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CLIL methodology in Secondary education in Spain: a critical analysis

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Abstract

The importance of learning and becoming proficient in foreign languages has emerged with a prominent role in the field of education due to its relevance in contemporary society. Particularly, the bilingual education system, which integrates English as the main additional language, has experienced an increase in recent years due to the growing globalization in today's society. This has led to the teaching of core subjects in the Primary, Secondary and Tertiary contexts by means of English. In order to do so, a pedagogical approach developed in recent years is CLIL, which has gained recognition on an European, National and regional level. This approach is characterized by methodological principles that require careful implementation in terms of successful achievement of the language and learning of contents by means of a second language. Although it has been considered efficient by several researchers, it is not immune to negative aspects. The purpose of this work is to provide background knowledge on the CLIL approach and to apply it in the practical analysis of a couple of pages from an academic textbook used in Secondary education for teaching sciences.

Key words: CLIL, content and language integrated learning, methodology, bilingual education, Secondary education

Resumen

La importancia de aprender y dominar lenguas extranjeras ha adquirido un papel destacado en el ámbito de la educación debido a su relevancia en la sociedad contemporánea. En particular, el sistema educativo bilingüe, que integra el inglés como primera lengua adicional, ha experimentado un incremento en los últimos años debido a la creciente globalización en la sociedad actual. Esto ha llevado a la enseñanza de asignaturas troncales en los contextos primarios, secundarios y terciarios por medio del inglés. Para ello, un enfoque pedagógico desarrollado en los últimos años es el AICLE que ha ganado reconocimiento a nivel europeo, nacional y regional. Este enfoque se caracteriza por unos principios metodológicos que requieren una cuidadosa implementación en lo que se refiere al éxito en la consecución de la lengua y el contenido. Aunque ha sido considerado eficaz por varios investigadores, no está exento de aspectos negativos. El propósito de este trabajo es proporcionar conocimiento de fondo sobre el enfoque AICLE y aplicarlo en el análisis práctico de un par de páginas de un libro de texto académico utilizado en la enseñanza secundaria para la enseñanza de las ciencias.

Palabras clave: CLIL, aprendizaje integrado de contenido y lengua, metodología, educación bilingüe, educación secundaria

1. Introduction

English language teaching has acquired significant importance on a global scale. English has become the predominant lingua franca in various fields and as a direct consequence, the demand for English language skills has grown exponentially. English is considered the world's leading language of communication. Recognizing the importance of English language teaching, education systems across the world have integrated English language learning into their curricula from an early age. Many different models of bilingual education have been implemented, however in the last decade the most resonant has been Content and Language Integrated Learning (CLIL). Despite the belief that it is a pioneering approach, the teaching of content alongside language has its origins centuries ago. What is not new either are the pedagogical principles that this methodology suggests, as they were developed years earlier. Nevertheless, the CLIL approach brings together some characteristic methodological principles which, although they are not exclusively part of this approach, are used in it. The first and fundamental of these are the four key skills emphasized in this methodology, known as the 4C's: content, communication, cognition and culture. In addition, some of the others present in this approach are Bloom's Taxonomy, the Zone of Proximal Development and its linked scaffolding. At the same time CLIL promotes a learner-centered classroom structure, leaving behind the authoritarian figure of the teacher. In order to make this change possible and promote student-centered teaching, group work and cooperative learning play a fundamental role. While the methodological principles promoted are clear and studies show the wide range of advantages of CLIL, it is also necessary to consider the presence of negative aspects that make the experience not entirely beneficial. All these aspects should be considered or adapted to the situation before making the decision to implement this approach in the classroom. These negative factors mentioned above are often identified in the practical part, which will be dealt with in this composition. This research paper aims to provide information on the CLIL approach and put into practice the theoretical frame through an analysis of an educational didactic unit that contemplates the implementation of CLIL methodology.

2. Beginnings of bilingual education

The use of foreign languages as a medium of instruction for teaching has been a longstanding practice that can be traced back to centuries. It is a phenomenon that has transcended geographical and cultural boundaries, with evidence of bilingualism being present in different civilizations throughout history. While it is difficult to pinpoint the exact time when bilingualism began, it is clear that it has taken on different forms and meanings over time

(Sánchez, 2009). From ancient Greek schools teaching Latin to the present-day immersion programs around the world, the use of foreign languages for teaching has evolved and adapted to the need of the society at each point in history. Despite the extensive development of bilingualism, its importance and relevance in today's world cannot be overstated. With globalization and the increasing interconnectedness of different cultures and nations, the ability to communicate and understand different languages has become a valuable asset in various spheres of life (Hemmi & Banegas, 2021). This is particularly true in the academic realm, where the use of foreign languages in teaching has been recognized as an effective means of improving students' language proficiency and enhancing their understanding of different subjects and areas of knowledge (Clarke, 2012).

In old days, Greek and Latin were widely used to teach philosophy, literature and other disciplines in Europe and the area of the Mediterranean. In ancient Rome, bilingualism was common among the upper classes of society. Latin was the official language of the republic, and later, of the Roman Empire, but Greek was also widely spoken and studied by educated Romans. Knowledge of Greek was fundamental to the education of the Roman elite (Clarke, 2012). The writings of Greek philosophers, poets and orators were considered the pinnacle of literature and intellectual culture in antiquity. As a result, many wealthy patricians and commoners learned Greek in order to access these texts and to communicate with the Greeks during the diplomacy of trade. Secondly, contact with the Greeks led to a mixing of languages and cultures. The Romans adopted many Greek words and concepts, and many Latin terms have Greek roots. In addition, Greek literature influenced Latin literature, which led to a very rich and diverse literary production. Roman patricians and nobles had the economic and social capacity to have slaves and preceptors to teach their children various subjects. In the case of ancient Rome, Roman patricians had slaves who taught them philosophy in Greek, indicating that these patricians valued Greek education and culture (Sánchez, 2009).

Sánchez (2009) stated that the teaching of foreign languages was not immune to criticism and limitations. One of the main problems was that humanists, who were the promoters of education in classical languages such as Latin and Greek, became obsessed with the form and content instead of focusing on communication and application of the language. As a consequence, teaching became a dull formalism for students, as it focused on the memorization of grammatical rules and the translation of classical texts, rather than on fostering oral use and effective communication in the language. In addition, humanists often discouraged the teaching

of vernacular languages which limited education to a cultured elite who could afford education in Latin and Greek (Clarke, 2012).

From the 17th century onwards, there was a great evolution in the teaching of foreign languages. This century saw the emergence of pedagogical movements that sought to reform education, being pedagogical realism one of the most influential of these movements. It emerged in countries influenced by the Protestant Reformation and opposed humanism, which has been dominant in education during the Renaissance (Márquez, 2017). This new movement was based on the fundamental principle of sensible intuitionism, which stated that knowledge is acquired through direct experience and observation of facts. It focused on the idea that learning should be a practical and realistic experience that prepared students for everyday life and the labour world. Pedagogical realists believed that education should be based on reality and the concrete experience of the learner, and not only on theory and abstraction. They advocated the importance of meaningful learning, in which students could relate new knowledge to their own experience and reality, leaving behind teaching based on memorization and mechanical repetition (Sánchez, 2010). In the field of foreign language teaching, pedagogical realism advocated a more practical and participatory approach, oriented towards effective and active language use. This practical approach was reflected in the use of teaching materials such as dialogues and conversations, which enabled learners to practice the language effectively. Teaching methods more focused on oral communication were also developed, such as the natural method, which was based on imitation and repetition of common phrases and expressions (Sánchez, 2009).

As Walmsley (1990) states, Wolfgang Ratke (1571-1635) was one of the innovators in teaching who reacted against the school pedantry of the 16th century and was enthusiastic about the natural method. He also set that “Ratke represents the bridge between the older Lutheran ideals and their transmutation into educational practicality” (p.186). He was a German pedagogue who developed a teaching method based on the idea that learning should be natural and gradual, rather than relying on memorization and mechanical repetition. The Ratke method focused on teaching languages through reading simple texts and oral communication. The aim of this method was to develop those student’s skills that could be applicable in everyday life, rather than focusing exclusively on theory and abstraction (Sanchez, 2009).

Another of the most representative authors of this century was John Amos Comenius (1592-1670), who reflected on the instruction of languages. Comenius was a Czech pedagogue who devoted much of his life to the study of education and pedagogy, and is considered one of the fathers of modern education. It was during his studies of Ratke's works that Comenius first encountered the term "didactics". He was impressed by Ratke's ideas and went on to develop his own innovative methods of teaching and learning, which he outlined in his famous work, the *Didactica Magna*. With regard to language teaching, Comenius proposed a number of principles aimed at making the learning process more efficient and effective. One of these principles was that words should always be learned in relation to things, and not in isolation or in an abstract sense. Comenius believed that the best way to learn a language was through direct experience, so that learners could associate words with the objects and concepts they represent. Another principle proposed by Comenius was graded teaching, which sought to take the student from the simplest to the most complex notions, so that he could build up his knowledge in a solid and progressive way. In addition, Comenius proposed the use of pictures and drawings to facilitate learning, and the use of the student's mother tongue as a tool for teaching other languages (Lukaš & Munjiza, 2014).

As Llopis and Carrasco (1983) pointed out, throughout the 18th century a new cultural movement emerged in Europe, known as the Enlightenment. It was a cultural and philosophical movement characterized by a strong emphasis on reason, science and individual freedom. In this period, many intellectuals and writers advocated the idea that knowledge and reason could be used to improve people's lives and reshape society. Cartesian rationalism and English empiricism were two important philosophical currents within this movement, although others such as Kantian criticism and Jeremy Bentham's utilitarianism also developed. Moreover, the Enlightenment had a great influence on education, as many of its intellectuals considered education to be the key to the development of reason and individual freedom. It was at this time when foreign language teaching started to become part of the academic curriculum in some European countries. At that time, the teaching of Latin was still very important in formal education and the teaching of modern languages was less common. The grammatical method was one of the most popular approaches to foreign language teaching during the 18th century. This approach focused on the study of grammar and the translation of texts, and relied heavily on the teaching of Latin. Students learned grammatical rules and vocabulary, and then translated texts from the foreign language into the native language and vice versa. However, over time,

new theories and approaches to foreign language teaching emerged which were more oriented towards oral communication and practice.

3. Bilingual Methods

As García and Lin (2017) remark, bilingual education programs have gained popularity in recent times, leading to various methods being developed to achieve this objective. Some of the most popular approaches include immersion, semi-immersion, and dual immersion programs, which offer students an immersive environment to enhance their language skills by interacting with native speakers (Kim, Hutchiton and Winsler, 2015). The main difference between the three is the amount of target language content used over a range of time. In inversion programs, we usually speak of total inversion in which the entire academic curriculum is taught in a second language which is the target language and varies according to the academic context. Semi-immersion programs are divided between content taught in the native language and content taught in the target language, with a limited amount of time devoted to the use of the language being taught. The last model mentioned in the previous lines is dual immersion, which basically can be defined as an educational model in which two languages are taught at the same time (Molina, Cañado & Agulló, 2005). All of these approaches aim to provide students with a comprehensive bilingual education that emphasizes language skills and subject knowledge. In recent years, the growing demand for bilingual education has led to the increasing popularity of these programs. By integrating language, culture and academic knowledge into the curriculum, these programs prepare students better for the challenges of an increasingly globalized world.

3.1. Bilingual education

Bilingual instruction is a group of methods of teaching academic material in two languages. This approach to education involves offering lessons in the student's mother tongue and second language, with the goal of fluency in both. Baker (1993) defined the term "bilingual education" as a broad category of educational institutions that use the native language and a foreign language for formal instruction. This definition refers to situations where pupils belonging to linguistic minorities are taught in two languages of the majority language in order to facilitate their integration into the surrounding society. Bilingual education can take many forms, such as bilingual programs in which students who speak different languages study together, maintenance bilingual programs in which students learn another language while receiving instruction in their native language or transitional bilingual programs in which students receive

academic education material in both languages until they master the target one (Fishman & Lovas, 1970). Bilingual education has many benefits, including improved academic performance, enhanced cognitive development, and increased cultural sensitivity and understanding (Benson, 2002). It is also especially beneficial for students from different linguistic and cultural backgrounds because it allows them to learn a second language while maintaining and improving their mother tongue (Christian and Genesee, 2001).

In comparison with bilingual education, which focuses on the development and acquisition of competences in the native language and the target language, immersion programmes go one step further. They expose students to the target language in its entirety, with that language being the primary language of instruction and communication.

3.2. Immersion programs

In the past few years, there has been an increased interest in bilingual education programs that emphasize full immersion in the target language. Such courses can be monolingual, where teaching takes place only in the target language, or bilingual, where different subjects are taught in two languages (Lasagabaster & Sierra, 2010). The popularity of language immersion programs is due to their effectiveness in developing language skills in an authentic environment, thus providing more sustainable and effective learning outcomes (Hinton & Ahlers, 1999). Students can significantly improve their language skills by interacting with native speakers. Language immersion programs not only improve language skills, but also develop cultural awareness and intercultural communication. Knowledge of the target language and culture allows students to better understand and appreciate cultural nuances and perspectives. In addition, language immersion programs have been shown to have positive effects on cognitive development, particularly in areas such as problem-solving, critical thinking and creativity. With the growing demand for bilingual education, many educational institutions are adopting language immersion programs to provide students with a well-rounded education that encompasses linguistic, cultural and cognitive development. These courses are particularly useful in preparing students for a globalized world where multilingual and intercultural competence are highly critical competencies (Steele et al., 2017).

As the bilingual trend continues to grow, different approaches continue to emerge that aim to promote the concept. One widely recognized method in Europe is the CLIL method. This approach is a typical example of the many different strategies that can be used to achieve the

goals of bilingual education (Gabillon, 2020). As it is discussed by Prakash and Spoorthi (2022), in recent years the CLIL approach has become more popular because it provides students with a more holistic and stimulating learning experience. Therefore, many educational institutions and schools use the clil method to provide students with bilingual education. In this way, they can provide a broader education that emphasizes language skills and professional knowledge, preparing them for a globalized world where multilingual and intercultural competence are essential skills (Rodríguez, 2022).

4. Content and Language Integrated Learning (CLIL)

4.1. Historical background

Content and Language Integrated learning (CLIL) is an innovative language teaching method that has gained popularity worldwide in recent decades. While CLIL is widely recognized as the umbrella term for this approach, it has its own initials in other countries. AICLE (Aprendizaje Integrado de Contenidos y Lengua Extranjera) is the Spanish term used to designate the concept of CLIL. In the French-speaking European tradition, the term Enseignement d'une Matière par l'Intégration d'une Langue Étrangère (EMILE) is often used to refer to the same phenomenon. David Marsh, Professor of Applied Linguistics at the University of Jyväskylä in Finland, coined the term CLIL in the 1990s (Piacentini and Simões, 2020). This approach involves combining language instruction with academic content in subjects such as science, mathematics, history and literature (Coyle et al., 2010b). Instead of teaching language and content separately, CLIL integrates both aspects in the classroom, allowing students to learn language skills and subject knowledge simultaneously and meaningfully (Marsh, 2002). The main objective of CLIL is to equip students with high-level language and cognitive skills to meet the academic and work-related challenges of today's globalized world (Airey, 2017).

According to Oprescu (2015) and other authors, the CLIL approach, despite its innovative interpretation, is not new in the 21st century. Its origins can be traced back to 1965 in Quebec, Canada, where English-speaking parents created an immersion program model. The aim was to provide their children with a bilingual education that would allow them to speak, read and write in French (the official language of Quebec City to this day) and facilitate the learning of other languages and motivate students to delve into themselves (Hanesová, 2015). All this was done in accordance with the standards set by the curriculum and respecting the cultural traditions of Canadian English and French speakers. CLIL can therefore be seen as an evolution of Quebec's immersion program, with a focus on combining content and language learning in different

education contexts. Despite the differences in implementation, both programs share the goal of providing students with a bilingual education that promotes cultural awareness and language skills.

Despite its origins in Canada, this immersion programme model, which integrates content and language learning simultaneously, has undergone considerable spread to the rest of the world. CLIL has become a broadly adopted educational methodology on the European continent, leading at the same time to other countries integrating CLIL into their educational systems. In the following section, the European framework in relation to CLIL is mentioned, going deeper into its implementation in Spain and ending with the indirect way in which the Autonomous Community of Andalusia emerges plurilingualism and accepts CLIL in its educational institutions.

4.2. The European framework

The Department of Education implemented the CLIL approach in 1998 by establishing experimental bilingual centers in German and French, aligning with European guidelines and initiatives. This particular context was emphasized in the Commission's 2004-06 Action Plan (2004), which aimed to promote language learning and linguistic diversity. The establishment of these bilingual centers was a testament to the department's commitment to enhancing language education and providing students with opportunities to develop proficiency in multiple languages, in line with the objectives outlined in the European Commission's Action Plan (Bazo & Peñate, 2000). In addition to the Action Plan, in 1980 the European Commission set up a European Education Information Network, Eurydice (Información de la Unidad de Eurydice de España, n.d.)¹. This serves Member States for the exchange of descriptive information on the organization and functioning of education systems and national policies, and for comparative studies on issues of common interest. Both have their main focus on promoting language learning and linguistic diversity in Europe.

As cited in Porras-Loyola (2013), there was a need to shift certain paradigms in foreign language education due to the interdependence that European countries started experiencing since the late 1960s. The Council of Europe and the European Common Market recognized the importance of developing and articulating alternative methods for teaching foreign languages

¹ <https://www.educacionyfp.gob.es/mc/redie-eurydice/quienes-somos.html>

to ensure that adults become competent in multiple languages, especially those spoken within the community, as a result of the increasing globalization of markets and relationships between member countries. In today's Europe, it's crucial for citizens to have the necessary language skills to communicate and understand each other. The European Union is based on free movement, and individuals with good language abilities can take advantage of this to work or study in another member state. Communication is essential for economic and social integration in a globalized world, and multilingualism is valued and promoted throughout the EU (European Union).

Content and Language Integrated Learning (CLIL), has gained significant traction in European education systems as a powerful pedagogical approach. Across Europe, almost all countries have incorporated CLIL into their school systems, with some offering it on a voluntary basis and others making it a mandatory component of education. As it is established by Marsh et al. (2012) the aims of it is “to provide a set of principles and ideas for designing CLIL professional development curricula” (p. 3). The framework's primary objective is to facilitate reflection and not imposed rigid guidelines, acting as a model and a conceptual lens. It was produced within the context of a CLIL curriculum development initiative sponsored by the European Centre of Modern Languages (ECML), and it considers the different structures, content, intensity, and language selections of CLIL programs in European member nations. Instead of concentration on particular programs, the European Framework for CLIL Teacher Education emphasizes the broad competencies that CLIL instructors require at a macro level (Lasagabaster & Zarobe, 2010).

4.3. An Spanish overview

Gómez and Mármol (2017) pointed out that in the case of Spain, the implementation of bilingual programmes in English and Spanish in public schools dates back to the collaboration agreement signed between the Ministry of Education and the British Council in 1996. The main objective of this agreement is to develop bilingual programmes through the integration of a curriculum that combines Hispanic and British aspects. Since then, this agreement has undergone several renewals, the most recent being in 2013, complemented by additional addenda signed in 2016. These addenda extend the collaboration between the Ministry of Education, Culture and Sport and the British Council for the implementation of integrated curriculum projects and joint educational activities.

Spain has rapidly experienced significant growth in the implementation and study of CLIL. This can be attributed to the country's cultural and linguistic variety (Porrás-Loyola, 2013). The diversity within the Spanish CLIL programs means that there is no universal blueprint that can be applied across the country. However, this diversity can serve as a useful model for other countries seeking to promote foreign language learning. CLIL programs are commonly implemented in mainstream schools throughout Spain, with support from educational authorities (Lasagabaster & de Zarobe, 2010). These programs vary significantly from one region to another and can be classified into two main contexts: monolingual communities and bilingual communities. In monolingual communities, education is conducted in Spanish and one or two foreign languages, whereas in bilingual communities, education is undertaken in co-official regional languages (Basque, Catalan, Galician and Valencian) and Spanish, as well as one or two foreign languages during CLIL implementation (Lasagabaster, 2017). In the later mentioned communities, which have more experience in this area, the regulations are more extensive, while in the case of monolingual communities, where bilingual programmes have been introduced more recently, the regulations are less extensive and the updates are, in some cases, very recent (Gómez & Mármol, 2017). This is the case in Andalusia, referred to in the following section.

4.4. CLIL in Andalusia

In Andalusia, the CLIL approach has been implemented in schools as part of the *Plan de Fomento del Plurilingüismo* (2005). It was approved by an agreement of the Governing Council on 22 March 2005. In the process of full integration in Europe, it is considered essential for Andalusian students to acquire the ability to communicate in multiple languages. It proposed a methodological renewal which prioritizes the development of communicative competence and fundamental skills, such as speaking, writing, listening, reading and conversing, as established in the Common European Framework of Reference for Languages (CEFR)². Plurilingualism involves the development of communicative skills that draw on linguistic knowledge and experiences, in which languages relate to and interact with each other.

The primary goals of the aforementioned plan revolve around three core objectives (Junta de Andalucía, n.d.)³. Firstly, it aims to achieve fluency in foreign languages among the residents

² <https://www.coe.int/en/web/common-european-framework-reference-languages/level-descriptions>

³

http://w01.centrodeestudiosandaluces.es/actividades/sitios/archivos/12864459242077543087_Casto_Sanchez.pdf

of Andalusia, emphasizing the importance of effective communication. Secondly, it focuses on the strategic aspect of educating and equipping Andalusian students with linguistic and cultural plurilingualism, enabling them to successfully navigate an increasingly globalized world. Lastly, the Plan addresses the sociological objective of establishing stronger bonds between the diverse and multicultural Andalusian community and emerging languages and cultures, promoting greater understanding and appreciation.

According to the current regulations in the Andalusian Community (Order of 28 June 2011 BOJA 135 of 12 July 2011), a bilingual school is defined as an educational institution that promotes the acquisition and development of students' linguistic competences in relation to the five language skills through the implementation of Content and Language Integrated Learning (CLIL). These schools follow a methodological, curricular, and organizational model that incorporates the principles of CLIL. In Andalusia, there are a total of 993 schools offering bilingual education, which have adopted the CLIL approach. In these schools, a minimum of two non-language subjects are taught in English, French, or German, and at least 50% of the students receive instruction in one of these languages.

The use of CLIL in Andalusia has garnered positive evaluations, as research studies indicate that students are making notable progress in both subject content and foreign language acquisition (Lorenzo et al., 2010). These findings have led researchers to conclude that CLIL holds the potential for substantial cognitive benefits. They confirm that CLIL learners surpass their monolingual counterparts in terms of progress, demonstrate evidence of incidental learning and positive transfer through content-focused instruction, showcase comparable competencies between early and later start learners, and highlight the advantages of team teaching between content and language specialists, resulting in a wider range of discourse input. Ultimately, CLIL has emerged as “a grassroots initiative: A European solution to a European need” (Lorenzo et al., 2010, p. 19)

Each legislation, whether at European, national or regional level, marks the implementation of CLIL or in some way close to it. Depending on the situations, laws and other influences in each area, it will be implemented in different ways. What needs to be clear when it comes to training and implementation are the pedagogical principles that this methodology promotes in

order to be able to start from a solid theoretical basis. The following section is devoted to the principles promoted by CLIL and existing techniques that are integrated into CLIL.

5. CLIL's core pedagogical principles

In the following, we will first present the main framework on which CLIL is based, which marks the difference between CLIL and other methodologies. Subsequently, other principles that already exist and are characteristic of this methodology will be brought into focus.

5.1. 4C's: content, cognition, communication and culture

According to Coyle et al. (2010b), the foundations of the CLIL methodology are four fundamental elements, known as the 4C's, that define and differentiate it from others. As they stated: "is the planned pedagogic integration of contextualized content, cognition, communication and culture into teaching and learning practice" (Coyle et al., 2010a, p. 6). This suggests that the CLIL approach involves a well-planned framework that combines content, cognition, communication and culture. By integrating these four key elements, CLIL provides students with not only language proficiency but also cultural knowledge and critical thinking skills.

The 4C's of CLIL methodology can be defined in the following way (Coyle, 2010a). The first C, content, refers to the content used in the subject. However, it is important to emphasize that "content matter is not only about emerging knowledge and skills, it is about learners creating their own knowledge and understanding and developing skills (personalized learning)" (Coyle, 2006, p. 9). This can involve putting into practice the use of real-life or authentic materials and situations that are relevant to learners' interests and needs. This contributes to creating a meaningful and engaging learning experience. The second C, cognition, involves the development of higher order thinking skills such as analysis, synthesis and evaluation. By integrating cognitive development, CLIL helps learners to develop critical thinking, logical reasoning and problem solving skills. In this methodology, content is linked to learning and thinking so that learners are able to freely interpret the content. Cognition is very important in CLIL as it helps develop the cognitive skills that enable learners to process, understand and apply what they learn effectively (Coyle, 2008). Moreover, not only in the content part, but by actively using language in the context of the content, linguistic competence is strengthened and consequently the ability to understand and communicate in the target language. The third C, communication, focuses on the development of language competence through meaningful and

purposeful communication. Learners are encouraged to use language as a tool for communication and interaction, not just as an object of study. For this, it is necessary to learn a language by relating it to the learning context, to learn through that language, to reconstruct the content and its related cognitive processes. The main characteristic of the language used to carry out communication is simple, transparent and accessible language. The fourth C, culture, involves exploring and understanding different cultures, values and beliefs. As is well known, the relationship between cultures and languages is quite complex. So the aim of the fourth C in CLIL is to help learners develop intercultural competence, which is increasingly important in our globalized world. Taken together, the 4 Cs of CLIL methodology provide a comprehensive framework for language learning and subject teaching that is effective and engaging for learners.

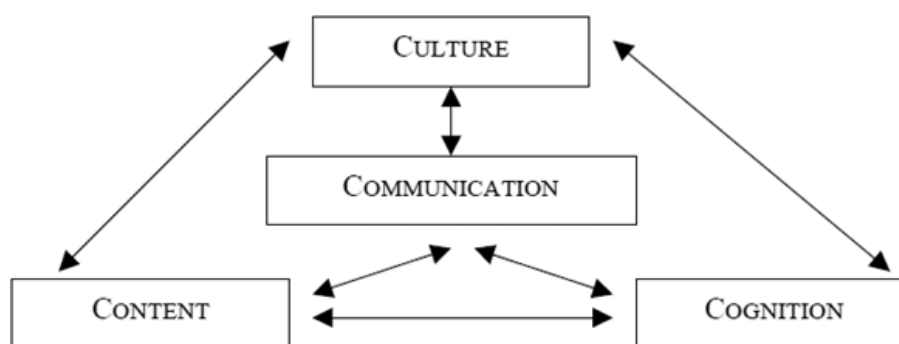


Figure 1: 4C's⁴

The 4Cs framework, encompassing content, communication, culture and cognition, aims at promoting effective communication and collaboration in diverse contexts. Moreover, the 4Cs can be seen as prerequisites to successfully classifying thinking according to the six cognitive levels of complexity established in Bloom's Taxonomy 1956, revised by Krathwohl, 2001⁵. By developing the 4Cs, students are equipped with the necessary tools to progress to the higher levels of Bloom's Taxonomy, such as analyzing, evaluating and creating, rather than only asking them to memorize or remember, considered lower-order cognitive skills.

⁴ Nikolic, Dusan. (2017). Intelligibility within a Modified CLIL Framework. *Glottodidactica - International Journal of Applied Linguistics*. 44. 119 - 130. 10.14746/gl.2017.44.1.07.

⁵ https://quincycollege.edu/wp-content/uploads/Anderson-and-Krathwohl_Revised-Blooms-Taxonomy.pdf

5.2. Bloom's Taxonomy and its implications for CLIL

One of the four C's refers on which the CLIL pedagogical approach has its basis refers to the cognitive framework, based on Bloom's Taxonomy 1956, revised by Krathwohl, 2001. This Taxonomy is a system that organizes educational objectives into categories based on their level of cognitive complexity and specificity. It was first developed by Benjamin Bloom in 1956 and has undergone revisions since then to make it more comprehensive and relevant (Krathwohl, 2002). It is a hierarchical framework for categorizing learning objectives and outcomes according to six cognitive domains, ranging from lower-order thinking skills such as remembering and understanding to higher-order skills such as analyzing and creating. While these two frameworks may appear distinct at first glance, they are in fact deeply interconnected, with each informing and supporting the other. Forehand (2010) realizes that the terms "taxonomy" and "classification" are interchangeable and can alleviate any discomfort with the language. It is also stated that Bloom's Taxonomy is a hierarchical system for categorizing thinking into six levels of cognitive complexity. Over time, these levels have frequently been represented as a staircase, as Forehand (2010) argues, "leading many teachers to encourage their students to climb to a higher (level of) thought" (p. 2).

Bloom's Taxonomy has gone through several revisions over the years to better reflect current educational practices and theories of learning. The original version of the taxonomy, developed by Benjamin Bloom in the 1950s, consisted of six hierarchical categories of cognitive skills: knowledge, comprehension, application, analysis, synthesis and evaluation. In 2001, a group of educators led by Lorin Anderson, a former student of Bloom, revised the taxonomy to make it more user-friendly and applicable to a wider range of educational contexts. The revised taxonomy consists of six categories of cognitive skills: Remembering, Understanding, Applying, Analyzing, Evaluating and Creating (Forehand, 2010).

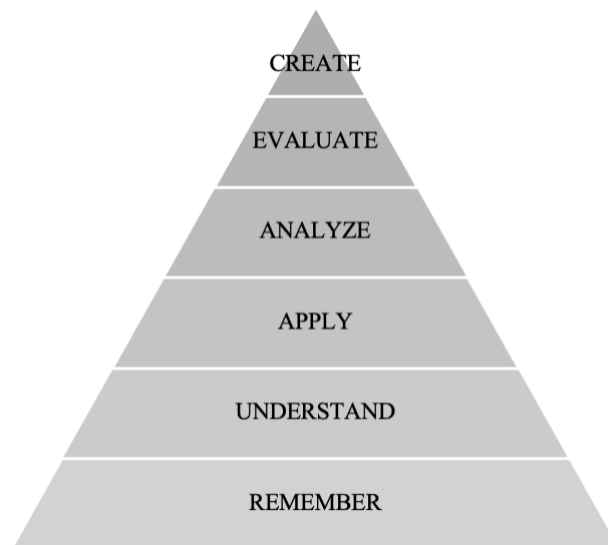


Figure 2: Bloom's Taxonomy⁶

According to Anderson and Krathwohl (2001), as was cited in Forehand (2005), the revised terminology comprises the following definitions:

- Remember: in this first level, learners are expected to recall factual information from memory. This can include basic concepts, definitions, or facts. Remembering can involve simple tasks such as listing or naming and it serves as the foundation for higher-order thinking skills.
- Understand: learners are expected to comprehend the meaning of information and explain it in their own words, demonstrating their grasp of it. Understanding requires more than just memorization.
- Apply: learners utilize their knowledge to solve problems or complete tasks in a specific context. Applying required learners to take what they have learned and use it in practical, real-world situations.
- Analyze: in this fourth level learners are supposed to break down complex concepts into their constituent parts and examine their interrelationships.
- Evaluate: learners assess the quality of information based on predetermined criteria.
- Create: in the highest point of the pyramid, learners are expected to generate new ideas combining their own knowledge in innovative ways, being able of generating independent and original thoughts.

⁶ <https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/>

The 4C's framework and Bloom's Taxonomy can be seen as mutually reinforcing, with each supporting and enhancing the other in a continuous cycle of learning and development. When learners engage in complex cognitive tasks such as analysis and evaluation, they may face difficulties that require them to utilize their communication and collaboration abilities to overcome. Likewise, as learners improve their communication and collaboration skills, they may become better equipped to express and defend their ideas, thus boosting their capacity to participate in advanced cognitive activities like synthesis and evaluation. Both frameworks have a mutually beneficial relationship, with each complementing and reinforcing the other in a dynamic and continuous process of learning and development. Through acknowledging and utilizing the interplay between these two valuable tools, educators and learners can foster enhanced comprehension, improved communication and more meaningful involvement with intricate concepts and ideas.

As evidenced by its widespread use, this renowned system has effectively addressed a gap by offering educators one of the earliest organized categorizations of the learning and thinking processes. The hierarchical structure, which encompasses six levels where each subsequent stage necessitates mastery of the preceding one, remains comprehensible. Assessing students' capabilities is a crucial aspect of teaching and achieving this necessitates identifying the various levels of intellectual behavior that are significant to learning. Bloom's Taxonomy served as the tool for gauging thinking ability. The Revised Bloom's Taxonomy has proven to be an even more effective tool in meeting the needs of today's teachers in light of the significant societal changes that have occurred over the past fifty years (Forehand, 2010). The structure of the Revised Taxonomy Table matrix is particularly useful as it offers a clear and succinct visual representation of how standards relate to educational goals, objectives, products and activities, as noted by Krathwohl (2002). Its alignment between various components is essential for teachers to develop effective lesson plans and assess student progress effectively.

Krathwohl (2002) states that Bloom's Taxonomy provides a useful framework for educators to create lesson plans that are aligned with standards and allow students to achieve deeper learning and understanding. Each level builds upon the previous, with creating being the most advanced and challenging level. The ultimate goal is to enable learners to perform a task independently after initially receiving guidance and assistance from their teachers. The process of gradually transitioning from guided assistance to independent mastery of a task represents a

key aspect of the Zone of Proximal Development (ZPD) in educational settings, which will be explained in the section below.

5.3. Zone of Proximal Development and scaffolding

Another pedagogical axis for the CLIL framework is the notion of scaffolding, and the Zone of Proximal Development (ZPD). This notion was introduced by Vygotsky the Zone of Proximal development is a concept used to describe the difference between what a learner can do independently and what they can achieve with guidance and support from a more knowledgeable other (Vygotsky & Cole, 1978). He defines the ZPD as “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (Vygotsky & Cole, 1978, p.86). It represents the sweet spot where learning is most effective, as it challenges the learner just enough to push them beyond their current level of competence, without overwhelming them with tasks that are too difficult. This process involves a gradual progression in which the teacher guides the learning experience, providing support and feedback as necessary until the student can perform the task autonomously (McLeod, 2012). The ZPD theory posits that this approach leads to more meaningful and successful learning outcomes by stretching the learner's abilities just beyond their current level of competence. By working within this zone, learners can develop new skills and understanding with the guidance and support of their teacher, eventually becoming independent and proficient in their own right.

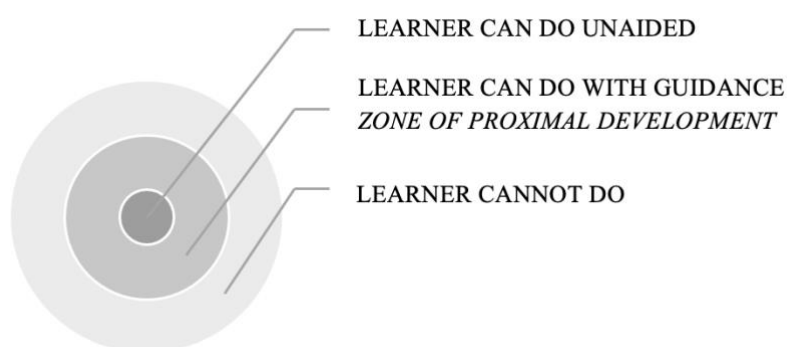


Figure 3: Zone of Proximal Development⁷

⁷ Kurt, S. (2020). Vygotsky's Zone of Proximal Development and Scaffolding - Educational Technology. Educational Technology. <https://educationaltechnology.net/vygotskys-zone-of-proximal-development-and-scaffolding/>

Within the ZPD, learners are encouraged to take on challenges that are just beyond their current level of competence with the guidance and support of their teacher, allowing them to gradually expand their skill set and knowledge base. This is achieved by providing learners with the necessary scaffolds or support structures, which can take many forms, including modeling, prompts, feedback and coaching. By employing these scaffolds, the teacher can gradually withdraw support as the learner gains competence, until they are capable of performing the task autonomously (Lee, 2012). This process of scaffolding helps to ensure that students are appropriately challenged and supported, enabling them to achieve a greater level of mastery over the task at hand.

Referring to the groundbreaking investigations carried out by Bruner and Sherwood (1976), Wood et al. (1976) and other experts, the concept of scaffolding was intimately linked to Vygotsky's sociocultural theory, with a special focus on his zone of proximal development idea. Scaffolding refers to the temporary assistance or guidance given to learners by a more knowledgeable individual, such as a teacher or mentor, to help them develop their skills and understanding. This support can take many forms, such as providing examples, simplifying complex ideas, or breaking down tasks into smaller, manageable steps. It involves providing temporary support and guidance to learners within their ZPD, which allows them to develop their skills and understanding. The scaffolding process begins with the teacher supporting, initiating and sustaining interest in the topic at hand, while the learner gains confidence and motivation to engage with the material. As learners gradually take control of the tasks and become more competent, they become responsible for their own learning, and teachers can begin to remove the scaffolding. This process of gradually reducing support and promoting independent learning is essential for learners to develop their skills and knowledge fully. The goal of scaffolding is to help the student to develop the skills and knowledge necessary to perform the task on their own, without the teacher's help. During the scaffolding process, the teacher gradually reduced the level of support as the student becomes more confident and capable. This allows the student to take more responsibility for their own learning, and eventually, they are able to perform the task independently. The teacher's role is to provide the right amount of support at the right time and to be responsive to the student's needs.

Mehisto et al. (2007) explain that scaffolding enables students to use their existing knowledge and skills to analyze and process new information, make connections between

different concepts and deepen their understanding of the topic at hand. By providing support and guidance, scaffolding can help students build momentum and achieve quick successes, which can reduce frustration and increase motivation. Additionally, scaffolding can help students develop a better understanding of the learning process, which can help them save time and enjoy a more positive learning experience overall. In essence, scaffolding is a teaching approach that provides a secure and supportive learning environment for students. According to Mehisto et al. (2007), scaffolding helps students by providing the necessary building blocks, such as language and background knowledge, to tackle complex tasks. By doing so, scaffolding helps to motivate students and ensures that they acquire the necessary skills and knowledge. Scaffolding is a highly effective instructional tool because it allows for individualized instruction, engage learners and streamlines the learning process, allowing students to focus on learning more efficiently.

5.4. From teacher-fronted teaching towards student-centered approach

Menegale (2008) and Ali (2019) noted that implementing a student-centered methodology in primarily teacher-fronted lessons poses a challenge. Teachers can consider how to structure the lesson to allow for more student participation, such as by incorporating group work, discussions, or other interactive activities. Additionally, it is important to identify how much time is allocated to student talking time and ensure that there are opportunities for all students to contribute to the lesson. Another crucial factor is the type of questions asked by the teacher. Closed-ended questions that only require a one-word answer can inhibit discussion and limit student participation. By asking open-ended questions that require students to extend their thinking and share their opinions, teachers can foster a more engaging and collaborative learning environment. To transform a teacher-fronted lesson into a more student-centered one, educators can gradually introduce more opportunities for active student involvement. For instance, teachers can assign small group projects that require students to work together to solve problems or complete tasks (Wright, 2011).

Long and Porter (1985) suggested that increasing interaction between learners in the classroom can have several benefits for language learning. According to their research, interaction can provide learners with opportunities to negotiate meaning, receive corrective feedback and practice using the target language in authentic situations. Furthermore, Long and Porter emphasized that learner-learner interaction can promote the development of learner autonomy, as learners are encouraged to take responsibility for their own learning and to work

collaboratively with their peers. This can lead to a more student-centered and participatory classroom environment. Porter (1986) conducted a study to investigate the nature of learner-learner interaction in the language classroom. The study found that learners, when given the opportunity, talked significantly more to each other than to the teacher, using similar interactional devices to those used by native speakers. These interactional devices included prompting and echoing the interlocutor, as well as singling out and correcting each other's mistakes. The study also found that learners were able to negotiate meaning effectively with each other, and that their conversations were more spontaneous and dynamic than those with the teacher. Moreover, Porter (1986) argued that learner-learner interaction can provide learners with valuable opportunities to develop their speaking skills and to engage in authentic communication. By interacting with their peers, learners can practice using the target language in a supportive and non-threatening environment and receive feedback and corrections from other learners who are at a similar level. Overall, Porter's research highlights the potential benefits of promoting learner-learner interaction in the language classroom and suggests that teachers should provide opportunities for learners to interact with each other and engage in meaningful communication. This can help to create a more dynamic and student-centered classroom environment and promote the development of learners' speaking skills and communicative competence (Porter, 1986). The most useful strategy to foster learner-learner interaction in the classroom is implementing cooperative learning strategies.

5.5. Cooperative learning

Jacobs et al. (2006) note that group work in the classroom not only leads to increased output from students compared to traditional teacher-led approaches, but it also allows for a wider range of linguistic functions to be performed. This is because groups provide a natural context for the development of communicative skills such as conversation, which cannot be easily replicated in a teacher-centered setting. Research has shown that the use of group work in language classrooms have a positive impact in various aspects of language learning, such as fluency, accuracy and complexity of language use (Storch & Aldosari, 2010). Group work provides learners with more opportunities for communication and negotiation of meaning, which leads to more interaction and language use in real communicative situations. Additionally, group work can also help to create a more inclusive and collaborative learning environment, which can promote learner motivation and engagement. By engaging in group activities related to content learning, learners can collaborate and share ideas, which can

enhance their understanding of the subject matter and promote deeper learning (Evnitskaya, 2021).

With cooperative learning as a teaching strategy, students get involved working together in small groups to achieve a common goal. The benefits of this approach have been widely studied and documented in the field of education. Casal (2006) highlights the following benefits of cooperative learning:

1. Promotes interaction: it encourages students to interact and collaborate with each other. This interaction promotes socialization, encourages the exchange of ideas and fosters teamwork.
2. Facilitates cognitive and personal growth: it provides opportunities for students to develop higher-order thinking skills such as problem-solving, decision-making and critical thinking. It also promotes personal growth by encouraging students to take responsibility for their own learning and by providing a supportive environment for experimentation and risk-taking.
3. Improves learning, retention and academic achievement: it has been shown to improve students' understanding of course material, increase their retention of information and enhance their academic achievement.
4. Develops social skills: it provides opportunities for students to develop important social skills such as communication, leadership, negotiation and trust-building. These skills are essential for success in both academic and professional settings.

However, it is important to note that simply placing students in groups does not guarantee that they will automatically develop these skills. Teachers must actively engage students in interactive behaviors and attitudes in order to maximize the benefits of cooperative learning. This may involve modeling and teacher effective communication skills, providing opportunities for leadership and decision-making and encouraging students to clarify their understanding of course material through discussion and debate.

The approach has gained popularity in recent years, and it is also used in Content and Language Integrated Learning (CLIL) contexts. Casal's argument that cooperative learning is beneficial in CLIL contexts, is supported by research that highlights the potential of the approach to enhance language and content learning (Casal, 2008). In addition, cooperative learning can also support subject learning by providing students with opportunities to engage in active learning, to develop problem-solving skills and to construct their own knowledge

through collaboration and discussion with peers (Youngblood & Beitz, 2001). Cooperative learning can help to foster these qualities by providing students with opportunities to take on leadership roles, to support each other in their learning and to work collaboratively towards common goals (Petre, 2020).

6. Positive and negative aspects of implementing CLIL in the classroom

Even though there has been a surge in the popularity of bilingual education, and therefore Content and Language Integrated Learning (CLIL) in recent times, it is important to consider the potential drawbacks before deciding to implement it. While CLIL has been shown to have many positive aspects and can lead to personal development, there are also negative aspects that must be taken into account. Therefore, it is important for schools and educators to carefully consider the benefits and drawbacks before deciding to implement it. A bilingual school itself is not enough to ensure academic success for students. It is necessary adequate training and support should be provided to ensure that teachers are equipped with the necessary skills and knowledge to effectively implement CLIL in their classrooms. Proper planning, implementation and monitoring can help ensure that CLIL is a positive experience for students and teachers.

CLIL is an effective method for improving student's oral and written communication skills. By studying subject content in the target language, students gain confidence in using it and expand their vocabulary, particularly in specialized terminology that is valuable for those pursuing bilingual or multilingual careers. Coyle et al. (2010a) emphasize that CLIL aims to create a meaningful learning environment where students can immediately apply the target language, removing any language barriers they may encounter. Unlike traditional language learning, CLIL focuses on using language to communicate about content, rather than solely on language acquisition. In other words, language is not the ultimate goal of CLIL, but a tool for communication. Students are exposed to authentic situations that require pragmatic and functional language usage, making their language learning more realistic.

Gatbonton and Segalowitz (2005) support that idea suggesting that Content and Language Integrated Learning (CLIL) helps develop language skills by providing opportunities to use language in real-world contexts. By teaching content through the target language, students are given the opportunity to use English in real-world contexts, which in turn helps them improve their language proficiency. This approach also helps students to develop critical thinking and problem-solving skills while learning about different subjects, thereby promoting deeper

learning and understanding. Thus, CLIL programs offer an effective way to learn English while also gaining valuable knowledge in various subjects.

One of the key benefits of CLIL is that it provides students with authentic learning experiences which means that they learn through practical, real-world situations and materials (Pinner, 2013). Authentic learning experiences in CLIL can take many forms, such as field trips, role plays, simulations, debated and project-based learning. This would provide students with an authentic learning experience that enables them to apply their scientific knowledge in a practical and meaningful way (Banegas, 2020). Furthermore, the use of authentic materials in CLIL can also help students learn by exposing them to real-life language use and giving them practical skills that they can apply in real-life situations (Ball et al. 2016). By providing students with authentic learning experiences, CLIL can help to increase student engagement and motivation, as well as improve their language and content knowledge. Additionally, CLIL can help students to develop important transferable skills, such as critical thinking, problem-solving and collaboration, which can be valuable in many areas of life (Sylvén & Thompson, 2015).

There is a general consensus among experts that Content and Language Integrated Language (CLIL) is a catalyst for critical thinking in various ways. One of them is that it required active engagement from students in order to comprehend and express subject matter in a second language (Hanesová, 2014). This implies that students need to scrutinize, assess and employ their content knowledge to effectively communicate their ideas in the target language. Additionally, CLIL frequently apports inquiry-based learning where students are prompted to ask questions, collect evidence and make conclusions based on their own observations and research. Such an approach can augment students' critical thinking abilities by allowing them to analyze information, evaluate evidence, and draw logical conclusions based on their own examination (Valverde Caravaca, 2019). Moreover, CLIL mandated that students engage in collaborative learning, which can further develop their critical thinking skills by enabling them to learn from and challenge each other's ideas (Schamber & Mahoney, 2006). By collaborating in groups, students are encouraged to share their own viewpoints and to contemplate the perspectives of others, which can help to nurture their ability to think critically about complex issues.

In the current era of globalization, being proficient in English has become crucial for personal and professional reasons. With English being the language of international

communication, it is widely used in academic, business and other sectors (De Zarobe, 2013). This is why many multicultural and foreign-language learning environments place a strong emphasis on English as a core language. Proficiency in English opens doors to higher education opportunities, as many universities and academic institutions use English as the primary language of instruction. Proficiency in English can serve as a direct way to improve employment prospects, wider access to knowledge and resources and the ability to establish connections with people from diverse regions of the globe. Additionally, being able to communicate effectively in English can lead to increased confidence and cultural awareness, as it allows individuals to navigate cross-cultural situations with greater ease (Casa Gualpa, 2023).

Foreign-language and multicultural learning environments provide opportunities to explore a world that is constantly expanding and evolving. As societies transition and global demand for multilingual skills in the workplace increases, modern learning environments are adapting to a new kind of plurilingualism (Alfaro & Martínez, 2017). These environments are influenced by unprecedented interactions between languages and cultures, which is unlike anything seen in the past. Furthermore, these foreign-language and multicultural learning environments promote cross-cultural understanding and empathy, which are crucial in today's interconnected world (Beardsmore, 2008). They provide students with the opportunity to learn about different perspectives, customs and beliefs, and to develop the skills needed to communicate effectively with people from diverse backgrounds. In addition, being fluent in multiple languages can lead to numerous benefits, such as improved cognitive abilities, greater job opportunities and expanded personal and professional networks (Hu, 2023). As such, the value of foreign-language and multicultural environments cannot be overstated.

Although Content and Language Integrated Learning (CLIL) offers numerous advantages, there are certain challenges that must be taken into account before deciding to implement it. It is worth noting that CLIL can be challenging for students who lack proficiency in the language of instruction. In such cases these students may experience difficulties in comprehending the subject matter, which can ultimately result in lower academic performance or even academic deficiency. Additionally, Suwannoppharat and Chinokul (2015) assert that CLIL may not be suitable for all students, as some may struggle with the added language requirements of the approach, making it hard for them to keep up with the material being taught. This can lead to disengagement, frustration and in severe cases, academic failure. Specifically, students who

lack a solid grasp of the language of instruction may encounter challenges when it comes to understanding the content, following the teacher's guidance, using the appropriate vocabulary and grammar and actively participating in class, which can negatively impact their motivation and self-esteem. CLIL has the potential to further disadvantage students who are struggling with language skills, while providing an advantage to those who are already proficient in the language (Madrid & Pérez Cañado, 2018). To ensure that all students can participate and access the content, teachers must acknowledge the linguistic diversity in their classroom and use strategies that cater to different language proficiency levels (Liu & Zhang, 2023).

If not handled properly, Bruton (2013) justifies that CLIL can widen the achievement gap among students with varying levels of language proficiency. While proficient students may excel, those who struggle with language skills may feel left behind. To prevent this, teachers should provide support and scaffolding, such as pre-teaching vocabulary and assessing language proficiency. By adopting a more inclusive and differentiated approach, CLIL can create a more equitable and effective learning environment. Teachers must also recognize the potential challenges of CLIL and offer appropriate support, which may include modifying subject content or providing additional language instruction.

The development of language, particularly in second language acquisition, can be significantly impacted by limited language exposure. When the language of instruction is not a student's first language, they may not have enough exposure to the target language to become proficient, which can lead to challenges in understanding and using the language in more complex situations (Lahoz, 2007). Exposure to language is crucial as it provides learners with the opportunity to listen, speak, read and write in the target language. It should be pointed out that insufficient exposure to language can present a potential challenge within the home environment, particularly among students whose parents lack proficiency in the target language, a totally normal occurrence. On certain occasions, parental responsibilities, such as job schedules or other commitments, may impede their ability to aid their children with homework or provide supplementary language stimulation at home. Thus, it is incumbent upon educators to acknowledge these obstacles and implement measures to mitigate them.

Furthermore, the lack of proper implementation can also result in a negative impact on the quality of education and student performance (McDougald, 2016). Ineffective implementation of CLIL may lead to confusion and frustration for teachers and students, which can hinder the

learning process. It is crucial for educators to receive adequate training and support to implement CLIL effectively. This can include professional development opportunities, collaboration with colleagues and access to high-quality teaching materials and resources. With proper implementation, CLIL can be a powerful tool for promoting language acquisition and content knowledge, as well as for developing critical thinking and problem-solving skills (Enciso et al., 2017).

7. Critical analysis of a sciences academic textbook used in Secondary education

This critical analysis will examine the implementation of CLIL (Content and Language Integrated Learning) methodology in a science textbook, in the field of biology and geology, targeted to the first year of Compulsory Secondary Education. The analysis will be focused on a specific didactic unit entitled “The universe and our planet” of an educational textbook published by Santillana-Richmond⁸, a benchmark in the area of education. The purpose is to provide an understanding of how the implementation of CLIL methodology in this teaching unit may contribute to the attainment of academic goals and to the holistic scientific and linguistic progress of students.

The 4C's (content, cognition, communication and culture) described as the characteristic framework used in CLIL methodology is implemented in the textbook. Starting with the content, the language and approach used to introduce it are simple and accessible for the age range. In addition, the use of illustrations facilitates the understanding of key concepts and definitions. There is a part in the annexes of the book where a glossary of terms of each didactic unit is offered, therefore it fully complies with the development of good content (see Appendix A). In terms of cognition, the activities and sections present encourage analysis, critical thinking and problem-solving to the maximum. It is important to add that knowledge connects with sections related to other areas such as digital, mathematical, technological, social and civic competence, among others (see Appendix B). Continuing with communication, oral and written communication in the target language is encouraged on each page, offering activities in which comprehensive reading is necessary. In addition, there are many other activities that promote oral comprehension and even sections that provide explanatory videos or audios produced in English (see Appendix B). Finally, culture is also reflected in the unit, not so much at the level of being able to talk about promoting cultural diversity, but the students are offered material

⁸ Taken from: <https://back-edupack.santillana.es/file/repository/136436.pdf>

characteristics of Spain. We find a section where the typical rocks and minerals in Spain are developed (see appendix C).

A further justification of a good didactic unit is the presence of Bloom's Taxonomy in the sequencing and gradual progression of activities, starting from those that require more basic cognitive skills to more advanced ones. In this didactic unit taken as an example, there are all the steps to follow for reaching the last one. Some exercises that exemplify each of the steps of Bloom's taxonomy pyramid are briefly presented in the following lines. First, there are remembering activities such as definitions and multiple-choice activities. There are also comprehension activities, where the learner has to interpret some images or summarize information. Apply activities are mostly present at the end of the unit or in very practical sections where experiments can be performed. Students will then be able to analyze by comparing and identifying relationships between the elements presented. Through paired or group discussions, they will be able to evaluate as they proceed to justify their decisions. Finally, completing the Taxonomy, creative activities are available in which they design presentations, posters or build models. In this way, the six categories elaborated by Bloom would be completed. Throughout the whole didactic unit, these types of activities can be seen. However, in the "activity round-up" section, used as a review of the contents emerged in this topic, the above-mentioned types of activities and their positioning in Bloom's taxonomy can be seen in a gradual way (see appendix D).

With the presence of activities that can be done individually, in pairs and in groups, the Zone of Proximal Development is put into practice, serving as a scaffolding technique for the students. As a first step, by means of the questions asked in the "starting points" section (see appendix E), the teacher can obtain a general class perspective on the previous knowledge of topics in relation to the unit and therefore administer the scaffolding techniques deemed appropriate. In addition, through individual activities, the teacher can collect information on the individual progress of each student and provide support as needed (see appendix F). With the implementation of paired activities, students can help each other in the area of development in which they find themselves (see appendix F). Finally, with teamwork, students are empowered to develop more elaborated activities (see appendix D, 2). In the three types of activities that predominate in the didactic unit, the teacher can give initial guidance and progressively diminish the support until the students are capable of performing the task without help.

The didactic sequence proposed in this textbook leaves behind the teacher as an authoritarian figure in the classroom, thus emerging a learner-centered teaching, which, as highlighted above, is part of the methodological characteristics of CLIL. This practice can be identified in the textbook simply by an overview of it, as it includes abundant visual input to support the written information, thus encouraging a greater and easier understanding of the concepts. In addition, learning objectives are presented from the outset to help students control their learning (see appendix G). This learner-centered practice encourages the learner to play an active role in class. Some of the sections in which adapted and student-centered teaching can clearly be seen are the following. First of all, each teaching unit begins with a section called "How do we know?" in which students are given full freedom to express their opinions. Other sections which, in my opinion, promote active participation in class are "Critical thinking" (see appendix D, 2), "Starting points" (see appendix E), "How do we know?" (see appendix E). I consider that another part that puts the student at the center is "Know how to" (see appendix H) as they are developed in a practical way, giving the student the opportunity to have new experiences that will be learnt and integrated through real experiments.

One of the characteristics mentioned in the CLIL's methodology section that this textbook possesses is its focus on the interaction among students through group activities. This book encourages cooperative learning, as it also integrates pair and group work (see appendix H, 2). Activities designed for pairs or small groups are presented, such as the "Work with the image" (see appendix F) section. As a final project, this example unit proposes an astronomy exhibition or to create a hands-on experience in which you will see the formation of a crater through the impact of a meteorite (see appendix I). With these projects, their learning process is positively influenced with great motivation and satisfaction when they see the practical and tangible side of what they learn.

Although having good materials created based on the methodological principles promoted by CLIL is important, it is not enough on its own. The proper implementation of CLIL methodology in the classroom is of high importance in order to achieve, in general, satisfactory results. Unfortunately, according to my personal experience, there is a lot of work to be done on the practical side of CLIL. Some experts such as Lasagabaster and de Zarobe (2010), Hillyard (2011), Custodio Espinar (2019), Custodio Espinar and García Ramos (2020), among others, allude to the fact that in order to bring CLIL to its maximum effectiveness there must

be rigorous planning, together with teacher training and continuous updating, to achieve a coordinated integration of curricular content and language.

8. Conclusion

In relation to the last section devoted to critical analysis, several conclusions can be drawn in relation to the issues addressed in the paper. It can be affirmed that English is increasingly present in our lives, as a consequence of the great changes towards a more globalized and interconnected world that we are already witnessing. As a response, large institutions such as the European Union, which has the power to influence the countries of Europe, are aware of this, and English is increasingly being integrated into educational contexts. Although it is not a current method and its origins go back several years, CLIL is presented as a novel methodology for teaching curricular content and language at the same time. That is why extensive research has been undertaken in recent years to find the methodological principles that characterize it. These principles are becoming focused on the student, in which the main purpose of teaching is based on the acquisition and assimilation of content and language in a new way, leaving behind the figure of the authoritarian teacher. The central dilemma is whether the implementation of these principles is actually carried out in practice. There are many advantages concerning the methodology, but at the same time, there are also inconveniences that make the implementation of the CLIL methodology not as exhaustive as desired. As has been proven in the critical analysis of a science academic textbook used in Secondary education, the textbook adequately integrates all CLIL principles. Therefore, it can be concluded that the main problems regarding the methodological implementation of CLIL in our country are not theoretical factors, but rather practical ones that would need to be studied carefully in order to present adequate solutions that would benefit the practice of CLIL in Spanish educational institutions.

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10. Appendices

Appendix A

Scientific glossary

1 The universe and our planet

astronomical unit the distance from the Earth to the Sun: approx. 150 million km.

axis of rotation imaginary line that passes through the geographic North Pole and the geographic South Pole.

eclipse when three celestial bodies are aligned and one blocks the view of another. Eclipses can be solar or lunar.

ecliptic plane an imaginary plane that passes through the centre of the Sun. It contains the orbits of most objects orbiting the Sun, including the Earth.

equatorial plane an imaginary plane that passes through the equator and divides the planet into the North and South Hemisphere. It is perpendicular to the axis of rotation.

equinox moment of the year when day and night are equal in length.

geocentric model a theory that put the Earth at the centre of the universe.

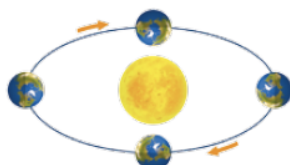


heliocentric model a theory that put the Sun at the centre of the universe.

light year the distance light travels in one year: about 9.5 trillion km.

Milky Way the galaxy where our solar system is located.

revolution the circular movement of one celestial body around another.



rotation the turning of the Earth on its axis that causes day and night.

solstice day when the difference in length between day and night is the greatest.

tide the rise and fall of ocean water due to the gravitational pull of the Moon. High tide occurs when the water level rises. Low tide occurs when the water level becomes lower.

2 The geosphere, minerals and rocks

core the inner layer of the Earth. Its temperature is over 4000 °C.

crust the outer layer of the Earth. It consists of continental crust and oceanic crust.

igneous rock rock formed from cooled magma.

impurities small amounts of other substances found in minerals. They can change some mineral properties.

lustre the way minerals reflect light. It can be metallic or non-metallic.

mantle the middle layer of the Earth, below the crust, which is made up of rock. The temperature is from 1000-4000 °C, so some areas are molten.

metamorphic rocks rocks formed from the effects of heat or pressure, for example, slate.

Mohs scale of hardness a classification of minerals by hardness from 1, soft, to 10, very hard.

non-silicates minerals which do not contain silicon, such as oxides, native elements, sulphides, carbonates and halides.

quarry a type of above-ground surface mine where blocks of rock, such as marble or granite, are mined.

sedimentary rocks rocks formed by the accumulation and compaction of sediment, such as fragments of clay, sand or rock.

silicates the most abundant minerals on the Earth. They are made up of silicon, oxygen and other elements, for example, mica.



streak the colour of a mineral in powder form.

3 The atmosphere

global warming a gradual increase, 0.5-0.9 °C, in world temperatures over the last century.

greenhouse effect a physical process in which thermal radiation is absorbed by atmospheric gases. This process increases the temperature of the atmosphere.

ionosphere the highest and thickest layer of the atmosphere.

mesosphere a layer of the atmosphere with a thickness of about 40 km that contains ice clouds and dust.

Appendix B

The universe and our planet 1

The structure of the solar system

The solar system was formed approximately 4.5 billion years ago from a nebula composed of gas and dust. It is divided into two parts: the inner solar system extends from the Sun to Neptune, and the outer solar system lies beyond Neptune.

The solar system also consists of a huge number of smaller objects: moons, comets, asteroids, dwarf planets.

Asteroids, small rocky fragments, are found primarily in the **Asteroid belt** between Mars and Jupiter, and in the **Kuiper belt** beyond Neptune.

Comets are celestial bodies made of ice and rock. As comets get closer to the Sun, these materials heat up and form their characteristic tail of gas and dust.

Every object in the solar system, except the moons, moves around the Sun in orbits that are almost circular.

ACTIVITIES

5 Describe the structure of the solar system. Make a mind map.

6 Find out about three comets. When can you see each one?

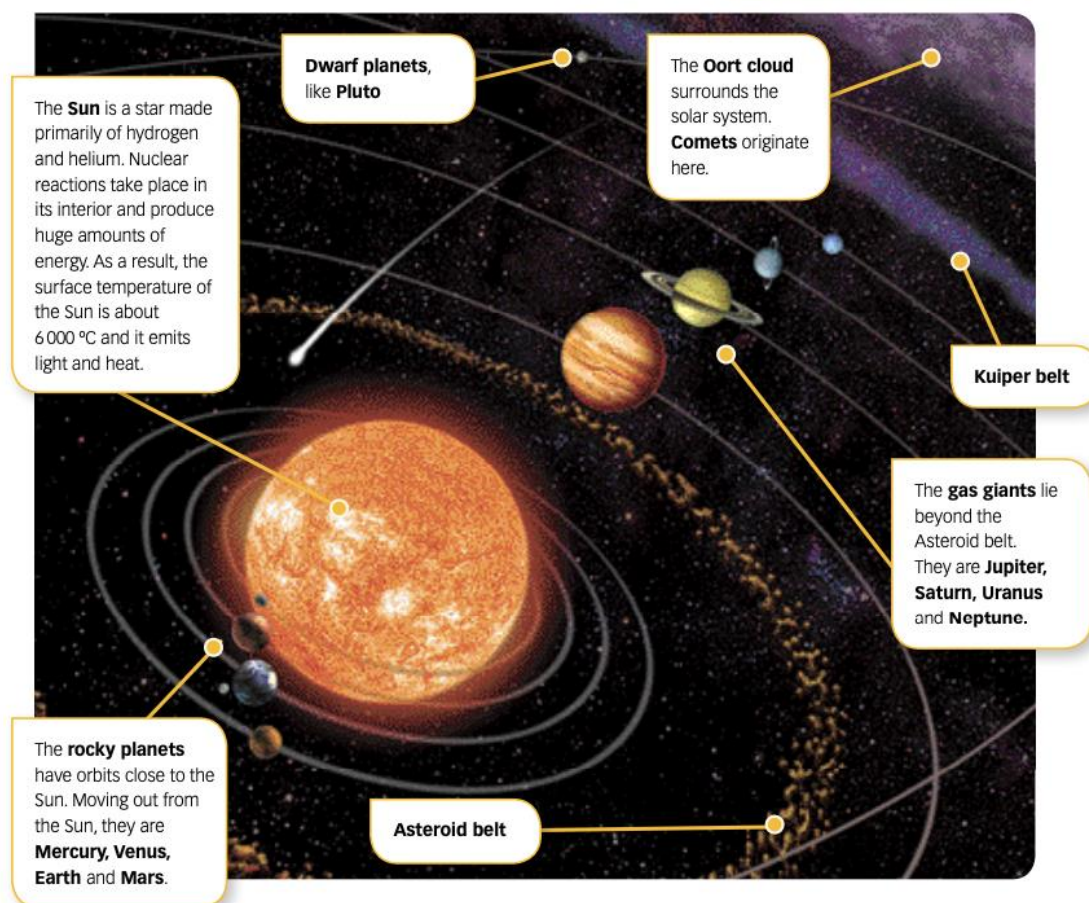
7 The asteroid belt is 3 AU from the Earth. Asteroids travel at 20 000 km/h. How long would it take one to reach Earth?

8 What parts of the solar system are described?

Digital competence

Competence in Mathematics, Science and Technology

Listening



11

Appendix C

Rocks and minerals in Spain

Spain is a country with a long history of mining. Some of its mines, like Riotinto, have been used to extract rocks and minerals for thousands of years.

Today, the mining of ornamental rocks like marble and granite, is very important. Spain is the world's third largest producer of these types of rocks. It is also a producer of red clays, which are used in the manufacturing of bricks, tiles, etc.

The extraction of minerals in Spain is also important, specially fluorite, gypsum, feldspar and sepiolite.

Most of Spain's production of rocks and minerals is focused on obtaining materials for construction.

Marble

- Marble is a crystalline, metamorphic rock that can be different colours.
- The most well-known marble quarries in Spain are in Macael in the province of Almería. The high-quality white marble extracted there makes up more than 90% of Spain's total production.
- The marble from these quarries was used to construct buildings like the Alhambra and the Generalife in Granada, and the Mezquita-Catedral de Córdoba.



Gypsum

- Gypsum is a sedimentary, evaporite rock. It forms when water with mineral salts evaporates.
- Spain is Europe's leading exporter of gypsum. This rock is mined in twelve autonomous communities. Europe's largest gypsum quarry is in Sorbas in the province of Almería.
- Most of the gypsum that is mined is used to manufacture cement, plaster for construction, etc.



Cinnabar

- Cinnabar is a bright red mineral. We can extract mercury from it.
- The mines of Almadén in the province of Ciudad Real contained the largest deposit of mercury in the world. The mines closed in 2002 and have been turned into a mining park.
- Mercury is used in some thermometers, thermostats and lamps.



Metallic minerals



gold



silver



magnetite



sphalerite



- Gold and silver are native elements. They are found in nature in a pure state as minerals and they are composed of a single element. Other metals are obtained from specific minerals. For example, iron is extracted from hematite and magnetite, and zinc is obtained from sphalerite.
- Spain's most important mining basin for the extraction of metallic minerals is Riotinto in the province of Huelva. These mines have been in use for 5 000 years.
- Gold and silver are used in jewellery and medicines.

Slate

- Slate is a metamorphic rock that easily splits into thin sheets. It is usually black and lightly shiny.
- Slate is mined in big opencast quarries. The main slate quarries in Spain are in Bierzo in the province of León and in Valdeorras in Ourense.
- Thin layers of slate, called slabs, are mainly used to make roofs. Spain is the world's biggest producer of roofing slate.



Halite

- Halite or rock salt is a sedimentary evaporative rock. It forms when water with mineral salts evaporates.
- The extraction and trading of common table salt on the Iberian Peninsula has a long history. Today, rock salt is mainly produced in Cantabria, Comunitat Valenciana and Cataluña.
- Halite is used in the chemical industry to produce chlorine and caustic soda, and in the processing of hydrochloric acid and sodium bicarbonate. It is also used to season and preserve food.



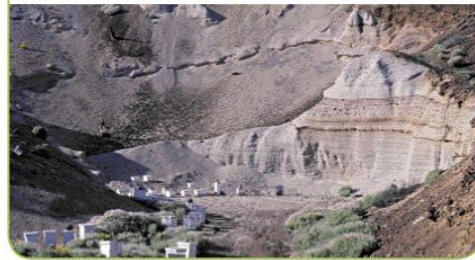
Granite

- Granite is an igneous rock composed of quartz, feldspar and mica. It is the most abundant rock in the continental crust. It can be grey or pink depending on the colour of the feldspar.
- Spain is the biggest producer of granite in Europe. The main quarries are in Galicia, central Spain, Extremadura, Andalucía and Cataluña.
- It is mainly used in construction and for flooring because it is hard, resistant, easy to polish and decorative.



Pumice

- Pumice is an igneous rock that can be different colours. It is very light and porous.
- Spain is the third largest producer of pumice after Italy and Greece. The main quarries are in Tenerife and Las Palmas de Gran Canaria. In other parts of the Peninsula, like in Campo de Calatrava, pyroclastic rocks are mined. These are solid fragments of volcanic material.
- Pumice is used as a thermal insulator and to make cement and concrete. It is also used in toothpaste, soap and as an ornamental garden rock.



Appendix D

1

ACTIVITY ROUND-UP

1 Copy and complete the key concepts.

- According to the model, the Earth was at the centre of the universe. According to the model, the Sun was at the centre of the universe.
- Today, we believe that the universe came into existence as the result of an called the Big Bang.
- The distance from the Earth to the Sun is approximately 150 kilometres, which is equivalent to one . A light year is equivalent to kilometres.
- The universe is made up of , which are found in groups or . Our galaxy is called the .
- The solar system contains the rocky planets , , and ; the belt and the gas giants , , and .
- The four systems of the Earth are the , the , the and the .
- Like the other planets, the Earth moves in two different ways: it on its axis, which takes hours, and it around the , which takes days.
- The Moon takes days to rotate once on its axis, and days to orbit the Earth.
- The Moon looks like the letter D when it is in the phase.
- In a solar eclipse, the passes directly between the Sun and the .
- During the , day and night are equal in length. During the , the difference in length between day and night is at its greatest.

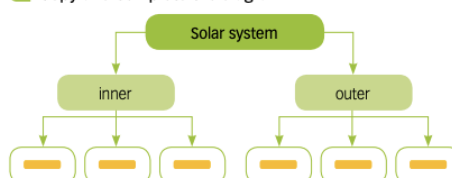
2 Copy the table and complete it.

Objects	Description and examples
Rocky planets	Made of rock and a metallic core.
Giant planets	
Asteroids	
Comets	

3 Write definitions for these words:

- eclipse*
- tide*
- solstice*
- equinox*
- ecliptic plane*

4 Copy and complete the diagram:

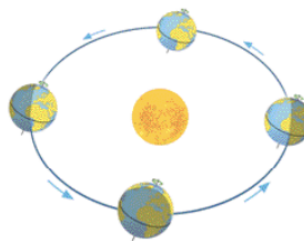


5 Draw the eight planets in order from smallest to largest (not to scale). Write their names and some characteristics in the same order.

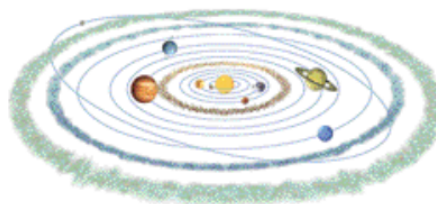
6 Make a drawing of the Sun and the Earth. Label the part of the Earth where it is day and the part where it is night.

Add the axis of rotation, the equator and the ecliptic plane. Label the North Pole and the South Pole, and draw an arrow to show the direction of the Earth's rotation.

7 Copy the drawing in your notebook and label the winter and summer solstices, and the spring and autumn equinoxes in the Northern Hemisphere. Label the sections of the orbit where the days are longer and shorter in that hemisphere.



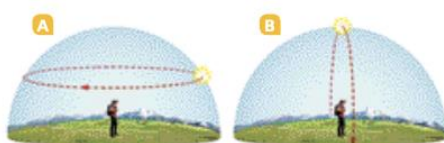
8 Copy the drawing and label: the Earth, the Oort cloud, Jupiter and the Kuiper belt.



- 9 The largest known star is NML Cygni. It has a radius of 1 155 million km.

- Express this radius in astronomical units.
- If NML Cygni was placed where the Sun is, which planets would be inside this star?

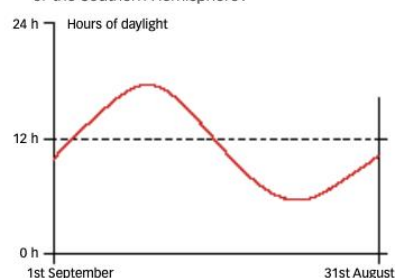
- 10 In what part of the world can we find these paths of the Sun?



- 11 Imagine a square house in the Northern Hemisphere. Each of its four sides face one of the four cardinal points. Which side faces the Sun all day in winter? Which side receives no Sun all day?

- 12 The graph represents hours of light from sunrise to sunset for one year (1st September – 31st August) at a specific place. Copy the graph and do the activities.

- Mark the points that correspond to the summer and winter solstices and the spring and autumn equinoxes on the graph.
- Is the place that it corresponds to in the Northern or the Southern Hemisphere?



CRITICAL THINKING. Science and technology collaboration

Nebulae and telescopes

Nebulae are clouds of gas and dust that float inside galaxies. They are created from dying stars. The stars explode when they have burnt through all their fuel, throwing out the dust and gas that form the nebula.

At first, nebulae are more or less spherical, but they soon disperse in space and mix with other clouds of gas.

Some of the most beautiful images captured by the Hubble Space Telescope are of these glowing nebulae.



Carina Nebula

- 13 The Orion Nebula is the only nebula visible with the naked eye. It can be seen clearly with a pair of binoculars. It is found in the centre of the sword in the constellation Orion. Search for information on how to find this constellation and try to observe the nebula in the sky.

- 14 Write a brief description of what the nebula in the photo, or another nebula you know, reminds you of. Remember that, as beautiful as they are, nebulae are created through an incredibly violent process: the enormous explosion of a dying star.

- 15 Form groups of three or four and design a mural showing how nebulae are formed and how they change over time. Search the Internet for drawings or photos to illustrate the process.

- 16 Do you think it is important that research organizations and technological companies work together? Why? Prepare a report about technological inventions that have helped discover and understand the universe throughout history.

Group work

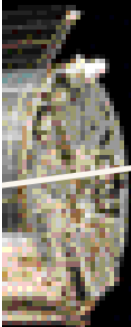
Appendix E

HOW DO WE KNOW?

How do we learn about the universe?

In 1610, the Italian mathematician Galileo was the first person to use a telescope to observe the sky. Today, there are Earth-based radio telescopes and space telescopes. The Hubble Space Telescope can observe the most distant regions in the universe. It has increased our knowledge of the structure and history of the universe.

GIVE YOUR OPINION. Which type of telescope can make more detailed observations of the universe: a space telescope or a radio telescope on the ground? Why?



Hubble is a large, optical telescope in space that orbits the Earth above the distortion of the atmosphere. It detects visible light in space, as well as invisible infrared and ultraviolet radiation.

The Hubble Space Telescope has made it possible to see the structure of our universe.



STARTING POINTS

- What can we find in our universe? What can you identify in the picture?
- The Earth, the Sun and the Moon are celestial bodies. What type of celestial body is each? What other celestial bodies do you remember?

Appendix F

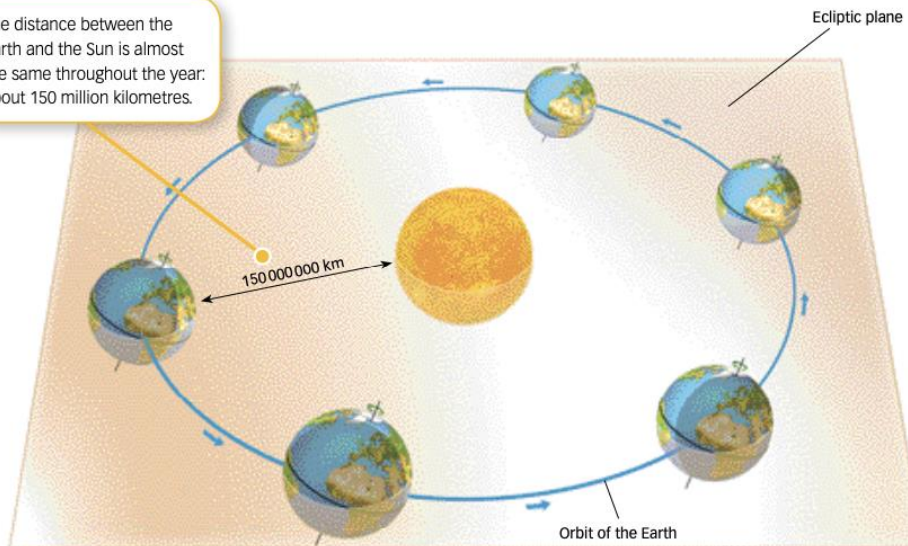
The universe and our planet 1

Revolution

Revolution is the movement the Earth makes in an orbit around the Sun. The orbit of the Earth is an ellipse, almost a circle. It takes 365 days, **one year**, to complete one revolution. The orbit of the Earth is contained within the ecliptic plane that passes through the Sun's centre.

Revolution has two important consequences. First, due to the **tilt of the axis** of rotation, revolution causes the annual cycle of **seasons**. Second, for part of the year, one pole faces toward the Sun, so there is no night there. At the same time, the other pole faces away from the Sun, so there is no day there. For the next part of the year, the situation is reversed.

The distance between the Earth and the Sun is almost the same throughout the year: about 150 million kilometres.

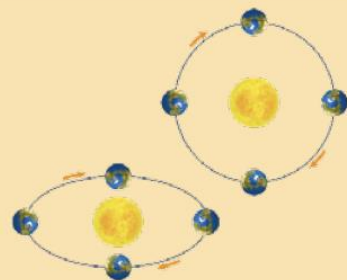


WORK WITH THE IMAGE

- 3 What shape is the Earth's orbit? Is the distance between the Earth and the Sun always the same?
- 4 In which of the six drawings of the Earth would there be daylight for 24 hours at the North Pole? And at the South Pole?

ACTIVITIES

- 5 Write definitions for these terms:
 - axis of rotation
 - ecliptic plane
 - equatorial plane
 - rotation
- 6 What consequences do these movements of the Earth have?
 - rotation
 - revolution
- 7 Look at the two drawings on the right. Which one looks like the orbit of the Earth? What mistake is there in the drawing? Copy it correctly.
- 8 Where would the difference between the length of day and night be greater throughout the year, at the South Pole or the North Pole?



Activities in pairs

Individual activities

Appendix G

LEARNING OBJECTIVES

- Understand the differences between the models of the universe.
- Describe the structure of the solar system.

WORK WITH THE IMAGE

- 1 What planets are missing from each model of the universe? How can you explain this?
- 2 Ask questions about the objects in the solar system: *Where is/are ... found? What is the ...?*

2

The solar system

Our understanding of the universe has changed throughout history. The Ancient Greeks proposed a **geocentric model**. According to this model, the Earth was the centre of the universe and the Sun, Moon and planets orbited the Earth.

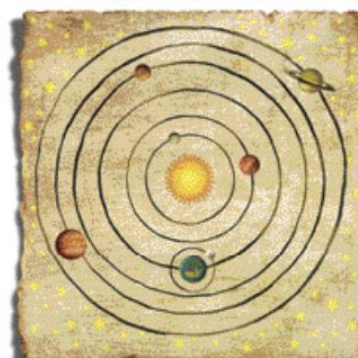
This model had its basis in observations of the Sun and the Moon. They appear in the east and move across the sky until they disappear in the west.

The geocentric model was accepted until about 500 years ago. Then in 1542, Nicolaus Copernicus proposed a **heliocentric model**. In this model, the Sun was the centre of the universe, and the planets and stars revolved around it. In 1610, Galileo Galilei invented the telescope and proved the heliocentric theory.

Geocentric model



Heliocentric model



ACTIVITIES

- 3 Ask about earlier models of the universe: *Who proposed / invented / proved ...?*
- 4 What is the difference between the universe as we know it today and the previous models?

Our understanding of the universe has changed thanks to the development of astronomy and the use of more and more sophisticated equipment, like telescopes and artificial satellites.

We know now that the Sun is a small star and that our solar system is a small part of a galaxy called the Milky Way. We also know that our galaxy is one of many, many galaxies in the universe.

At present, the majority of experts agree that there is no single place that can be considered the centre of the universe.

Appendix H

1

KNOW HOW TO

Scientific competence



Observe and describe the constellations

Constellations are groups of stars that, when seen from the Earth, appear to form a shape or image. Babylonian, Greek, Chinese, Egyptian and Mayan astronomers all described different constellations. Throughout history, most cultures have associated the constellations with their own mythologies.

We are going to hold a class exhibition about the constellations and their astronomical and mythological significance.

The exhibition will have several panels. Each panel will be about a different constellation and will have three parts:

- A **sheet of black poster board** with holes in it to represent the stars. Some stars are brighter than others, so the holes will be different sizes. You will draw lines connecting the stars to show the shape of the constellation.
- An **astronomy fact sheet** about the science behind the stars in the constellation.
- A **mythology fact sheet** about the mythology associated with the constellation.

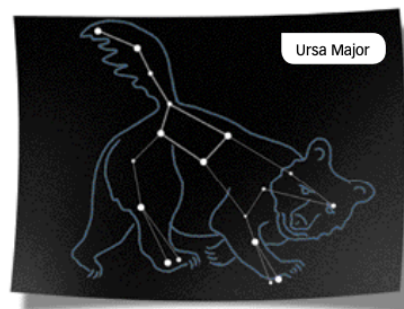
In the library, you will be able to find books with information on the constellations and how to identify them, such as star atlases.

You can also find a lot of information on the Internet, as well as beautiful images you can use as a model to prepare your constellation.

Model of a constellation

Choose a large sheet of black poster board suitable for your constellation. The bigger it is, the more detail you will be able to include. But remember that if it's too big it will be harder to make.

- Punch holes in the poster board to represent the stars in the constellation. Some stars are brighter than others, so punch larger holes for the brighter stars and smaller holes for the less bright ones.
- Draw lines to connect the stars and make the outline of the constellation. Use a silver marker or a white pencil.
- Use another colour marker to draw the mythological creature or figure that is associated with that constellation.



Fact sheet

Use a light-coloured poster board to make an **astronomy fact sheet** about the stars in the constellation. Include the following information:

- The name of the brightest star in the constellation, its size compared to the Sun and the distance of the constellation's stars from the Sun in light years.
- The time of year that it is easiest to see.
- Its position in the sky and its location relative to nearby constellations.
- An interesting fact about the constellation's discovery or one of its stars.
- A picture of the constellation taken using a telescope, from the Internet.

Make a **mythology fact sheet** about the constellation using another light-coloured poster board. Include the following information:

- The Greek or Roman myths associated with the constellation. These often involve mythological characters who represent different human qualities, such as bravery, beauty, love, etc.
- References to the constellation found in other cultures.
- Drawings or photos of paintings and sculptures that represent the characters from the mythology associated with the constellation.

Astronomy fact sheet: Ursa Major

Ursa Major is a constellation located in the sky near to the geographic North Pole. It never sinks beyond the horizon.

It is made up of seven main stars that form the shape of a plough. They are between 60 and 110 light years from the Earth.

Ursa Major is one of the most easily visible and recognisable constellations in the sky. It is also one of the most characteristic constellations in the Northern Hemisphere. It is visible throughout the year.

The handle of the plough is made up of three stars. The middle star, Mizar, is binary (it is actually two stars) and can be seen clearly with a pair of binoculars.

Because Ursa Major is so easy to identify, it has been used since ancient times as a reference point for locating other constellations.

Mythology fact sheet: Ursa Major

According to Ancient Greek mythology, a beautiful nymph called Callisto was seduced by Zeus. His wife, who was jealous, then turned Callisto into a bear.

One day, Callisto's son Arcas went hunting and came across a bear. Not knowing it was really his mother, he tried to kill it, but Zeus intervened. He told Arcas that the bear was really his mother.

To keep her safe, Zeus transformed Callisto into Ursa Major (which is Latin for Great Bear) and sent her up into the sky. He then turned Arcas into a bear as well, and sent him to keep his mother company, forming the constellation Ursa Minor.

The Greek word for bear is *arktos*, and this is where we get the word Arctic from. This is because the Arctic is in the Northern Hemisphere, near to Ursa Major and Ursa Minor.

- 17** Do you know a star or constellation that is easy to spot in the sky? What is it called and how can you find it?
- 18** During your research, have you found out any interesting or surprising facts, such as the size of a star, its brightness, etc.? Explain.

- 19** Do the constellations really have the shapes we describe, or do we just imagine they are arranged this way because of how they look from Earth? Explain your answer.
- 20** Search for information on the constellation Orion. What does it look like, where is it and what myth is associated with it?

COOPERATIVE PROJECT

An astronomy exhibit

Form groups of four to make the poster and fact sheets. Each group should choose a different constellation.

Present your work:

- Describe the constellation and where to find it in the sky.
- Explain your fact sheets.
- Explain any mythological or cultural connections and describe the illustrations on your fact sheet.



- Place the black poster board on your classroom window to light up the constellation.

Appendix I

1

1

Formation of a crater from a meteorite impact



On the surface of the Moon, we can see almost circular areas surrounded by irregular ridges. These are lunar craters. They are large basins made up of basaltic rocks formed by the impact of huge asteroids. The Moon's surface also has thousands of smaller impact craters.

In this experiment you are going to simulate the impact of a meteorite on a surface to observe its appearance and compare it with lunar craters.

Objectives

- ▶ Simulate the impact of a meteorite on the Moon's surface.
- ▶ Observe an impact crater and compare it with the ones on the Moon's surface.

Equipment

- | | |
|-------------------------|-------------------------|
| – a large plastic tray | – dry clay soil |
| – a small plastic scoop | – a sieve |
| – fine, dry sand | – a marble |
| – white plaster powder | – a catapult (optional) |

Steps

1 Prepare the Moon's surface

Put a layer of sand approximately 1 cm thick in the tray. Smooth it out with the scoop (A).

Add a layer of white plaster of the same thickness and smooth it out (B). Try not to press it down.

Use the sieve to sprinkle the clay soil over the white layer until it is completely covered (C).



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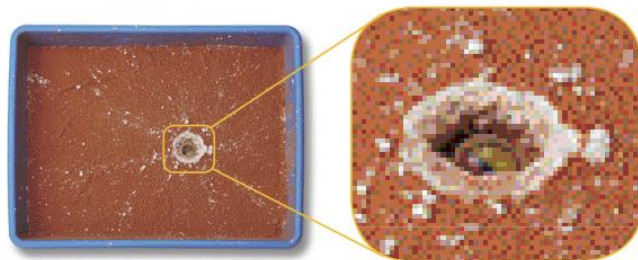


2 Simulate the meteorite impact

Throw or launch the marble vertically above the surface to create an impact crater. You can use a catapult for this (D).

To avoid altering the results, do not pick up the marble. First, observe the structure of the impact crater. If you have a camera, take some photos of the whole structure and some close-ups of the crater. If you do not have a camera, describe or draw it.

Then launch the marble again to create a second crater a few centimetres away from the first.



Results and conclusions

- 1 Observe the size of the crater. How big is it compared to the marble?
- 2 The material that is thrown out during the formation of a crater is called ejecta. Draw a picture of the tray that shows what the ejecta looks like.
- 3 Around the crater, you might see some larger fragments of white plaster. Can you explain the relationship between the size of the fragments and the distance they have fallen from the crater?
- 4 Launch the marble again to create a second crater a few centimetres away from the first. The ejecta from the second crater will partially cover the first one. Draw a picture that shows how the distribution of the ejecta helps us to find out which of the two impacts happened before and which happened after.
- 5 Look at the image of the Moon. The *Mare Nubium* is an area of basalt formed by an impact. *Tycho* is another impact crater with clearly visible ejecta situated near the lunar south pole. Which one happened first? Draw a picture to explain your answer.

