in terms of students' learning of SSV, a deeper analysis indicated a significant difference, with only 10 of the 27 target SSV elements being used accurately in the oral presentations (see Table 5). There are a number of possible causes for this discrepancy. First of all, there is a chance that some SSV terms were overlooked in the presentations because students struggled to understand their meaning and application. Furthermore, it is possible that students were unable to actively recall and incorporate a wider variety of SSV into their discourse due to the cognitive load associated with organising and giving oral presentations, as well as the pressure to finish within a set amount of time. Learners' capacity to use and incorporate SSV into their presentations may have been affected by a number of factors. First, it may have been simpler for students to remember and use SSV terminology if they had more EFL competency and topic comprehension. Second, learners' willingness to actively apply the newly acquired words may have been affected by task familiarity as well as differences in classroom dynamics and teaching methods. These observations suggest that inte-

grating SSV into speaking tasks and activities within the CLIL framework would enhance students' language and subject learning results.

7. Discussion

This study examined students' SSV gains in lower secondary CLIL and non-CLIL science classes in Italy. Three research questions guided the investigation: 1. a comparison of SSV vocabulary gains between CLIL and non-CLIL learners using a pre-test/post-test design; 2. an analysis of which receptive SSV items were better recalled within the CLIL group, based on frequency and cognate status; and 3. an analysis of productive vocabulary use in CLIL students' oral presentations.

With respect to the first research question, results indicated significant differences in lexical learning gains between the two groups (see Ojeda Alba 2009; Canga Alonso 2015). While both CLIL and non-CLIL students improved from pre-test to post-test, the CLIL group exhibited greater gains overall, including for both cognate and non-cognate items. These differences may be linked to the nature of instructional input in the CLIL setting, which included multimodal elements and greater exposure to English. It is possible that these conditions contributed to deeper lexical processing and facilitated form-meaning connections, although further research would be needed to isolate the effects of individual instructional variables.

Non-cognate items, considered more difficult due to limited resemblance to L1 equivalents, were retained relatively well in the CLIL group ($t = -3.98$, $p = 0.0016$). For example, terms like *magnetic field* and *surface*, which are less transparent to Italian learners, were among the items most accurately recalled. It is plausible that multimodal input supported this outcome by presenting meaning through multiple channels (e.g., visuals, gestures, captions). Cognate items such as *atmosphere*, *asteroid*, and *orbit* were also frequently retained, potentially due to cross-linguistic similarity and existing background knowledge. These patterns are consistent with prior work on word transparency (e.g., Peters, Webb 2018) and suggest that both cognates and non-cognates can be learned when instruction provides varied and meaningful input.

Regarding the second research question, which addressed which SSV items were better recalled by CLIL learners, results suggest that frequency and cognate status played a role in word retention, though they were not fully predictive. Certain high-frequency items were not well retained, while some lower-frequency cognates were. These inconsistencies might imply that additional factors, such as word salience, multimodal reinforcement, and learners' attention, may also influence vocabulary acquisition.

The third research question focused on students' productive use of target vocabulary in oral presentations. While receptive performance was relatively strong, only 10 of the 27 target items appeared in student output. More concrete and visually supported terms such as *orbit*, *surface*, and *core* were used more frequently, whereas abstract items like *magnetic field*, *fuse*, or *axis* were largely absent despite being

recognised in the tests. This discrepancy might reflect a common challenge of activating newly learned vocabulary in spontaneous speech, particularly for lower-proficiency learners. Nonetheless, some students did use semantically dense vocabulary in their presentations, suggesting that productive use may be possible when tasks are meaning-driven and supported by multimodal scaffolding.

Several pedagogical strategies can be adopted to enhance students' subject-specific vocabulary development in CLIL classrooms. A key role is played by the deliberate integration of lexical scaffolding into content teaching, whereby subject-specific terminology is explicitly highlighted, recycled, and contextualised through multimodal input, including visuals, diagrams, glossaries, and graphic organisers. Pre-teaching and post-teaching of key disciplinary terms can support comprehension and retention, particularly when combined with tasks that encourage active lexical processing, such as classification, definition building, and concept mapping. Classroom interaction further contributes to vocabulary development by promoting the use of disciplinary language in meaningful communicative exchanges, including guided questioning, collaborative problem-solving, and peer explanation.

Overall, the findings offer insights into how learners process and retain different types of vocabulary in CLIL environments. Identifying which items are more or less readily acquired may help educators design input and scaffolded tasks more effectively. Although limited in scope, the study contributes to ongoing discussions in CLIL research around multimodality, input enhancement, and vocabulary learning (e.g., Lin 2015).

8. *Conclusions*

This study investigated the learning of subject-specific vocabulary among lower secondary school students in CLIL and non-CLIL science classes. The results indicate that the CLIL group made greater receptive vocabulary gains compared to their non-CLIL peers. These gains were observed for both cognate and non-cognate items, though the extent to which these outcomes can be attributed to CLIL instruction alone remains uncertain. The use of captioned multimodal input in the CLIL setting may have supported this learning process by offering varied representational modes, although this warrants further empirical validation.

Despite improvements in receptive knowledge, the productive use of the target vocabulary was more limited. Only a subset of the target words appeared in students' oral presentations, suggesting that moving from recognition to active use is a gradual process that may require sustained practice and targeted instructional support.

The short duration of the intervention is a key limitation, as vocabulary learning is a cumulative process. Future studies should investigate the effects of prolonged CLIL exposure on long-term retention and productive language use. Another limitation relates to the context-specific nature of the study. Conducted in a single school, the findings reflect a particular educational setting and cannot be readily

generalised. Nonetheless, the controlled environment enabled greater consistency across participants in terms of background variables. Further research involving a larger sample, more diverse contexts, including upper secondary schools where CLIL is more established in Italy, could offer a broader perspective on how vocabulary development progresses across educational stages.

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