PROMISED

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PROMISED

PROMoting twin transition through **I**ntegrated steam in bilingual **S**econdary **ED**ucation

HISTORY OF VERSIONS

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ACRONYMS

CEFR	Common European Framework of Reference for Languages
CLIL	Content and Language Integrated Learning
CT	Computational Thinking
EDP	Engineering design process
HOTS	Higher Order Thinking Skills
IBL	Inquiry-based learning
L2	Second language/foreign language
LOTS	Lower Order Thinking Skills
NRC	National Research Council
STEAM	Science, Technology, Engineering, Arts, and Mathematics

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INTRODUCTION

The well-established need to increase plurilingual competence among learners has recently been brought to the fore in the form of the Common European Framework Companion Volume. Here, the promotion of an action-oriented approach which focuses on purposeful, collaborative classroom tasks rather than solely on language learning (CoE, 2020, p. 30) underscores the fact that language acquisition extends beyond traditional language classes to include a variety of subject areas where language is integrated as part of the learning process. For this purpose, Content and Language Integrated Learning (CLIL) is considered an ideal approach since it helps students to develop and improve language and content competencies in an integrated approach, being a dual educational approach with an additional language used to learn and teach both content and language (Marsh, 2002).

On the other hand, STEAM (Science, Technology, Engineering, Arts, and Mathematics) skills are increasingly necessary for a society where technology plays a significant role and represents a fundamental pillar to overcoming the challenges of environmental sustainability that society is so concerned about. Ecological, economic, political and social problems arise in a rapidly changing society with an unpredictable future. However, within the classroom, teachers face the lack of appropriate, innovative educational models to empower young people to acquire new skills for such changes. That is the main reason recent reports have highlighted the lack of a genuine presence of STEAM competencies in educational systems. Nevertheless, wicked sustainability problems—complex, multifaceted challenges like climate change, biodiversity loss, and resource depletion—demand solutions that transcend traditional disciplinary boundaries, necessitating an integrated learning approach. Integrated learning fosters the collaboration of diverse fields, blending knowledge from science, technology, engineering, mathematics, and the humanities to holistically address these intricate issues. This approach equips learners with the skills to think critically and systemically, fostering innovation and adaptability. By engaging with crosscutting concepts and diverse perspectives, integrated learning cultivates a comprehensive understanding and equips individuals to devise robust, sustainable solutions for the interconnected challenges of our world.

There are currently several CLIL projects in secondary education that use STEAM activities, although usually in an isolated way or without integrating different subjects. While it is true that this approach uses active methods, it reproduces the limitations of traditional teaching in its compartmentalized and isolated treatment of curricular content. Moreover, this problem is aggravated in secondary schools, where a specialized teacher teaches each subject. Integrated teaching models try to overcome these limitations. Several research results show that through the integration of different disciplines, the competencies of students are enhanced beyond the acquisition of knowledge and the repetition of life models of previous generations, being a better way to prepare the future generations for our societal problems.

In this context, the idea of PROMISED (PROMoting twin transition through Integrated steam in bilingual Secondary EDucation) was conceived. This project proposes the design of a didactic

model that incorporates an integrated STEAM education involving the disciplines of science, technology, engineering, arts, mathematics, humanities, and ecological awareness in a second language. The aim here is to prepare students to solve pressing global problems through innovation, creativity, critical thinking, effective communication, collaboration and, ultimately, new knowledge in a plurilingual and pluricultural world.

The Erasmus 2023-1-ES01-KA220-SCH-000157221 PROMISED project, with partners form Spain (UBU, UGR, CFIE & Kveloce), Belgium (Howest) and Slovakia (UMB), aims to develop and implement a new and innovative didactic model of efficient, integrated, and inclusive STEAM teaching in bilingual contexts for secondary education, fostering the double digital and green transition. This dual transition, both ecological and digital, within secondary education is essential in preparing our youth for the challenges of the 21st century, as environmental issues and rapid technological advances are two of the greatest global challenges. Furthermore, by reinforcing ecological awareness and the digital transition, we promote the development of critical and systemic thinking (environmental problems cannot be addressed in isolation, as they are interconnected with economic, social, and political factors), fostering creativity and innovation to solve global problems (such as developing technological solutions that promote sustainability, like renewable energy, energy efficiency, waste management, sustainable agriculture, etc.). This also encourages social and environmental responsibility due to the direct impact of their decisions on the environment, shaping responsible global citizens, and contributes to reducing the digital divide, not only by improving access to information but also by enabling its effective and critical use. These two areas, digital and green transition, are therefore, fundamental pillars for tackling future challenges, preparing young people for an ever-changing economy, and building a more just, equitable, and sustainable world.

The intention here is to promote an authentic learning environment that resembles the real world, where different areas of knowledge are often intertwined. Three results are foreseen. Firstly, a pedagogical framework to explain in detail the methodology for the development and implementation of the STEAM +CLIL integrative didactic model in European secondary schools. This pedagogical framework will be the basis of four integrative STEAM bilingual lessons, focused on the development of the necessary skills for the twin transition, with comments on methodology and a complete teaching plan. Finally, the project will include comprehensive guidelines for secondary school teachers, pre-service teachers and stakeholders for a successful implementation of integrate STEAM proposals in bilingual settings.

This document is the foundation of our first task. Furthermore, this introduction, it is organized in four sections, including the theoretical underpinnings; the original pedagogical model developed for this project; a brief description of several didactical methodologies useful for applying the model at secondary bilingual contexts, and an application section, where we provide selected examples aligned with our model.

We hope that this book will prove to be a useful tool for teachers in bilingual sections interested in developing new pedagogical models in their classes.

THEORETICAL UNDERPINNINGS

The theoretical underpinnings of this pedagogical framework were carefully selected to support a comprehensive educational framework that enhances student learning across languages, disciplines, and real-world problem-solving. The focus on **plurilingual competences** is rooted in the Common European Framework (CEF) to emphasize the value of multilingualism in developing cognitive, cultural, and global competencies, preparing learners for international communication. This aligns with the **CLIL approach**, which integrates content and language learning, ensuring that students acquire both subject-specific knowledge and language proficiency. The **Language Triptych** was included to provide a structured way of teaching language in context, which complements the CLIL approach by specifying different types of language learning within subject matter education.

Similarly, **crosscutting concepts** were chosen to bridge the gap between different scientific fields, facilitating the transfer of skills across disciplines and enhancing interdisciplinary learning—an essential feature of the **STE(A)M skills** model. The inclusion of **sustainability competences** and their link to crosscutting concepts and STE(A)M skills reflects the increasing importance of addressing global challenges like climate change through education, while **computational thinking and digitalisation competences** were selected for their relevance in today's digital age, helping students develop the technical and problem-solving skills necessary for modern scientific inquiry.

These elements collectively aim to equip students with a diverse set of competencies, preparing them for the complexities of future societal and environmental challenges.

A. PLURILINGUAL COMPETENCES

The Common European Framework (CEF) plays a meaningful role in promoting the eight competences for lifelong learning, needed for personal fulfilment, a healthy and sustainable lifestyle, employability, active citizenship and social inclusion. Multilingualism, one of the eight key competences, enhances cognitive abilities, cultural awareness, and global competences for European students, especially implementing CLIL in Secondary Education.

The CEF distinguishes between multilingualism (the coexistence of different languages at the social or individual level) and plurilingualism (the dynamic and developing linguistic repertoire of an individual user/learner). Plurilingualism is presented in the CEF as an uneven and changing competence, in which the user/learner's resources in one language or variety may be very different in nature from their resources in another.

Plurilingual competence involves the ability to call flexibly upon an interrelated, uneven, plurilingual repertoire. It involves:

1. Language Repertoires

This aspect involves the range of languages and dialects that a person can use, even if not with full fluency in all of them.

Example: A person might speak English and French fluently, have conversational skills in Spanish, and understand basic German.

2. Code-Switching

The ability to switch between languages or language varieties in different contexts, sometimes within the same conversation.

Example: A person might start a sentence in Spanish and switch to English mid-sentence because it better expresses a particular idea.

3. Translanguaging

Using elements of multiple languages within the same conversation or text, drawing on all linguistic resources to make meaning.

Example: A student writing an essay might use a mix of French and English to better articulate their thoughts, using French for complex philosophical concepts and English for technical terms.

4. Intercultural Competence

The understanding and appreciation of cultural differences and the ability to navigate interactions in culturally appropriate ways.

Example: A businessperson understanding the cultural nuances of how to greet colleagues from Japan versus how to greet those from Germany.

5. Metalinguistic Awareness

Awareness of how languages work and the ability to reflect on and analyze language use.

Example: A child learning to read might notice that in English, many words are spelled differently from how they sound and begin to understand why.

6. Strategic Competence

The ability to use strategies to communicate effectively despite gaps in one's language proficiency.

Example: A traveller who doesn't speak the local language might use gestures, draw pictures, or use a translation app to ask for directions.

7. Pluricultural Competence

Understanding and leveraging knowledge of different cultures to enhance communication.

Example: A diplomat might use their understanding of Middle Eastern customs to build rapport and trust during negotiations with counterparts from that region.

8. Partial Competence

The recognition that it is possible to have varying levels of proficiency in different languages, often proficient in one area (e.g., speaking) but not another (e.g., writing).

Example: An immigrant might be able to speak and understand the local language fluently but struggle with reading and writing it.

9. Language Mediation

Facilitating communication between speakers of different languages, often through translation or interpretation.

Example: A person translating a conversation between a non-Spanish-speaking doctor and a Spanish-speaking patient.

10. Adaptative Skills

The flexibility to adapt language use to different situations and audiences.

Example: A student might use formal language in an academic essay but informal language when chatting with friends.

Recognizing learners as plurilingual and pluricultural individuals, then, involves permitting them to use their full range of linguistic skills when needed, while also encouraging them to identify both similarities and differences among various languages and cultures (CoE, 2020, p. 30). In the case

of Spain, plurilingual competence is one of the eight key competences that students must acquire and by the end of compulsory education (Orden EFP/754/2022). When finishing compulsory education, students must use one or more foreign languages effectively in order to respond to their communicative needs due to different situations in different fields such as personal, social, educational and professional. Spanish, as the national language, is the primary medium of instruction, while regional languages such as Catalan, Galician, and Basque are also taught and used as instructional languages in their respective autonomous communities. English is widely taught as the primary foreign language from early education, with additional foreign languages like French and German offered as elective subjects.

The plurilingual competence in the Belgian educational system is characterized by its emphasis on multilingualism, reflecting the country's linguistic diversity with Dutch, French, and German as official languages. In Belgium, students are typically required to learn at least two of these languages, depending on the region they reside in—Flemish-speaking Flanders, French-speaking Wallonia, or the bilingual Brussels-Capital Region. This competence is nurtured through immersive language programs, where subjects are often taught in multiple languages, and through the integration of cultural studies that promote an understanding of different linguistic communities. Additionally, there is a strong focus on developing metalinguistic awareness, code-switching abilities, and intercultural competence, ensuring that students can effectively navigate and contribute to Belgium's multilingual and multicultural society.

In the Slovak educational system, plurilingual competence is fostered through a structured language curriculum that emphasizes the learning of multiple languages, primarily Slovak as the national language, and English as the primary foreign language, along with opportunities to study additional languages such as German, French, Spanish, or Russian. Starting from primary school, students receive compulsory language education, with a focus on both linguistic skills and cultural understanding. The curriculum is designed to promote metalinguistic awareness and intercultural competence, encouraging students to appreciate and engage with different linguistic and cultural contexts. Extracurricular activities, language immersion programs, and international exchange opportunities further enhance students' ability to communicate and adapt in a multilingual world, preparing them for both local and global interactions.

B. THE CLIL APPROACH

In order to increase levels of plurilingual and other competences in the last two decades, an increasing number of educational institutions have adopted Content and Language Integrated Learning (CLIL) to improve plurilingual and other competences. CLIL is unique as an approach because of its dual aim to improve both language skills and subject knowledge. The approach, then, involves instruction in various subjects such as science, music, and physical education using a foreign or second language (L2) and this helps to reinforce communicative abilities in said language.

Among some of the cognitive and linguistic theories upon which CLIL is based, we can find the following:

- The use of CLIL to enhance Cognitive Academic Language Proficiency (CALP) as discussed by Cummins (2008).
- The development of content, communication, cognition and culture among learners (see Coyle, Hood & Marsh, 2010; discussed in Section 4).
- The support of constructivist learning (see Vygotsky, 1978).

The application of these theories in CLIL highlight how this approach supports both language acquisition but also fosters deeper levels of cognitive engagement.

While bilingual education is well-established in countries such as Canada, this specific form of content learning is relatively more recent, but growing practice in Europe. CLIL fosters communicative skills in the L2, empowering students to engage effectively in a variety of contexts and enabling them to operate more successfully in social, personal, academic, and professional environments on an international scale. According to Bentley (2010), the aims of CLIL include the following:

- Introduce learners to new concepts through studying the curriculum in a non-native language.
- Improve production of the language of curricular subjects
- Improve performance in both curricular subjects and the target language
- Increase confidence in the target language and the L1
- Provide materials which develop thinking skills
- Encourage stronger links with values of community and citizenship
- Make subjects the main focus of classroom materials

The objectives of CLIL go beyond linguistic and content learning to foster broader educational outcomes, including critical thinking, community values, and academic confidence across languages.

Among potential benefits, we can see clear advantages for language learning in terms of improvements and communicative competence in the L2. However, in terms of the impact of CLIL in non-language subjects such as history or science, results can vary from having a positive or at least non-detrimental effects in subject specific competences to negative effects (Hughes & Madrid, 2020). Outcomes, then, can differ significantly across countries and schools due to factors like the age of the students, the resources available, and the language proficiency and CLIL methodology expertise of the teachers. Research suggests that CLIL can enhance L2 proficiency without detriment to native language skills, preferably if schools engage in interdisciplinary projects, also known as integrated units of work, generally based around a common theme and real-world problems. Nevertheless, challenges such as academic struggles, decreased motivation, or feelings of helplessness might affect younger students, whose language abilities are still developing. PROMISED project will help to overcome these struggles.

As indicated, the adoption of CLIL differs among countries. In Spain, over the past two decades, every Autonomous Community has implemented some form of bilingual education rooted in Content and Language Integrated Learning (CLIL) across primary, secondary, and, more recently, early childhood education (ages three to six). This achievement is due to Spain's decentralized education system, where education policy is decentralized to each Autonomous Community under national legislation, which provides overarching guidelines for the entire country. As noted by Megías Rosa (2012), this decentralized structure has positioned Spain as a trailblazer in CLIL, facilitating the comprehensive adoption of programs seen across Europe. As highlighted by Lasagabaster and Ruiz de Zarobe (2010), Spain's experience serves as a model for other nations seeking to promote foreign language acquisition through CLIL methodologies.

The organization of the educational system(s) in Belgium is the responsibility the country's three Communities. Flanders, where Howest university is localized, introduced CLIL in its secondary education in 2014. It took a long time to convince all political partners that CLIL was not a threat to the mastery of the first language, being Dutch. The roots of this fear to introduce foreign languages in subject courses alongside language classes (which are on all timetables of pupils in secondary education) lay in the Belgian history. It took Belgium up till 1963 to finally recognize by law the official school language in the different regions. French was for a long time valued as an important language, and Dutch was not equally valued. This understandable but unjustified fear of losing the value of the Dutch language again was the main reason for the delay in launching CLIL. To be sure that CLIL would not harm the mastery of the L1, pilot projects were set up in 9 schools. The results were positive, and the CLIL-decree was negotiated and finally approved in 2013. In September 2014, 21 schools started with CLIL and the number has grown exponentially up to 101 official CLIL schools in September 2018. There are schools that offer CLIL without permission of the Ministry of Education. We leave them out of the figures. It is important to know

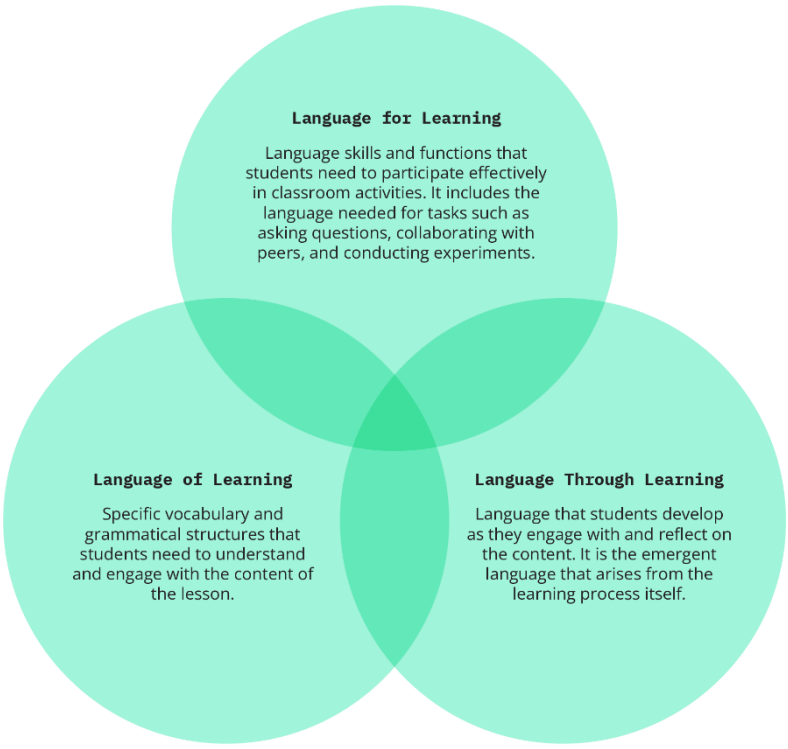
that Flanders has chosen to go for “hard CLIL” (focus on the non-language subject in which the foreign language is used as a vehicle to achieve the subject goals).

In Slovakia, CLIL has a tradition of more than fifteen years. As in other European countries, it has been implemented in several primary and secondary schools and their number is increasing. In primary schools, CLIL is mostly applied in foreign language lessons as the so-called soft CLIL, with its application being mostly episodic (only in selected lessons and topics). The choice of topics, teaching methods and tasks depends almost exclusively on the teacher's decision. The most numerous group of teachers who apply CLIL are non-native but qualified foreign language teachers or non-language teachers who have sufficient language competences in a foreign language. As regards the type and grade of schools, the most widespread in Slovakia is the primary CLIL, in which we differ from other countries. Similarly, high is the number of schools that apply CLIL at lower secondary level (usually those with good experience with CLIL in primary education). At the upper secondary level, CLIL is applied mainly by grammar schools, but in a much lower number compared to primary schools. It is rarely used in secondary vocational schools.

Plurilingual competences align well with the CLIL approach, as both emphasize authentic language use, integration of content and language, and the development of communicative competence across multiple languages and cultures. These approaches contribute to a richer educational experience for learners, preparing them for global citizenship and effective communication in diverse contexts.

C. LANGUAGE TRIPTYCH: LANGUAGE OF, FOR AND THROUGH LEARNING

When addressing the learning of a curricular subject through a CLIL approach, it is necessary to reflect which language is needed. We can distinguish among the language of learning, language for learning and language through learning.



For example, in a STEAM lesson on photosynthesis, the "language of learning" would include terms like "chlorophyll," "photosynthesis," "carbon dioxide," and "glucose". The "language for learning" might involve phrases like "Can you explain how...?", "Let's compare our results," or "What happens if...?" and the "language through learning" could include students' ability to describe the process of photosynthesis in their own words, summarize their findings, or present their experiment results to the class.

By using the Language Triptych, teachers can ensure that students not only learn the content but also develop the necessary language skills to engage with and understand the material deeply. This integrated approach is particularly effective in a CLIL setting, where the dual focus is on both content and language acquisition.

D. CROSSCUTTING CONCEPTS

Crosscutting concepts (NRC, 2012) are integral ideas that bridge disciplinary boundaries, serving as connecting threads across various fields of science and engineering. These concepts include patterns, cause and effect, scale, proportion, and quantity, systems and system models, energy and matter, structure and function, and stability and change. They provide a framework that helps students and practitioners understand and integrate knowledge across different scientific domains, a fundamental aspect of PROMISED model. By emphasizing these recurring themes, crosscutting concepts foster a deeper comprehension of the natural and engineered world, promoting the ability to transfer skills and understanding from one context to another, and enabling a more cohesive approach to scientific inquiry and problem-solving. They can be

described as ways of thinking that are covered in all STE(A)M disciplines. It is worth stressing that in this project, following Knorr-Cetina (1999), we use the term "science" to relate to endeavours in both the natural and social sciences and their intersections, noting the surfacing of epistemic cultures across the different and distinct forms of science. So, the crosscutting concepts applies to both.

Patterns

Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Patterns in the symmetry of flowers and snowflakes
Fingerprints
The Cycle of Seasons
Demographic trends
Patterns of social mobility

Cause and effect: Mechanism and explanation.

Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

Growth, development and reproduction of organisms

Natural selection

Weather and climate

Forces and their interaction

Effect of raising the minimum wage (cause) on the purchasing power of low-income workers (effect)

Employee burn-out

Scale, proportion, and quantity

In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Chemical concentrations and mixing ratios

Making a scale model (e.g. cell in large format)

Atlases

Studying poverty (local, national, international)

Systems and system models

Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

Designing an automated process

Physical, mathematical and computer models

Influence of health care on access to education

Influence of interventions in the physical environment on social behaviour

Energy, matter and objects (flows, cycles, and conservation)

Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

Ecosystems

Chemical reactions

Climate issues

The earth as a system

Information flows on social media

Structure and function.

The way in which an object or living thing is shaped and its substructure determines many of its properties and functions.

Function and structure of a computer program

The workings of the human heart

Relationship between the structure of an organization and the way it functions

Stability and change.

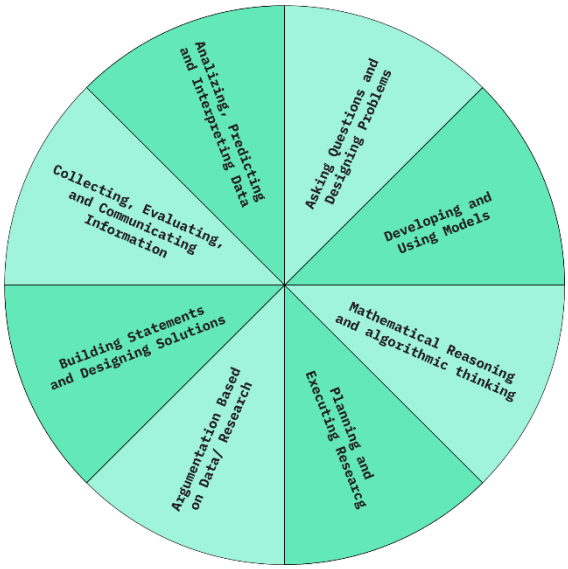
For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Dynamic equilibrium: eating carbohydrates and burning glucose while keeping the sugar level in our blood constant

Climate (climate change, climate refugees)

E.STE(A)M SKILLS[1]

There **are eight skills** that are provided in STEM education, research and design skills that need to be learned and practiced through the various disciplines and collaborations. These 8 skills can be combined in the meta-competence integrated problem solving.



Asking Questions (for science) and Defining Problems (for engineering)

In science, this involves formulating inquiries about natural phenomena. In engineering, it is about identifying challenges or designing issues to solve.

Explanation: How does a rainbow form? Why do windmills usually have 3 blades?

Determining criteria for the solution of a given problem: What volume should my solution fit in? What fabrics do I have available?

Identifying limitations of a solution for a particular need: How long will my solution last? For which situations is this solution insufficient?

[1] The skills highlighted in this section are widely recognised by experts in STEM education; however, there is less consensus regarding STEAM skills. Therefore, while we aim to develop a STEAM+CLIL model, we will adopt the well-established STEM skills, which are inherently embedded within the broader scope of STE(A)M competencies

Planning and executing research

Students have to carefully plan how to proceed for answering the question or the problem.

Identifying parameters involved: The increase of population depends on...

Accurate recording of observations and measurement results: Table, quantities, units, accuracy...

Analyzing, predicting and interpreting data

Examining data sets, identifying patterns, and drawing meaningful conclusions.

Interpreting epidemiological data to predict the spread of an infectious disease and propose appropriate measures.

Analysing trends in social media activity to predict what types of content will be popular among young people.

Mathematical reasoning and algorithmic thinking

Applying mathematical concepts and computational tools to analyze scientific problems.

Isolating specific similarities and differences from situations: Equal or different environmental factors in biotopes.

Setting up a simulation or a step-by-step plan: Predicting economic trends, drawing up a determination schedule.

Solving equations: Determining the value of a quantity by means of other, known quantities.

Predicting behaviour: calculate Earth's population in ten years, based on actual data.

Developing and using models

Creating simplified representations of complex systems to understand and predict their behaviour.

Analysing flaws/limitations in systems or statements: The particle model is inadequate for the explanation of electric current and therefore needs to be adjusted.

To solve a problem: A scale model of a bicycle helmet in a wind tunnel.

Communicating ideas: Using a system diagram to show the impact of the excessive consumption of meat.

Argumentation based on data/evidence

Constructing and defending scientific claims using data and reasoning.

Comparing and evaluating ideas and solutions: Arguments to support that an unfertilized ostrich egg consists of only one cell.

Investigating a phenomenon: Expansion of substances using measured values of temperature and length.

Building Data Models: Organizin measurement data effectively.

Building Statements (for science) and Designing Solutions (for engineering)

In science, explaining natural phenomena based on evidence. In engineering, creating solutions to practical problems.

To **develop a hypothesis** about the influence of social media on teen behaviour.

Creating a plan to improve a building's energy efficiency through renovations.

Collecting, evaluating, and communicating information

Examining data sets, identifying patterns, and drawing meaningful conclusions.

Collecting survey results on consumer preferences for market research.

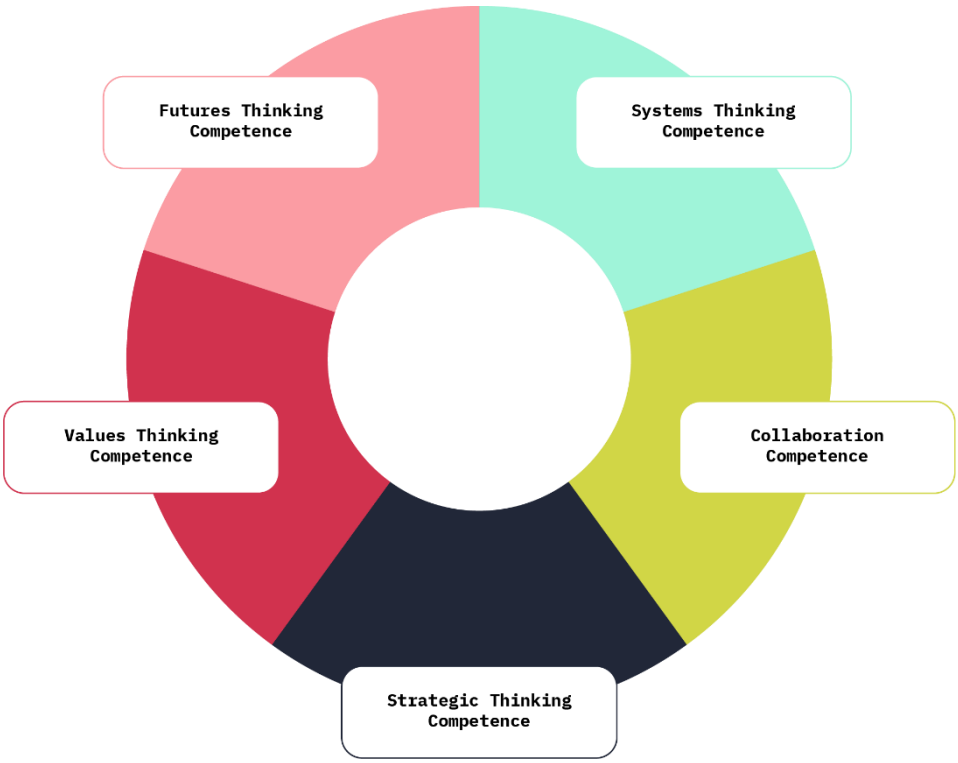
Evaluating scientific articles to understand climate change trends and report to stakeholders.

F. SUSTAINABILITY COMPETENCES AND THEIR RELATIONSHIP WITH CROSSCUTTING CONCEPTS AND STEM SKILLS

The most pressing problems that we as a society need to solve are realistically linked to sustainability. Problems such as climate change, deforestation, water scarcity and biodiversity loss are what we refer to as 'wicked' problems. These problems are characterized by their complexity, uncertainty, and interconnectedness, making them seem impossible to solve. Because the factors contributing to these problems are often incomplete, in flux, and difficult to define, solving wicked problems requires the search for solutions across disciplinary boundaries and must combine knowledge from various areas. Achieving the necessary competencies to solve such problems has become a priority in all educational systems.

There is broad agreement that advancing sustainability transformations requires specific competencies, such as those on climate, water, energy, food, etc, as well as general competencies. Wiek, Withycombe, & Redman (2011) have proposed six key competencies in sustainability. These competences, including Systems Thinking, Futures Thinking, Values Thinking, Strategic Thinking, and Collaboration, all contribute to a meta-competence, Integrated Problem-Solving Competence (Figure XXXX), which is also the foundation of the eight STEM skills. These competencies are practical tools that can help us address the complex challenges of sustainability.

Following Wiek et al. (2015) these competences can be defined as:



Systems Thinking Competence

Ability to analyze sustainability problems cutting across different domains (or sectors) and scales (i.e., from local to global), thereby applying systems concepts including systems ontologies, cause-effect structures, cascading effects, inertia, feedback loops, structuration, etc.

Students in a science class are tasked with analyzing the local water supply system. They study how water is sourced, treated, and distributed, and then examine the impacts of pollution on this system. They identify cause-effect structures, such as how agricultural runoff leads to water contamination, and explore feedback loops, like how polluted water can affect local wildlife, which in turn impacts human health and agricultural productivity.

Futures Thinking Competence

Ability to anticipate how sustainability problems might evolve or occur over time (scenarios), considering inertia, path dependencies, stability and change, and triggering events; as well as creating and crafting sustainable and desirable future visions, considering evidence-supported alternative development pathways.

In a social studies project, students create scenarios for their community 20 years into the future, considering various sustainability challenges like climate change, urbanization, and technological advancements. They develop multiple pathways, including optimistic and pessimistic scenarios, and discuss the potential triggering events and path dependencies that could lead to these futures. They then craft a vision for a sustainable and desirable future for their community, supported by evidence-based strategies.

Values Thinking Competence

Ability to specify, compare, apply, reconcile, and negotiate sustainability values, principles, goals, and targets, informed by concepts of justice, equity, responsibility, etc., in various processes, including visioning, assessment, and evaluation.

During a debate in a civics class, students discuss the values underlying different sustainability initiatives. They compare principles of justice, equity, and responsibility in contexts like renewable energy, waste management, and conservation. For example, they might debate the fairness of imposing higher taxes on fossil fuels to reduce carbon emissions, considering the impacts on low-income families versus the broader environmental benefits.

Strategic Thinking Competence

Ability to design and implement systemic interventions, transformational actions, and transition strategies toward sustainability. This not only accounts for unintended consequences and cascading effects but also enables them to develop intentional plans that leverage assets (carriers) and stakeholder coordination (alliances) to overcome systemic inertia, path dependencies, and other barriers to reach envisioned outcomes.

In an environmental club, students design a campaign to reduce plastic waste in their school. They create a detailed plan that includes strategies such as increasing recycling bins, organizing awareness workshops, and collaborating with local businesses to reduce plastic packaging. They anticipate potential barriers, such as student and staff resistance, and plan interventions to address these, like creating engaging educational materials and incentivizing participation through competitions.

Collaboration Competence

Ability to motivate, enable, and facilitate collaboration towards sustainability. This includes project management, communication, negotiation, and leadership skills. The emphasis on collaboration underscores the importance of teamwork in addressing sustainability challenges.

As part of a group project, students are assigned to develop a community garden. They must coordinate with various stakeholders, including school administrators, local government, and community members. They practice project management by assigning roles, setting timelines, and regularly communicating progress. They also develop negotiation skills by securing permissions and resources and enhance their leadership skills by motivating peers to participate.

Integrated Problem-Solving Competence

Ability to apply different problem-solving frameworks to complex sustainability problems and develop viable solution options. This capacity enables graduates to meaningfully integrate problem analysis, sustainability assessment, visioning, and strategy building.

In a multidisciplinary project, students tackle the problem of food waste in the school cafeteria. They start with problem analysis by collecting data on the amount and types of waste produced. They then conduct a sustainability assessment to understand the environmental and economic impacts of this waste. Based on their findings, they brainstorm and develop viable solutions, such as implementing a composting program, creating a menu-planning system to reduce excess food, and educating peers on the importance of minimizing waste.

The first two competences, Systems and Futures Thinking, are closely related to the crosscutting concepts discussed before. The last one, Integrated Problem solving is the STEM meta-competence. It is achieved, as proposed by renowned educators, through methodologies like inquiry-based or engineering design that imply collaboration. The aim of these competences, along with Values and Strategic Thinking, is to enable students to become actively involved in solving our serious social problems, thereby integrating sustainability competences with STEM skills.

In short, proposing to our students the search for solutions to real problems related to sustainability not only allows us to address the crosscutting issues but also to develop both sustainability competences and STEM skills. This integration is crucial as it equips students with the necessary tools to tackle real-world sustainability challenges, making their learning experience more relevant and applicable.

G. COMPUTATIONAL THINKING & DIGITALISATION COMPETENCE AND THEIR RELATIONSHIP WITH STE(A)M SKILLS

The DigComp framework[2] identifies the key components of digital competence in 5 areas.

Information and data literacy

To articulate information needs, to locate and retrieve digital data, information and content. To judge the relevance of the source and its content. To store, manage, and organise digital data, information and content.

Browsing, searching and filtering data, information and digital content

Evaluating data, information and digital content

Managing data, information and digital content

[2] The **European Framework for the Digital Competence of Educators (DigCompEdu)** is a scientifically sound framework describing what it means for educators to be digitally competent. It provides a general reference frame to support the development of educator-specific digital competences in Europe

Communication and collaboration

To interact, communicate and collaborate through digital technologies while being aware of cultural and generational diversity. To participate in society through public and private digital services and participatory citizenship. To manage one's digital presence, identity and reputation.

Interacting through digital technology

Sharing information and content through digital technologies

Engaging in citizenship through digital technologies

Collaborating through digital technologies

Netiquette

Managing digital identity

Digital content creation

To create and edit digital content. To improve and integrate information and content into an existing body of knowledge while understanding how copyright and licences are to be applied. To know how to give understandable instructions for a computer system.

Developing digital content

Integrating and re-elaborating digital content

Copyright and licenses

Programming

Safety

To protect devices, content, personal data and privacy in digital environments. To protect physical and psychological health, and to be aware of digital technologies for social well-being and social inclusion. To be aware of the environmental impact of digital technologies and their use.

Protecting devices

Protecting personal data and privacy

Protecting health and well-being

Protecting the environment

Problem solving

To identify needs and problems, and to resolve conceptual problems and problem situations in digital environments. To use digital tools to innovate processes and products. To keep up to date with the digital evolution.

Solving technical problems

Identifying needs and technological responses

Creating using digital technologies

Identifying digital competence gaps

H. RELATIONSHIP BETWEEN STE(A)M SKILLS AND DIGCOMPEDU

Starting from the DigiCompEdu framework, we can link some STE(A)M skills to digital skills. In other words, we can work on digital skills while also covering the STE(A)M skills. This link immediately provides a 'description' of which features the deployed technology should have. For example, if digital competence requires information to be able to be searched and filtered, we need to use a technology that is capable of doing so.

First of all, there are two overarching competencies that should always be addressed in any project that uses technology, namely **safety** and **problem solving**. The other linked digital skills and STE(A)M skills can be found below, in which we also provide some examples from different subjects.

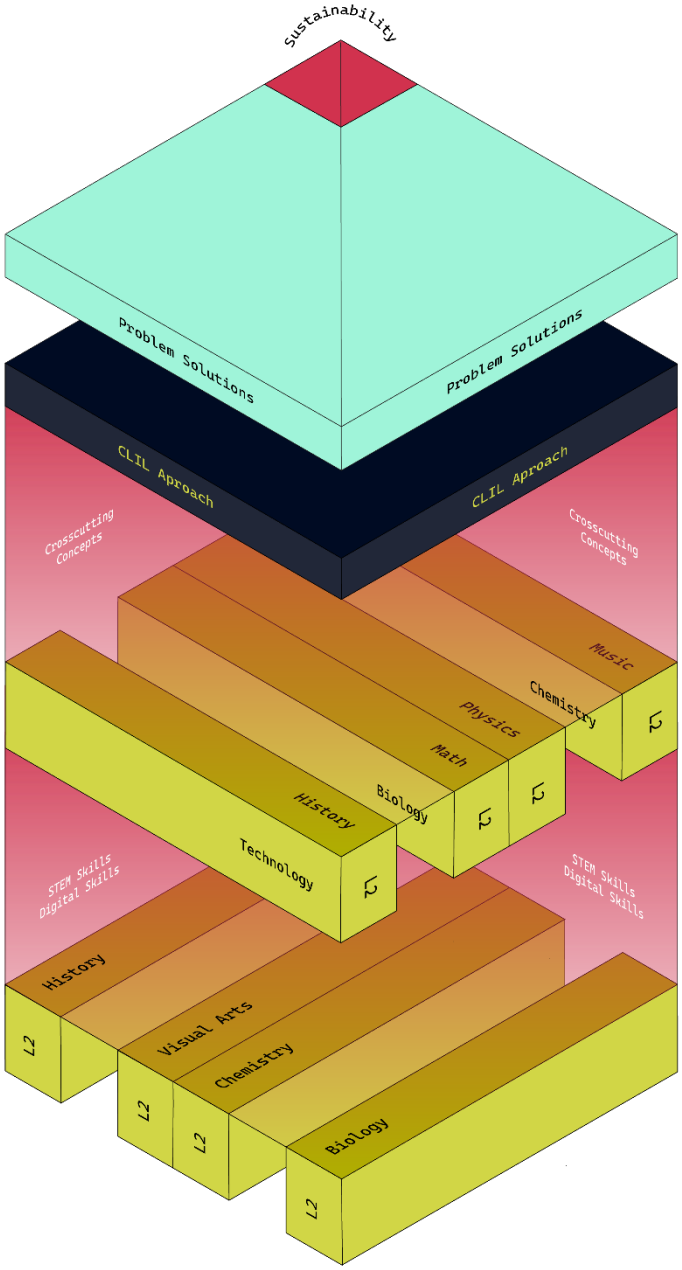
Asking Questions and Defining Problems	
Information and data literacy	Students use online research databases to formulate relevant questions and define problems for a project on the impact of climate change on local ecosystems.
Communication and collaboration	Students use online survey platforms to design and distribute questionnaires to collect data on public opinion regarding government policies for a project on political science. By comparing the answers, they refine their research question. Students use shared folders and documents to collect their information.
Developing and using models	
Digital content creation	Students can create digital simulations or models to visualize complex scientific concepts, for example, using software like Blender for 3D modelling. Students use augmented reality to indicate on a map where there are certain obstacles on the public road that are a nuisance for wheelchair users.
Mathematical reasoning and algorithmic thinking	
Digital content creation	Programming can be integrated into projects where students build and program robots to perform specific tasks, such as designing a

	self-driving car.
Planning and executing research	
Communication and collaboration	Students can collaborate on projects via online platforms such as Google Drive or Microsoft Teams, where they can share documents, brainstorm, and provide feedback.
Argumentation based on data	
Information and data literacy	Students use data analysis software to identify statistical trends and use them as evidence to support their arguments in a debate on renewable energy sources versus fossil fuels.
Building Statements and Designing Solutions	
Digital content creation	During a research project on 'renewable energy', students use digital tools such as Google Earth and Padlet to create interactive maps showing the locations of wind turbines and solar panels in their surroundings.
Collecting, evaluating, and communicating information	
Information and data literacy	Students collect data on plant growth rates in different environmental conditions using sensors and share their findings through a digital presentation during a project on plant growth and ecology.
Analyzing, predicting and interpreting data/evidence	
Information and data literacy	Students utilize data analysis tools to make weather predictions based on historical meteorological data as part of a project on climate modelling and forecasting.

PROMISED PEDAGOGICAL MODEL

A. THE MODEL

Putting together the elements discussed before, we propose the model sketched in figure below. The model considers the difficulties that teachers and students have in developing interdisciplinary projects from scratch. Therefore, the PROMISED model staggers the acquisition of the various skills and competencies from a more ”disciplinary” approach to a more “interdisciplinary” one, bearing in mind that all the teaching-learning process will be in the L2.



The first level consists of pillars, the horizontal bars represent the different subjects that are relevant to support the STE(A)M competences. They are, as it were, the foundations for the knowledge and skills needed to use the STE(A)M approach in a more integrated way. **Concepts** as well as **STEM and digital skills** are covered in the various disciplines. Since this model is supposed to be used in bilingual sections, CLIL competences must be always addressed. This can be done through the use of stories, news, etc in an L2 that can trigger the desired ideas in the disciplines. In all these disciplines, it is important that both the knowledge and the skills are sufficiently repeated and therefore fixed. This is preferably to be done before more integrated STE(A)M activities are discussed. The following box shows how some of the STEM and digital skills can be addressed indifferent disciplines.

Developing and designing models

Physics: Students create models to study projectile motion by designing and testing different types of projectiles (like paper rockets) to determine which flies the furthest.

Art: Students model three-dimensional sculptures and analyze balance and proportion in their designs, experimenting with different materials and shapes to achieve aesthetic goals.

***Digital skills*:** Groups can use 3D modeling software to visualize and refine their designs, whether for the physics project or the sculpture.

Argumentation based on data

Computer science: Students analyze user data from a simple app they developed, making arguments about user engagement based on collected metrics (like usage frequency).

Music: Students examine historical sales data of music albums to argue which genre had the most significant impact on popular culture in a specific decade.

***Digital Skills*:** Groups utilize data visualization tools to present their findings, such as charts or infographics, highlighting key insights.

Building statements and designing solutions

Technology: Students design a prototype for a simple renewable energy device, such as a solar oven, focusing on functionality and efficiency.

History: Students create a presentation on the impact of the Industrial Revolution on modern engineering, discussing how historical advancements have shaped current technologies.

***Digital Skills*:** Both subjects require students to create digital presentations that articulate their designs or historical analyses effectively.

Analyzing, predicting, and interpreting data

Mathematics: Students analyze data sets related to sports statistics, making predictions about player performance based on historical data.

Environmental science: Students interpret data on local climate trends to predict future environmental changes, such as shifts in biodiversity.

***Digital skills*:** Both groups employ statistical software for data analysis, helping them to visualize patterns and make predictions.

In all the cases, a CLIL approach should be used where language and content are integrated, and it is necessary to reflect which language is needed to learn the curricular subjects.

The second level shows how diverse disciplines can address jointly a topic. This cross-curricular connection is made at least between two subjects, besides the L2. The **cross-cutting concepts** are the connecting elements. Characteristic of this way of working is the combination of learning content and activities from the various subjects, whereby the boundaries between these subjects are still quite clearly visible. The outcome is more or less fixed and therefore the autonomy of the students is limited. At this level, it is also determined which learning goals (disciplinary, multi- and interdisciplinary) will be worked on and which skills will be used to achieve them. Just as in the foundation of the model, the necessary conditions are determined here. The following boxes show some examples for two and three subjects.

Two subjects

a. The human body (Crosscutting Concept: Systems)

In **B**iology class students learn about the different organ systems in the human body. They do so through models of dissections. They can document observations on how food moves through the body (STEM skills). Students can use digital 3D models or VR simulations to explore the human body in an interactive way. They could also use a tablet of computer to interact with an anatomy app, allowing them to rotate, dissect, and observe human organs in detail (Digital skills).

In **M**usic class students compose short musical pieces that represent the rhythm or flow of a particular human system, such as the circulatory or nervous system. They could explore how the steady pulse of a heartbeat can inspire the pace, while the branching pathways of nerves could influence the structure of a composition (STEM skills). Students could create soundscapes using music software (e.g., GarageBand, Soundtrap) that mirror the complexity and interconnectivity of human systems (Digital skills)

b. Chemical elements in art creation (Crosscutting Concept: Patterns)

In **C**hemistry students learn how chemical elements like copper, iron, and various pigments (e.g., mixing oil or water based paints) behave in the presence of oxygen, acids, or bases. This knowledge directly feeds into their **A**rt project, where they could deliberately use these materials and reactions to create visually interesting and scientifically meaningful artwork (e.g., creating art that evolves over time as metals rust or pigments fade).

In all the cases, a CLIL approach should be used where language and content are integrated, and it is necessary to reflect which language is needed to learn the curricular subjects

Three subjects

a. Technological Innovations (Concept: Stability and change)

In **H**istory students investigate how the Industrial Revolution introduced technological innovations such as the steam engine and electricity, and how these innovations brought both stability and change to society. They analyze continuity and change in areas such as working conditions, transportation, and urban development (Skills: collecting, evaluating and communicating information).

In **P**hysics, students examine the stability and change in energy transformation, such as in the functioning of a steam engine. They analyze how stable energy transfer occurs and which variables (like pressure or temperature) affect the system's efficiency, causing changes in its operation (Skills: developing and using models).

In **E**conomics, students study how technological innovations like automation affect stability and change in the labor market and production systems. They analyze how new technologies stabilized production processes (by increasing efficiency) but also caused jobs to change or disappear (due to automation) (Skills: analyzing, predicting, and interpreting data). The concept of stability and change links these different disciplines through the idea that technologies can both maintain stability (such as efficiency) and bring about change (such as in employment), depending on the context. Each subject approaches this from a unique angle, while developing different STEM skills**.**

Cells (Concept: structure and function)

Natural **S**cience, **T**echnology and **M**athematics are involved in the same project 'cells'. In this project, animal and plant cells are first studied under the microscope (natural science) and then modelled on a large scale in 3D (technology). Mathematics is used to teach and practice the calculations needed to make the scale model.

In all the cases, a CLIL approach should be used where language and content are integrated, and it is necessary to reflect which language is needed to learn the curricular subjects.

The third level is located in the roof of the building. At this level, truly integrated STE(A)M projects in an L2, focused in developing sustainability competences, are proposed. On the one hand, the integration of the various disciplines is maximal, i.e. that pupils use appropriate knowledge and skills from those disciplines, but that they no longer actually realize to which disciplines that knowledge or skills belong. The partitions have disappeared. To achieve this, it is important that the underlying STE(A)M and digital skills have been sufficiently addressed (practiced and tested) in the first level and the crosscutting concepts understood, in different contexts than those that are discussed in the roof.

On the other hand, the starting challenge is also sufficiently open, i.e. there is enough room to come up with certain solutions and that the autonomy of the students is therefore automatically greater. The students will therefore research and design appropriately in function of a broader challenge from their plurilingual and pluricultural world. In our model, this “roof” should address problems related to sustainability.

In class, the eco-fiction book *Wildwood* by Colin Meloy is being read in a L2, coming out a problem regarding how school surrounding biotope have changed. Researching the fauna and flora of the area (mapping the occurrence of different species with chi-square test) and comparing them with data from other areas (e.g. via digital databases and apps) can lead to the challenge of increasing biodiversity in that area. What should be done to increase the species of flora in particular, so that the entire food chain based on them increases in species richness? Students will learn the "**language of learning**" that would include terms like "murder of crows”, “wilderness”... The "**language for learning**" might involve phrases like "Can you explain how...?", or "What happens if...?" and the "**language through learning**" could include students' ability to comparing data, summarize their findings, or present their solutions to the class.

Students need also to master the **8 STE(A)M skills** and several **cross-cutting concepts** are addressed -- **cause and effect; scales, systems, structure and function; stability and change**. Also, diverse digital competences can be developed, in particular related to **Information and data literacy, communication and collaboration and digital content creation**. Regarding plurilingual competences, . . . Finally, the problem can help students to increase their **sustainability competences**, putting particular emphasis on the **Strategic Thinking** when designing their solutions.

In all the levels of the PROMISED model, the learning strategies and scaffolding for applying CLIL approach, including the language triptych, should be defined in advance by teachers from different subjects. Collaboration of two or more teachers (depending on the level) will provide opportunities to plan and work together to ensure this integrative way of learning. Teachers together can guarantee that students not only learn the content but also develop the language skills to understand the content deeply in an L2. Students will therefore develop language and content competencies in an integrated way.

B. INCLUSION ISSUES

STE(A)M + CLIL class can be particularly challenging for students for many reasons, not least of which is the language ability of individual learners and for this reason, several inclusive strategies could involve the following among others:

- Differentiated instruction, for example through simplified text or explanations, varied resources and tasks, personalised learning outcomes, or other activities tailored to specific learning (dis)abilities.
- Use of materials and resources which consider different learner's styles and preferences.
- Group work and collaborative activities, tasks and projects which encourage peer support and learning.
- Scaffolding techniques, which help build upon prior knowledge and link learning to other situations.
- Adapted assessment methods to cater for specific learning needs.
- Incorporation of translanguaging (or code switching) to support the learning and acquisition of fundamental contents and skills.
- Encouragement of learner agency and autonomy including goal setting, and familiarity and mastery of all necessary resources.
- Implementing ICT resources to promote language and content skills.

While language level, cognitive abilities and learner preferences are key concerns in the CLIL class, the focus on diversity and inclusion also implies generating motivation and creating meaningful learning opportunities in a context that is welcoming for all learners and in which everyone feels accepted.

Moreover, attention to diversity in the CLIL classroom is a crucial aspect of educational practice, reflecting the country's commitment to inclusivity and equity in education (Casas Pedrosa & Rascón Moreno, 2023). CLIL programs aim to teach both subject content and language simultaneously, often in a target language such as English, while catering to the diverse needs and abilities of students.

Content-adapted language and visual aids

While the consideration of content-adapted language may be related to the previously discussed section in terms of differentiation, the nature of CLIL education requires us to focus specifically on this area. It is essential that language in the class is adapted to the current language proficiency of students. This adaptation could involve:

- The use of clear instructions
- Pre-teaching key terms at the beginning of a session
- Avoidance of unnecessarily complex statements

- Use of repetition, synonyms and parallel expressions
- Employment of a range of visual aids and multimodal resources as well as body language
- Use of diagrams, graphs, tables, mind maps etc.
- Strategic use of L1
- Use of ICT resources

These are just some of the possible strategies that we can use to facilitate access to content for all learners. Additionally, we could mention the need for training not only in general aspects of CLIL, but also in terms of the specific area of attention to diversity and differentiation in subjects taught through the medium of a foreign language. The main idea here is to enhance student engagement as well as language and content acquisition by considering and adapting to existing limitations in proficiency.

SOME ACTIVE METHODOLOGIES

This section presents some active methodologies that can be used in education. These methodologies are all based on the idea that students should be actively involved in their own learning. They should be encouraged to think critically, problem-solve, and collaborate with others.

The following active methodologies are discussed in the text:

Teaching Method	Description
CLIL	Teaching subjects through a foreign language
Storytelling	Teaching through stories
Inquiry-based Learning	Teaching by asking questions and investigating
Social Knowledge/ Studies and History	Teaching about society and history
Modeling	Teaching by creating models
Engineering Design Methodology	Teaching by designing and building things
Design Thinking	Teaching by solving problems creatively
Coding	Teaching by writing computer programs

These active methodologies can be used in a variety of educational settings, including schools, universities, and adult education programs. They can also be used to teach a variety of subjects, including mathematics, science, language arts, and social studies.

A. CLIL

CLIL refers to situations in which subjects or parts of subjects are taught through a foreign language (Marsh, 1994). From this methodological approach, students achieve an optimal level of cultural understanding, linguistic diversity is considered, and it is an attempt to overcome the limitations of traditional teaching by integrating the curriculum. One of the most basic considerations is that there should be a balanced treatment among four key areas, which are: a)

content, b) communication, c) cognition, and d) culture (see Coyle, Hood & Marsh, 2010), which are shown in Figure 1.

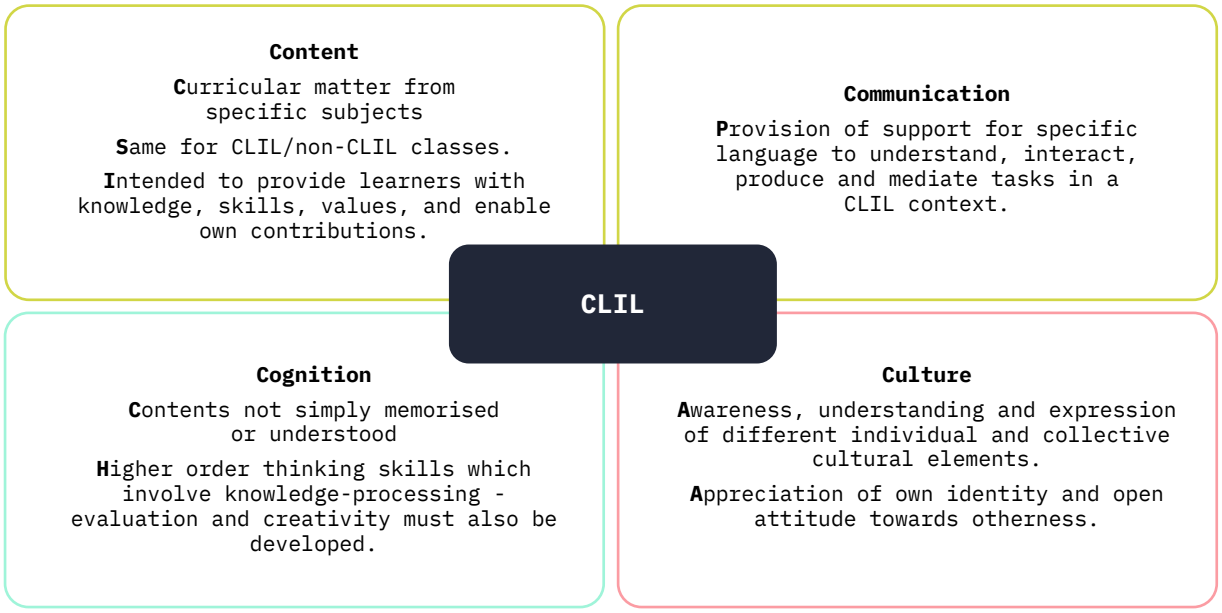


Figure 1: The 4 C's Based on Coyle, Hood & Marsh (2010)

Content represents the backbone of any educational program. It therefore must be at the centre of any pedagogical decision-making processes. In this type of scenario, the teaching of subject contents through the L2 facilitates more natural forms of language acquisition; but here it is necessary to ensure that learners acquire all necessary subject-specific knowledge and skills.

In terms of communication, this involves contextualized, functional and authentic encounters with the L2 and generally involves the activation of students' receptive productive interactive and mediation skills. It is important to mention here that while the subject teachers do not act as language instructors, but they should be aware of the need for basic linguistic enabling situations, such as ensuring comprehensible input and having high but reasonable expectations for learner interaction and output.

Improving learners' cognitive development is another fundamental precept of CLIL, and in these settings, learners need to develop their higher order thinking skills (see Coyle, Hood, & Marsh, 2012). Tasks that require analysis, synthesis, and the provision of creative responses, for example, combine with communicative acts in the L2, and this often requires having a relatively high tolerance for linguistic error, particularly when dealing with cognitively challenging tasks.

Active collaborative learning
Students must be actively engaged and meaningful, purposeful tasks which content and language acquisition is developed simultaneously.

Examples of cooperative and collaborative activities or tasks:
Research-based group presentations
Jigsaw or information gap activities
Role-play simulations
Problem-solving tasks
Creation of multimedia content
Combined technological designs with artistic dimensions.
Debates and discussions
Integrated tasks
Concept or mind maps
Practical activities
Portfolios

Finally, cultural understanding, awareness, and expression are integral parts of CLIL education. Discovering and being critically aware of new concepts, different approaches, or different sets of values and behaviours can enrich students' perspectives and help them develop a more nuanced approach to learning contents, problem-solving and interacting with others.

As previously discussed, outcomes arising from CLIL-based education very greatly depending on a wide range of variables, including student age, interests and abilities, teacher training and subjects involved, as well as resources and materials available, among other aspects. While this is true, there are a number of principles which are considered fundamental in order for CLIL to take place in optimal conditions.

The 4 C's in action

Subject: Social Sciences
Content: Human Rights: Universal Declaration of Human Rights
Communication: Specific vocabulary. Modal verbs to discuss rights and responsibilities
Cognition: Analyze the principles of human rights.
Culture: Examination of human rights issues in different countries and cultural responses
Use of ICT & Technology: Online databases, digital storytelling tools, interactive human rights platforms. Genially
Examples of projects: Research and present case studies on human rights using digital storytelling tools and create an interactive presentation on the Universal Declaration of Human Rights in a foreign language.

It is possible to design a variety of activities and projects in the CLIL classroom, especially aligned with ICT to encourage motivation and interest on students. The positive effects on motivation levels and learning of curriculum content are directly related to the design of classroom activities and materials, as well as to the correct application of learning strategies and scaffolding, i.e. activities that promote cooperation, collaboration, integration of content and foreign language, and the provision of opportunities for participation. The integrated teaching of language and curricular content does indeed foster the emergence of opportunities for the development of learners' cognitive skills and creative thinking.

Integrated planning can take place at several different levels. For an individual subject, this planning could involve the integration of key and specific competences areas of basic knowledge along with the previously mentioned concerns of communication, cognition and culture. It is increasingly the case, however, that teachers and schools adopt an approach of curricular integration. In essence, this can involve the collaboration of two or more teachers from different areas working in tandem on a joint project which involves activities pertaining to subject-specific competences.

B. STORYTELLING

Storytelling is one of the oldest forms of communication and learning, humanity has always resorted to storytelling to educate and understand the world. After all, we are beings who tell stories (Bruner, 2003). The incorporation of literary texts into the teaching of L2 in Middle/High School can stimulate students' imagination, encourage autonomous reflection, and allow them to reach their own conclusions. Beyond cognitive development, the students have the opportunity to improve not only their communication in another language but also their understanding of other cultures.

The integration of storytelling into language learning develops communication and can serve as a common thread for the construction of knowledge (Greca & Sanz, 2022). These stories can be found in different formats or genres that allow us to adapt to the interests of our Middle/High school students. Comics and graphic novels are narrative genres that work as an effective tool when it comes to learning a language. Students often show a keen interest in these types of publications, which fosters a positive attitude and increased motivation within the classroom. This type of narrative uses a dynamic language, using two different codes, verbal and visual, which are organized in a sequential and complementary way to facilitate comprehension and learning. These features make reading fast and entertaining. Reading images will allow the students to make sense of and organize the information that comes to them, which will force them to select information, make decisions, and interpret the text in front of them (Fischbach, 2015). However, we must bear in mind that the teacher is essential for the proper interpretation of the images. Sometimes, these can have a marked symbolic and cultural character that must be interpreted correctly. On the other hand, comics use codes established and accepted by the reader such as vignettes, speech bubbles, labels, plans, onomatopoeia, or visual metaphors to transmit certain information. This heterogeneity of content – linguistic, iconic, and cultural – will favour both individual and cooperative work in the classroom.

Pedagogical functions attributed to comics in l2

Some narrative possibilities of comics and graphic novels

Superheroes (*Avengers* by *Don Heck, Jack Kirby and Stan Lee's Avengers*) **L**iterary classics (*Anne of Green Gables* by Mariah Marsden and Brenna Thummler, 2020),
Historical themes (*Catherine's War* by Julia Billet and Claire Fauvel, 2018),
Social themes (*When Stars are Scattered* by Victoria Jamieson and Omar Mohamed, 2021)
Environment (*Gaia. Diosa de la Tierra* by Imogen and Isabel Greenberg, 2022)

Comics is a well-known and everyday material that presents a pleasant and entertaining design, easy to interpret since the image facilitates the understanding and contextualization of the story it tells. This translates into greater motivation for the students, because it is a material that usually meets their preferences and interests. This versatility of topics and readings serves to promote a reading habit in students in a foreign language. Another advantage that we encounter when using this type of narrative genre is that we can find these works published in different languages.

The incorporation of comics and graphic novels in language teaching contexts to work on topics from different subjects is a potentially useful choice for the development of Content and Language Integrated Learning (CLIL) approach in Middle/High school. Comics can be effective tools for teaching literary, historical, scientific, or mathematical concepts visually and engagingly. The insertion of the cultural component in the comic becomes visible thanks to the incorporation of cultural elements in the stories and the inclusion of different characters and contexts. The cultural aspects are appreciated through the images that make up landscapes, cities, clothing, interpersonal relationships... This information is transmitted to the reader who builds bridges for mutual understanding and develops multicultural awareness.

Ecology and sustainability through manga comic

Nausicäa of the Valley of the Wind by Hayao Miyazakide is a fantasy genre, which reflects a world that is not recognized as a result of the global collapse as usual in the dystopian genre where nature plays a very important role in restoring balance. In this case, we are dealing with a manga comic, that is, from Japanese culture, so the way of approaching it differs from Western comics. The cultural weight in this case is evident in the reading of the comic itself, since it is read by opening the book at the end, from right to left.

We must not forget about language learning/acquisition. The *input* to which students are exposed has a kind of verbal and iconic nature that favours the understanding of the message of the comic. It recreates communication situations and allows the simultaneous introduction of vocabulary, linguistic structures, and socio-cultural aspects. This material is an opportunity to work on linguistic content within communicative situations and has been used in the language classroom in this way. Some of the activities designed for the development of language skills are: transcribing content in an indirect style, working on intonation from reading speech bubbles, using silent comics – *Emigrantes* (Shaun Tan, 2006) – and asking students to imagine the thoughts of the characters,

removing text from speech bubbles to create a dialogue, hiding a vignette from a sequence so that they can complete the story with the data provided by the rest of the vignettes, etc. It will also be necessary to work on the visual language of the comic, so we can work with the panels, the framing, the shots, the angle of vision, the lines of movement, or the gestures.

When selecting comics or graphic novels to work on in the L2 classroom in secondary school, we must consider several criteria that guarantee pedagogical success. First of all, it is important to choose works that are appropriate to the language level of the students. In addition, the selected texts must be an acceptable challenge for students, so that they are able, under the guidance of the teacher, to acquire new cultural, linguistic, and content knowledge. And of course, they must have narrative and artistic quality.

As with other literary genres, to achieve a correct understanding and interpretation of the text, we must design a series of activities that guarantee this objective. To this end, we distinguish the following stages for working on comics (Giovannini et al., 1996):

Pre-reading activities: stimulus that motivates students to read the comic.
Ask to see if they know this genre, if they have read comics or graphic novels, what titles they have read, etc
Show the drawing of the cover covering the title and ask them to suggest a title, or to formulate some hypothesis of what topic it will deal with.
Work with emotions, asking them what feelings the cover or title conveys to them.
Work with the author(s) information.
In this phase, students will work on different language skills such as listening following the teacher's guidelines, oral expression when answering the questions posed in class, reading to obtain information, and writing, when students have to answer some of the questions in writing instead of orally.

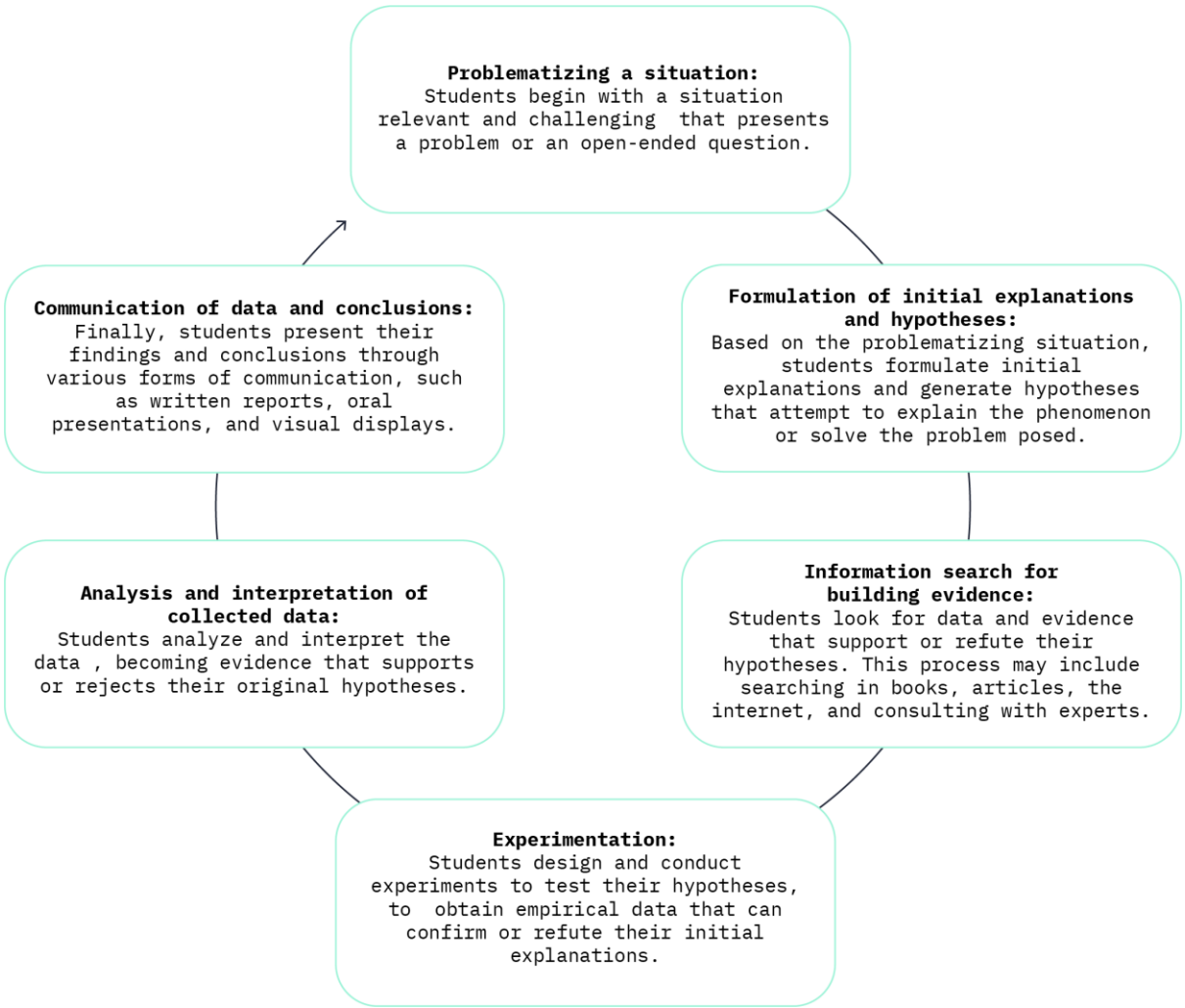
Activities during reading: to understand the text students are facing.
Ask them to identify the main and secondary characters and describe them physically and psychologically.
Analyse the comic panels (meanings of the different speech bubbles according to their design, kinetic lines, visual metaphors, use of colour, and typography).
Identification of emotions in the characters through the artistic style.
Styles within the work: aesthetic changes when the tone of the narrative changes.
Compare cultures: list the differences they find with their culture, how people dress, what the streets are like, the landscape...

Post-reading activities: Students reflect on their reading journey and the content they have acquired.
Organize a discussion about the reading (theme, characters they liked the most or the least, other works they have read they would relate it to, etc).
Create a strip where they synthesize the plot of the work with ICT resources (Canva, Pixton, or Creately that allow the creation of comics).
Design a trailer for the book to encourage other classmates to read the book.
Interview one of the characters in the book.
Write a short text explaining the difficulties they have encountered when facing reading, both in the verbal and visual code.

Comics in an L2 are a very versatile tool that allows us to work on a variety of content and adapt to the level of the learners. In addition, it has visual support that will facilitate the understanding of the message and develop the inference capacity of our students. It is a material that favours group work and sharing, promoting socialization and cohesion among the members of the class.

C. INQUIRY-BASED LEARNING IN NATURAL SCIENCES

Inquiry-based learning is a student-centered educational methodology that fosters curiosity, investigation, and autonomous discovery. Instead of passively receiving information, students actively engage in the learning process through formulating questions, exploring problems, and seeking solutions. This approach is based on the idea that knowledge is best constructed when students are deeply engaged with the content and can connect learning to their own experiences and contexts. The main stages of inquiry-based learning match the eight STEM skills.



If, upon analysing the data, the hypothesis is disproven, students can reframe new hypotheses and continue the inquiry process. Additionally, completing the inquiry process may lead to conclusions that open new problematic situations, encouraging ongoing exploration and discovery.

Furthermore, the methodology acknowledges that **knowledge is constructed** actively and meaningfully. Students are not merely absorbing information; they are processing, interpreting, and contextualizing it within their own experiences. This process is facilitated through collaborative activities, reflection, and application of learned concepts to real-world problems. Moreover, Inquiry-Based Learning places a strong emphasis on authentic **problem-solving**. By connecting learning to real-world scenarios, students grasp the practical utility of their knowledge while honing their critical thinking and problem-solving skills. Also, **metacognition and reflection** play crucial roles in this approach. Students are encouraged to reflect on their learning processes, identify effective strategies, and adapt them as needed. This fosters skills for independent and self-regulated learning, contributing to both academic success and personal growth.

Finally, Inquiry-Based Learning acknowledges the **diversity of learners** and promotes adaptation and flexibility in teaching methods. Educators must be responsive to individual student needs, adjusting their approaches accordingly to ensure inclusivity and engagement for all learners.

Implementation of inquiry-based learning

Types of inquiry-based learning

Open inquiry: begins with students' questions, followed by students designing, conducting and communicating results of an investigation. For example, students decide to investigate the carbon footprint of their school. They propose the questions, formulate hypothesis; design experiments, analyse data and reach some conclusions.

Guided inquiry: the teacher helps students develop inquiry investigations (usually, the teacher chooses the question for investigation and, sometimes, the design of the experiments). For example, the teacher proposes the study of the coefficient of friction of diverse materials. She can also propose the experimental setting. Students perform the experiment, collect, and analyse data and finally obtain some conclusions.

Coupled inquiry, combining a guided-inquiry with an open one, useful to target a particular concept, idea or standard, since it is the teacher who chooses the driving question to investigate.

The effective implementation of inquiry-based learning in the classroom requires careful planning. First, it is necessary to identify learning objectives, select relevant topics, establish necessary resources, and design a clear action plan. It is important that students know the steps they should

follow to complete the activity, from formulating questions to presenting results. Also, as inquiry-based learning involves collaborative, assign clear roles within the group to encourage collaboration and equitable task distribution. Independently of the type of inquiry, allow for some degree of flexibility so that students can explore different approaches and solutions to the problems posed. Finally, continuous assessment is essential for monitoring student progress and providing timely feedback that fosters growth and improvement. In the context of inquiry-based learning, assessment can take various forms, including observation, final products, self-assessment and peer assessment.

D. THE TEACHING OF SOCIAL KNOWLEDGE/STUDIES AND HISTORY

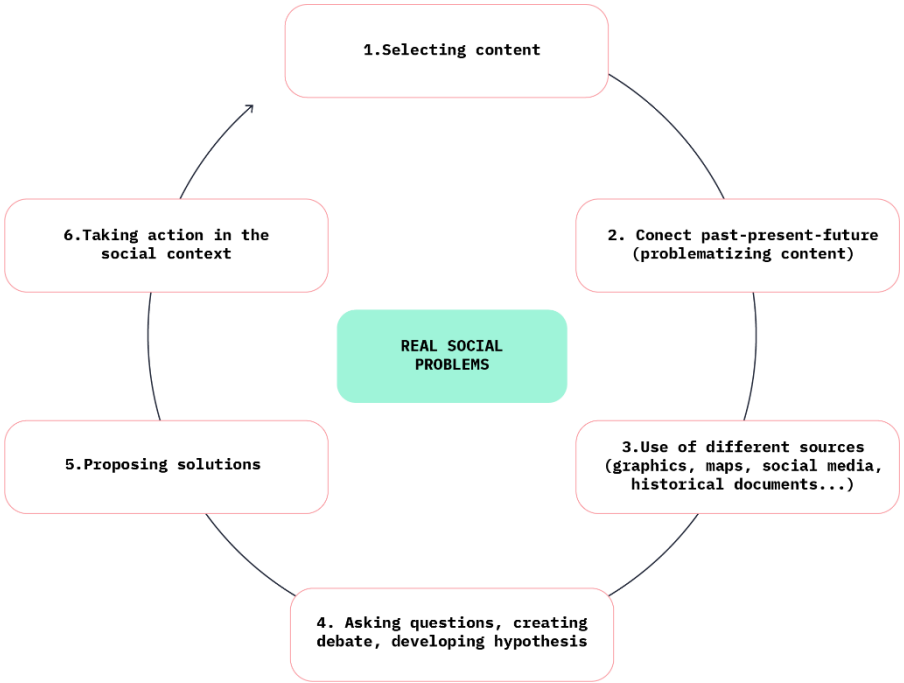
Teaching Social Sciences in the secondary education context poses a significant challenge for teachers. Traditionally limited to the learning of Geography and History, Social Sciences offer the possibility of incorporating a more globalized approach aimed at comprehensive learning. Whether from the subject of History or Geography, it is crucial to ask why and for what purpose these subjects are taught. The goal of teaching Social Sciences should focus on forming citizens who are critical, responsible, and actively committed to the well-being and development of society. This involves not only transmitting knowledge but also fostering skills of analysis and reflection on social reality. Students must learn to question, evaluate, and understand the social, historical, and political phenomena that affect their lives and communities. Moreover, they should develop as individuals aware of their rights and responsibilities, prepared to participate in democratic processes and contribute constructively to social change.

According to Bain (2005), History teachers must be able to teach their students how to understand History by designing historical problems. This involves not only addressing complex historiographical topics but also considering the students' own context. One of the main issues in teaching History is the deep disconnection between the past and the present. The past is often represented by a collection of data, dates, and figures, generally male and in leadership roles. For most young people, it is challenging to empathize with a context so different from their own.

Problematizing content allows for a connection between the past and the present, enabling an in-depth analysis of content through the evolution of social values. Santisteban (2019) presents the example of studying the Roman Empire through the concept of the "barbarian," which allows us to reflect on the term and find analogies in contemporary society. Therefore, History, Geography, and Social Sciences classes would become laboratories for practicing the resolution of social problems (Santisteban, 2019). This approach requires handling information from different perspectives and disciplines, using various sources of information. Returning to the previous example, the concept of "barbarian" used by the Greeks referred to the indecipherable speech of foreigners. Today, the term has evolved, but it is interesting to analyse whether attitudes towards

foreigners have also changed. This allows us to relate it to the construction of identity, the current situation of many countries that receive and send migrants, and how the issue is addressed in national and international politics. This study can be conducted using primary sources such as social networks, the press, archaeological material, and ancient texts.

In this sense, inquiry serves as a method of social analysis that goes beyond mere memorization of data and conceptual definitions, which has been proven ineffective and obsolete in understanding social phenomena. We must teach our students to make deductions and inferences from information to reach knowledge. We will not provide them with the content but the tools to create it. Inquiry proposes a learning process that starts with current social problems to select content, analysing its evolution and proposing solutions for the future. This work is more effective when diverse sources are used (graphs, tables, archaeological material, historical documents, maps...). Teachers will thus encourage discussion and analysis that lead to new questions, approaches, and possible solutions to the presented problem. It is crucial not to limit classroom work to merely academic objectives but to consider the possibility of taking direct actions in response to the problem posed. This will be the definitive meeting point between the past, present, and future.



Thus, the study of World War II can be approached from a current social issue such as the war in Ukraine. The geopolitics of the moment, although different, allow for some connections regarding the promotion of cultural identity or the impact on civilian populations, among others. Both aspects can be addressed using press releases, comments, and photographs published on social media, as well as maps, historical documents, letters, interviews, etc. From there, teachers, armed with various tools, can facilitate debate and the formulation of new questions, leading to a deeper

argumentation to try to provide solutions to the problem at hand. Taking the aforementioned conflict as an example, the image of a pregnant woman fleeing a bombing in Ukraine became the focus of media attention, triggering a network of misinformation in Russian media, claiming that the woman was an actress. This example can serve as a catalyst for sparking a classroom debate about the use of information by the media during World War II. The didactic possibilities are numerous, with various resources such as debate, research, simulations, etc., able to be employed.

Abandoning the reductionist view of History, focused almost exclusively on the public sphere, allows us to adopt a perspective based on understanding social relationships and practices. This promotes a holistic view that develops critical thinking skills and encourages responsible actions committed to the social context. Therefore, the analysis of social invisibilities and absent identities is essential for constructing counter-narratives based on social justice and human rights. These counter-narratives serve as alternatives to hate speech, which often targets women and the LGBTQ+ community, and are oriented towards social action and the development of critical thinking. In History education, it is essential to recognize and give visibility to the presence of groups in contextually vulnerable situations to prevent the spread of hate speech.

The integration of History into the study of a second language through CLIL not only enhances students' language skills but also helps develop essential competencies for academic and personal growth. Historical narrative is fundamental for the development of reading and listening comprehension, as well as written and oral expression. Students will need to narrate, describe, and argue about historical events in a language other than their mother tongue, leading to the development of communication and argumentation skills. It is crucial to organize information and present it logically, synthesizing content and adapting it to the context.

Moreover, learning History, and Social Sciences in general, is particularly interesting for the development of critical thinking and analytical skills. The subject's content requires interpretation and analysis of past events, so students will need to evaluate different sources of information, handle complex concepts, and express them clearly in a second language. It is important for students to participate in debates, where they have to research information and argue their points. A debate can be conducted as a role-playing game, for example, representing the three estates of the Ancien Régime in the period leading up to the French Revolution.

Furthermore, studying History through CLIL allows students to analyse their own culture, fostering the development of a critical and reflective identity, and promoting intercultural competence, which is essential for effective and respectful communication in a globalized world. The course of history has enabled the development of our society, shaping us into who we are today. Analysing cultural identity involves approaching other cultures and developing a critical and reflective perspective.

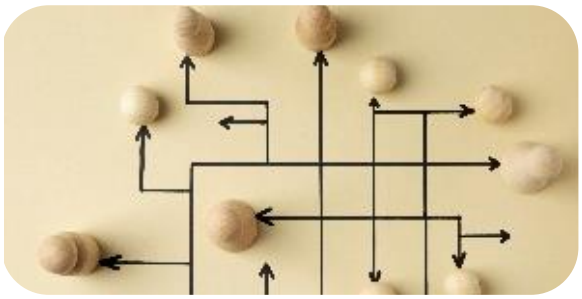
E.MODELING

Modeling, a cornerstone of science education, is a potent instructional strategy. It involves using representations of concepts or systems to aid students in comprehending and engaging with scientific ideas. These representations, whether physical, mathematical, conceptual, or computer-based, allow students to visualize and manipulate abstract concepts, thereby making learning more tangible and interactive. They can be used to predict outcomes, explain observations, or test hypotheses, making them a versatile tool in the science classroom.

Types of Models

1. Physical Models: Tangible, three-dimensional representations, such as anatomical models, molecular structures, or solar system models.

2. Mathematical Models: Equations and algorithms representing relationships between variables, used in physics and chemistry.



3. Conceptual Models: Diagrams, flowcharts, and drawings that illustrate processes or systems, such as the water cycle or food webs. Also, all the models used for understanding the complex relations in systems, such as positive and negative feedback models, predator-prey models, and diagrams of storage and flows.

4. Computer-Based Models: Simulations and virtual models that allow manipulation of variables and observation of outcomes, often used in complex systems like climate modeling or population dynamics.

Modelling improves comprehension, since students can better understand abstract concepts through visual and hands-on learning. Also, it involves students in the learning process, making them active participants rather than passive recipients. It enhances retention, since hands-on and visual learning experiences are often more memorable, leading to better information retention.

In the classroom, it is necessary to:

1. **Identify Key Concepts**: Determine which scientific concepts or systems would benefit most from modeling.
2. **Choose Appro-priate Models:** Select the model that best fits the learning objectives and the complexity of the concept.
3. **Integrate with Curriculum**: Ensure that models are seamlessly integrated into the curriculum and align with learning goals..
4. **Facilitate Hands-On Activities:** Provide opportunities for students to interact with physical models or engage in virtual simulations.
5. **Encourage Exploration**: Allow students to manipulate models, test hypotheses, and observe outcomes, fostering a sense of inquiry and discovery.
6. **Promote discussion**: Use models as a basis for class discussions, encouraging students to share their observations and insight6
7. **Assess Understanding**: Use formative and summative assessments to evaluate students' understanding and the effectiveness of the models.

Models are so crucial to science and engineering that systems and system models are also identified as a crosscutting concept. So, this strategy helps to address those concepts and can be used for the second and third levels of the PROMISED pedagogical model. For example, students can build molecular models using a 3D printer, understand exponential functions through their application to biological models of growth, and understand a historical phenomenon through the plot of statistical primary data.

F. ENGINEERING DESIGN METHODOLOGY

The engineering design process is a systematic methodology used to develop material solutions to complex problems, leveraging the principles of engineering and creative thinking. It involves a

series of sequential steps that guide engineers throughout the development of a solution. Although the specific details of each step may vary depending on the context and nature of the problem, it generally follows a similar structure. In the educational context, the engineering design process has become a fundamental tool for teaching STEM subjects. It allows students to apply theoretical concepts in practical situations, exposing them to real-world challenges and preparing them to tackle complex problems in their future careers.

One of the strengths of the engineering design process is its ability to integrate interdisciplinary knowledge. STEM subjects encompass a wide range of disciplines, and engineering design offers a framework that allows students to combine concepts and skills from various areas, such as physics, mathematics, biology, and computer science. This integration fosters a holistic understanding of problems and promotes a collaborative approach to solving complex challenges.

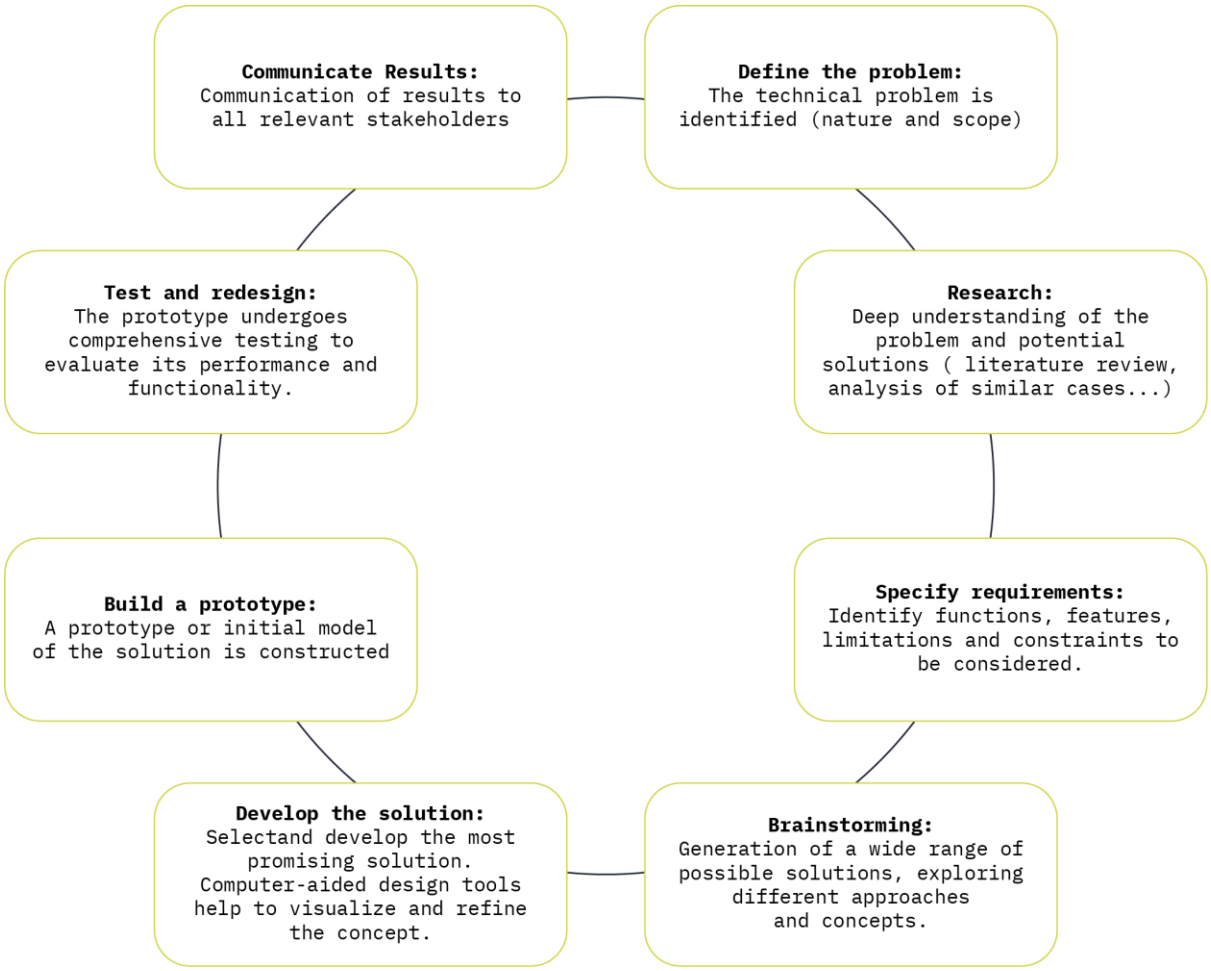
The engineering design process fosters innovation and creativity by challenging students to think originally and seek novel solutions to existing problems. By encouraging exploration and iterative design, students learn to experiment with different approaches and take calculated risks in the pursuit of optimal solutions. This innovative mindset not only drives advancements in the field of engineering but also prepares students to tackle global challenges and contribute meaningfully to society.

Sustainability in engineering design process

Sustainability is a fundamental principle in the engineering design process, especially in addressing current environmental and social challenges. Integrating sustainability factors into the design process involves careful evaluation of materials and resources, aiming to minimize environmental impact. This includes selecting renewable and recyclable materials and considering the entire product lifecycle to reduce waste and promote reuse. Energy efficiency is also crucial, as designing solutions that optimize energy consumption can lower operational costs and reduce greenhouse gas emissions by utilizing innovative technologies and alternative energy sources. Additionally, sustainable design must account for social and economic dimensions, ensuring solutions are technically viable, accessible, and affordable. Incorporating equity and social justice criteria ensures that the benefits of technological solutions are distributed fairly and do not exacerbate existing inequalities. By embracing sustainability, students can develop solutions that address technical problems while contributing to overall societal well-being and planetary health.

Stages of the engineering design process

These stages represent a systematic and structured approach to addressing technical problems.

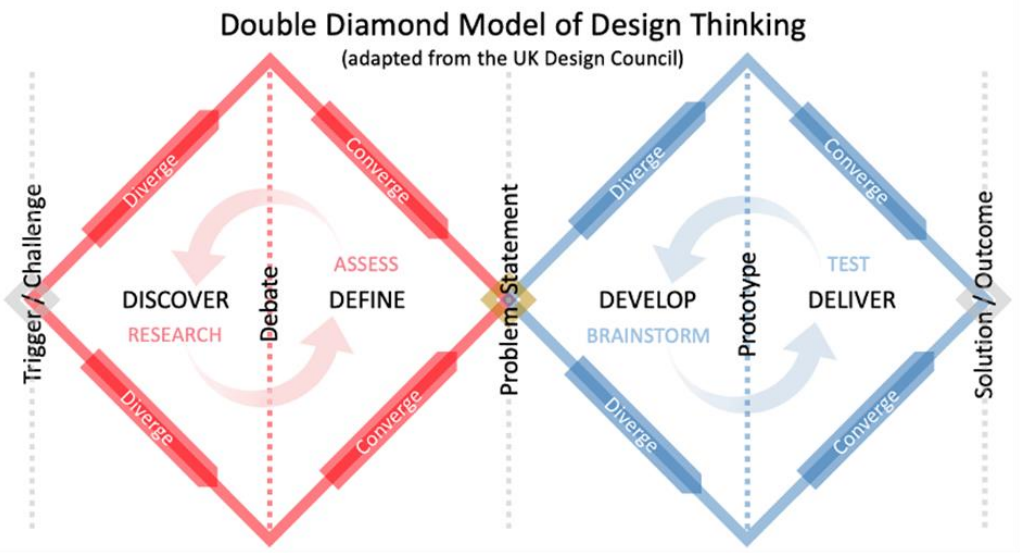


It should be noted that engineering design is a great opportunity to foster teamwork, emulating engineers who collaborate to design solutions to complex problems. In the classroom, this methodology allows students to assume different roles and responsibilities within a team, promoting essential interpersonal and technical skills for their future careers.

It is worth stressing that Inquiry-Based Learning (IBL) and the Engineering Design Process (EDP), although they differ in their approaches and specific objectives, can effectively complement each other to offer an enriching educational experience. Both approaches share several common elements, such as research, creativity, critical analysis, and communication of results. When integrated, they can provide a learning environment that enhances inquiry skills and design thinking in students. The main difference between IBL and EDP lies in their approach and purpose. While IBL focuses on the formulation and exploration of open-ended questions, promoting research and discovery, EDP is oriented toward solving specific problems through a structured process of design and solution construction.

G. DESIGN THINKING

Design Thinking is an approach to solve ill-defined problems that relate to humans' complex and varied needs. This approach looks at a problem from many angles, forces students to challenge assumptions, and includes various stakeholder groups in the process. Although the word 'design' often brings products to mind, here it refers to a process consisting of successive steps which must each be properly guided in order to lead to a satisfactory solution.



(extracted from Davis, B., & Francis, K., 2021).

The double diamond is a model for design thinking that helps innovators to navigate from concept to completion. It offers structure and guidance throughout the journey from problem definition to solution exploration, ensuring that no stone is left unturned when it comes to exploring the solution space. Furthermore, this model also proves its usefulness for use within STE(A)M-education. The two diamonds, as shown in the picture, represent a process of wider issue exploration (divergent thinking) followed by the implementation of focused action (convergent thinking).

Design thinking starts with a real-life, poorly structured challenge, involving many elements influencing each other. Any type of problem can be addressed (e.g. How can we transform the playground into a more exercise-friendly location? How can we waste less water at location x?). Each time, the first diamond guides users from a broader "how can we…" challenge to a more specific design question. This question is then utilized in the second diamond to inspire a variety of ideas before a selection is made.

The first phase (first diamond) helps students to understand, rather than assume what the problem is. In this phase, students investigate stakeholders and their needs, while making observations and investigating the situation. Then students use convergent thinking through an analysis of the collected data, in order to start re-defining the problem and to set clear objectives.

At the end of this part of the process, the issue should be more specific and the key factors involved in the problem should be clearly identified (e.g. There should be more space for climbing, but also for running… , Rinse water should be reused, leaks should be detected quickly, people should be more aware of the amount of water wasted…)

The second phase starts by using a range of divergent thinking tools to develop ideas about responding creatively to the problem such as brainstorming, brain sketching, idea-generation… (ex. "Trees with ladder ropes", "hills", "climbing frames" ; “collection tank for rinse water”, “rainwater collection”, “(electronic) warning system for leaking taps”, “information boards with water consumption”, “online campaign”…). It is very important to encourage students to collect a broad, diverse range of solutions. Quantity takes precedence over quality in this phase.

Once students have a collection of varied ideas, they return to convergent thinking to iterate, prototype and test their ideas. Many methods can be used during this phase, for instance: testing with stakeholders and field tests. During this iteration, students learn from their successes and failures, they test out different solutions at small-scale, rejecting those that will not work and adjust or redesign the ones that will. They do this until they can deliver a tested solution that meets the goals set at the end of the first phase.

This is not a linear process as the arrows on the diagram suggest. The phases can overlap and work together for example: making and testing very early-stage ideas can be part of discovery.

It’s worth stressing that engineering design and design thinking are both methodologies aimed at solving problems and creating effective solutions, but they differ significantly in their approaches, focus, and processes. In particular, engineering design ensures technical feasibility and reliability, while design thinking ensures user desirability and engagement. Integrating both methods can lead to holistic and highly successful solutions.

H. CODING

Computational thinking, by being tangentially related to mathematics, science and digital literacy, provides a common framework for working on a wide range of transversal skills through ICT (Paniagua et al., 2018). Coding involves two logical steps.

1) Imagining how the problem can be solved (computational thinking).

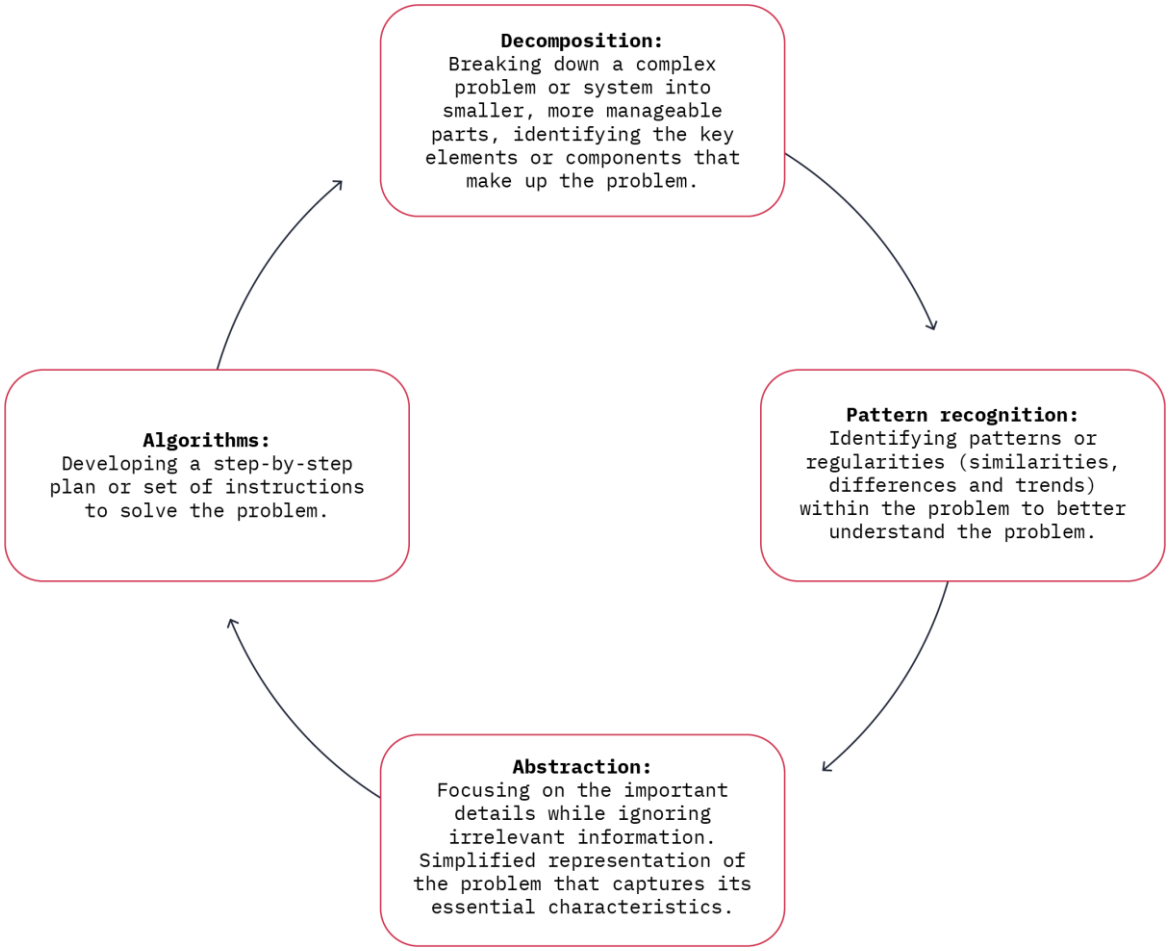
2) Transferring this problem to the computer to be solved (coding/programming).

Computational Thinking

Computational Thinking is a methodology for solving problems, designing systems and understanding human behaviour that relies on concepts specific to computer science (Wing, 2008).

The process of computational thinking consists of several components: algorithms, decomposition, pattern recognition and abstraction.

These steps are iterative and often overlapping, meaning that as you work through a problem, you might find yourself going back and forth between them. Computational Thinking is not just about solving problems with computers; it's a way of approaching problems more generally, applicable across various domains and disciplines.



Programming/ Coding

Programming can be described as: "Planning and developing a sequence of understandable instructions for a computing system to solve a given problem or to perform a specific task."[3] Programming is thus a much more complex and rich process than just coding. (Brodnik et al., 2021).

Brodnik et al (2021) identified five knowledge areas related to developing and using a program:

[3] The Digital Competence Framework for citizens (p. 33)

Algorithms

Covers the modelling of real problems as computational problems, the design and evaluation of their computational solutions, and related complexity and computability issues.

To create a method to find a path through a hedge maze, it is advisable to reduce the maze to its essential elements that are important for finding a way out. So, the kind of hedge, its height, the length and form of the paths, etc., are not relevant. Relevant for the model is the structure of the maze, i.e., which walls are connected to each other, and which part of walls are outside the maze. The computational problem is to find a wall that is outside the maze.

Programs

An algorithm needs to be translated into a programming language. The artifact resulting from this translation is the actual program, which is understood and can be executed by the automatic interpreter.

For instance, in a video game a sprite moves around. When it moves, it first makes a step with the left foot (one program instruction) and then a step with the right foot (the second program instruction). The double step represents a sequence of two program instructions. Further, when the sprite has to move for 10 double steps, it can do this with ten repetitions of the above sequence. Moreover, during its move, if the sprite bumps into a wall, it cannot take a step. To detect the wall, it checks the wall detect condition.

Relation between data and program

This area addresses how programs process abstract data to obtain output data from input data, the relationship between data and the information they represent, and ultimately the duality of being both programs and data.

A picture can be digitized as a grid of colour dots. Each colour can be modelled as a combination of three basic colours and therefore a colour dot is encoded as a triplet of numbers, indicating the brightness of the basic colours. The RGB model uses red, green and blue as basic colours.

Programs running on computers area

The focus is on the distinction between software (programs) and hardware (computing devices), and the role of programs in the use of computing devices.

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We want to play a computer game. In the first situation, we have a gaming device which is just a piece of hardware. When we switch it on, it loads and runs a piece of software like our gaming application and only then can we play the game. Conversely, in the second situation, we can have a computer game (software) on our memory stick. Until the memory stick is plugged into the device (piece of hardware), and the device loads the computer game from the memory stick and runs it, we cannot play the game either. From the above examples we conclude that we need both hardware and software to play the game.

Program execution

This area is about the execution of programs on a computing device and the effects its execution causes, including potentially malicious effects caused by malware or errors.

In the past, our text editing program crashed frequently, and we lost the result of our work. After the program upgrade this never happened again.

Coding in Ste(A)M

Focusing on the coding aspect, everything starts with teaching and practicing computational thinking. To teach computational thinking within STE(A)M, we start from a student-centred approach. There are a number of conditions necessary for the successful implementation of these lessons (Barr et al., 2011):

- **Low threshold, high ceiling**: at the start, CT should be offered in a very accessible way and with simple tools, so that everyone can take that first step without much effort. However, the lesson should also provide a high ceiling, which means that students who excel are not limited to simple introductory exercises, but can quickly move on to advanced exercises. A typical example of this is the program 'Scratch', which plays a prominent role in many studies on this subject.

- **Alternating between unplugged and plugged** exercises is very important in the development of CT. CT is a method of solving problems by means of technology (plugged), but this application can and should also be done with analogue technologies (unplugged) and not only with ICT.

- **'Use-modify-create'**[4] (Lee et al., 2011). In the "use" mode, students explore a prewritten program: predict the purpose and the expected outcome, investigate and examine the code, discuss findings and explain new concepts discovered during the exploration. In the "modify" mode, students modify a prewritten program: experiment with the program to learn more about the functionality, make changes and rerun the program, add additional code lines. In the "create" mode, students create a similar program: develop a program, test it, analyse output and errors, refine the program.

- **Game design and robotics** have often proven to be ideal starting points in the iterative process that is expected when applying ICT/Coding.

Research example

Within the STEAM-it[6] project in Flanders, some test cases were rolled out in the first grade of secondary education. Students were tasked with programming a drone to navigate a course optimally. For this purpose, students were divided into three groups.

Group 1: "low-threshold" started unplugged and learned what programming, abstracting and algorithms are. They learned to analyse the problem and divide it into sub-problems and thus divide their 'code' into small pieces and 'debug' it. After this phase, students started working with the drones and the accompanying software to program with blocks.

Group 2: "**programming with blocks**" started immediately working with the drones on the course. They were given explanations about the software and the challenges. The software used works with blocks (similar to Lego Mindstorms, Scratch...) so the effective 'code' is not visible, but the sub-skills of computational thinking are covered as much as in the effective writing of code.

Group 3: "writing code" also started working with the drones on the course. They were given pieces of code written out that they could assemble into a program or scrips. The pieces of code were accompanied by explanations, so the pupil understood that the code was for and how it was structured.

Results: Group 1 achieved similar results to group 2 in the drone course, even surpassing the other group in some cases. These students were found to show stronger insights into computational thinking than the students from group 2.

Group 3 was less successful in the course than the other groups. While the students show a stronger understanding of what effective code programming is, they do not demonstrate a greater understanding of the sub-skills of CT than the other groups.

Conclusion: Providing a clear insight into and naming the sub-skills of computational thinking appears to already result in a higher learning effect.

[4] https://ellipsiseducation.com/blog/use-modify-create-framework

APPLICATIONS

A. MAIN TOPICS

Six secondary schools from Spain, three from Slovakia, and two from Belgium, chosen by each project partner, participated in the study to determine which were the main topics they'd like to address in L2. They were encouraged to work within the different departments of the bilingual sections of their schools, establishing a prioritization of the relevant topics from an educational point of view. The results appear below:

1. Artistic Expression area

Priority contents	• Comic • Cultural and artistic heritage
Secondary contents	• Colour and composition • Volume

2. Physics and Chemistry area

Priority contents	• Chemical reactions • Units of measurement • Labware • Formulation • Solutions and concentration calculations
Secondary contents	• Chemistry in daily life • Applications of chemistry to the industrial world • Chemistry and the environment • Effects of chemistry on the human body: addictions • Use of the microscope

3. History and Geography area

Priority contents	• Climate emergency • The ages of history • Development and interpretation of maps • Location of continents and their characteristics • The oceans, rivers and seas • Trade routes • Contemporary history
Secondary contents	• Maps in relation to the history of Europe • Human Geography: study of demographic evolution • Promotion and conservation of cultural heritage • Art and history in the European context

4. Maths area

Priority contents	• Work methodology for problem solving • Statistics • Physical formulas • Proportionality and different types of relationships • Spatial geometry, perspective, mathematical calculations and unit conversions
Secondary contents	• Application of Mathematics in science and industry (logarithmic and exponential functions) • Current and ancient population statistics • Equations, algebra, derivates and integrals • Adaptation of materials to diversity

5. Music area

Priority contents	• Cultural differences through music • Body language • Songs in different languages • World dances and traditional local dances
Secondary contents	• Soundtracks • Music as a form of emotional intelligence • History of music

6. Natural Science area

Priority contents	• Atmosphere and hydrosphere • The cell • Ecology and sustainability • The human body
Secondary contents	• Hemophilia • Population dynamics and calculation • Biochemistry in general • Chemical reactions • Rocks and minerals • Promotion and conservation of the biosphere • Geological processes • Classification of living beings

7. Physical Education area

Priority contents	• The body and mental health • Environmental care
Secondary contents	• Body postures • Physical activity: movement related to ecology and human health • Nutrition • Alternative and inclusive sports • Self-regulation of emotional intelligence • First aid • International dances and sports • Sports as a healthy habit • The Olympic Games • Training and basic physical values

8. Technology and digitalization

Priority contents	• Work methodologies: problem-solving process • Sustainable technology: development of projects with electric and mechanical robotic systems • Computational thinking: programming and robotics
Secondary contents	• 3D printing applied to science and medicine

Highlighting these contents does not imply that there are no others that are equally applicable to the materials to be developed in the present project. Any other content can be considered, and it will not detract from the quality of the materials produced. Given the breadth and wide range of possibilities intended to be achieved in each of the learning situations to be developed, other contents not mentioned in the study can be implemented, undoubtedly complementing a wide and high-quality offering.

B. SELECTED EXAMPLES

On the following pages we present some examples that have been used in the classroom and that combine several of the elements highlighted in the framework we have presented here.

Title/name	**Clil & ibse methodologies in a chemistry learning unit**
School Author(s)	**Andrea Checchetti,Bruno Maria Clotilde, Instituto d' Istruzione SUperiore Leonardo Da Vinci.**
Origin of the project/ activity	The authors present a project work in which they offer their students of technical school a learning unit, called "Spectroscopy", combining CLIL methodology with IBL methodology. By using the IBSE methodology, the authors involve students in a series of activities of observation, exploration, use of computer equipment, data processing, reflections which will allow them to acquire the content through foreign language communication.
Age of the students and level	5th year of Secondary Education. 18-year-old students, with a poor motivation and Lower-B1 linguistic skills.
Degree of integration – explicit mention of the subjects/areas integrated	Chemistry +CLIL + IBSE (English) High integration of Chemistry & English
Duration	5 lessons (stages) of 60/90 minutes, developed during three weeks.

Place	Classroom / Virtual and Chemistry Lab
Short description of the activity	"Chemistry, CLIL and IBL" project work, propose a lesson on spectroscopy, to combine CLIL and IBSE methodologies using ICT tools in order to engage and motivate students in both science experiences and foreign language communication.
Activity outcomes	Students will: • be able to identify light as a form of energy • be able to describe importance and impact of light on human life • understand reflection of light • understand how the light interacts with matter • demonstrate that light travels in all directions away from a source
Cognitive aspects: Learning objectives of all the subjects	By the end of the unit students will be able to achieve teaching aims that include content (C) and language (L): • Classify EMw according to their wavelengths or frequencies (C) • Describe relationships between wavelength, frequency and energy(C) • Estimate complementary colour of a substance(C) • Correlate the absorption to the concentration (C) • Draw the block diagram of a double-ray UV-Vis spectrophotometer(C) • Discuss the phases of experimental activity(L) • Apply analytical procedure, working with order and security (C) • Write a lab report using specific vocabulary (L) • Explain their lab experiment in front of peers (L)

STEM skills and crosscutting concepts addressed	<u>All STEM skills</u> Crosscutting concepts • Cause and effect: mechanism and explanations. • Scale, proportion and quantity
Digital content/skills	• Browsing, searching and filtering data, information and digital content. • Evaluating data, information and digital information. • Sharing and collaborating through digital technologies.
Sustainability competences	Not addressed since the problem is not adequate
Contents addressed in STEM subjects	<u>Chemistry/Physics</u> • EMw and EMspectrum: blue and red radiations, UV, IR., etc. • Property of EMw: Wavelength, Frequency, Energy. • Complementary colours. • Transmittance and absorption. • Lambert-Beer law: relationship between concentration and absorption.
CLIL approach Language for learning	• How to compare different EMw through their properties. • How to carry out an experiment to calculate concentration. • Asking questions, debating, chatting, enquiring, thinking, memorizing,...
CLIL approach Language through learning	• Expressing their opinions: I think that, in my opinion, form my point of view,... • Explaining the processses: first , second, next.....

CLIL approach Language of learning)	Key vocabulary and terms related to the topic: EMws, property of EMw, analysis tecniques, lab equipment, lab processes.
CLIL Approach (subjects in L2; materials used; coordination among teachers, . .)	Students undertake active guided experimentation that involves a series of suitable scaffolding, both linguistic, procedural and multimedia aids. It is also necessary to integrate content and thinking skills, using a taxonomy. The right combination of CLIL and ISBE methodologies allows: • To activate prior knowledge • Continuity and progression of contents • Interrelation of contents • Activity (student-centred learning) • Personalized learning • Socialization • Functionality of learning • Sequencing of the activities and organization of time • The role of the teacher as a guide
Assessment	The teacher evaluates students by crossing data obtained from: • Observing how they work during practical activity (interest and • participation) - Progress report A • Observing how they learn to write scientific explanations linking their hypotheses to the evidence collected during the investigation phase - Progress report B • The results of final test - Progress report C
Materials / Resources / technical requirements	All materials are uploaded to the following Platform http://graasp.eu/spaces/570208cbc831445e00a05003 1) Video + Worksheet 1

	https://edpuzzle.com/media/56ffcfbd8ad0ee39419f9ec3 2) Template 3) Worksheet 2 4) Worksheet 3 5) Homework: Use of concept mapper tool
Financial resources	This work was supported by the Istituto d'Istruzione Superiore "Da Vinci-Nitti" of Cosenza (Italy) and the Istituto d'Istruzione Superiore "Leonardo da Vinci" of San Giovanni in Fiore (Italy).

Tips for educators / theoretical background or curriculum context	• CLIL forces non-native students to be involved in an L2 context, in which they should use the L2 for reading, writing and talking during the unit.
	• L2 becomes another support, a futher scaffolding in addition to ICT
	• The key concepts are essentially two:
	  ○ **Scaffolding** : to make language easier for learners
	  ○ **Taxonomy:** to engage learners with different kinds of tasks.
	• It is necessary to provide a suitable scaffold for the use of language, that could be verbal (such as writing prompts or definitions, metalinguistic clues,...), procedural (such as dictogloss, mutual dictation...) or learning tools (such as a graphic organizers , visuals)
	• Provide students with series of tasks, according to new Bloom´s Taxonomy to promote adquisition of LOTS (Lower Order Thinking Skills) and HOTS (Higher Order Thinking Skills)

Impact of the activity	The work was published in European Journal of Research and Reflection in Educational Sciences.
Links and Photos	https://www.researchgate.net/publication/315076781_CLIL_IBSE_METHODOLOGIES_IN_A_CHEMISTRY_LEARNING_UNIT

Reference	Bruno, M.C. & Checcheti, A. (2016). CLIL & IBSE methodologies in a chemistry leanring unit. *European Journal of Research and Reflection in Educational Sciences, vo. 4 nº 8.*

Title/Name	Applying CLIL to a history lesson
School Author(s)	**University of Cambridge ESOL Examinations**
Origin of the project/ activity	This lesson was developed as an example to explain how to apply CLIL to history and published in Teaching History through English- a CLIL approach (University of Cambridge). This book was written by experienced CLIL teachers and was designed to help CLIL teachers teach history through the medium of English.
Age of the students and level	12-13 y.o
Degree of integration – explicit mention of the subjects/areas integrated	History – CLIL (English) Interdisciplinarity among History, Art & English Crosscurricular links to geology, biology, arts and geography.
Duration	3-4 clases 60-90 min
Place	Classroom
Short description of the activity	The main lesson is about how people lived in the Paleolithic Age. The follow-up lesson is a cross-curricular lesson on Paleolithic art.
Activity outcomes	• Communicate information about life in the Paleolithic Age • Analyse historical sources and interpret how people lived • Use ICT to gather and select information about the Paleolithic Age • Transfer information from texts and sources to a fact file • Collaborate with a peer to check one another's work • Create index cards.

Cognitive aspects: Learning objectives of all the subjects	• To know about some aspects of life and art in the Paleolithic Age. • To be able to analyse historical sources in order to interpret how people lived. • To be able to use ICT for historical enquiry: to gather and select information. • To be able to transfer historical information from text to notes. • To be able to create a fact file by locating, selecting and organising historical information.
STEM skills and crosscutting concepts addressed	STEM skills: Asking questions and defining problems. Identifying issues related to life and art in the Palaeolithic Age. **Planning and executing research**. Explaining the process of water cycle. Planning the fieldwork. **Analyzing, predicting and interpreting data.** Analysing historical sources and interpreting how people lived. Collecting data and transferring historical information form text to notes. **Argumentation based on evidence**. Using evidence to support arguments about how people lived **Crosscutting concepts** **Scale, ratio and Quantity:** Comparing data in a mapline.
Digital content/skills	Browsing, searching and filtering data, information and digital content about the Paleolithic Age.
Sustainability competences.	Not explicitly addressed. Nevertheless, if the problem proposed is, for example, how sustainable was the life in the Paleolithic Age?

Contents addressed in STEM subjects	The Paleolithic Age related to social sciences, biology, geography and arts.
CLIL approach. Language for learning	• How to compare notes with mates, analyse historial sources and interpret how people lived,... • Answering LOTS and HOTS questions, debating, chatting, enquiring, thinking, memorizing,... • Summarising information and note -taking.
CLIL approach. Language through learning	• Expressing their opinions about possibillities in the past. • Communicating feedback to partner.
CLIL approach. Language of learning	Key vocabulary and terms related to the Palaeolithic Age: nomadic, outdoors, caves, woodhuts,...
CLIL Approach (subjects in L2; materials used; coordination among teachers, . .)	• Language teachers work on structures and vocabulary necessary for the subject-content lessons. • English as the medium of instruction for History. • Use worksheets, visuals, timeline, maps... to support learning. • Coordination between language and history teachers. • Use of L1 is accepted.
Assessment	Formative, ongoing classroom assessment by teachers and peers is a valued part of learning. Teachers could prepare a checklist of outcomes and write the date when there is evidence that the learner is working towards achievement of the learning outcome. (There is an example on the document).
Materials/ Resources/ technical requirements	Worksheets, ICT devices, maps, and cards.

Financial resources	Not mentioned
Stakeholders	CLIL teachers, students,preservice teachers,...
Tips for educators / theoretical background or curriculum context	Considerations when planning a CLIL history lesson: • Activating prior knowledge. Teachers need to find out what students already know about the topic. • Teachers need to plan the students input and output. • Wait time refers to the time teachers wait between asking questions and students answering them . In a CLIL lesson, a longer time than usual is needed so that students can process new subject concepts in a new language. • Collaborative tasks involve students in producing key subject-specific vocabulary and structures in meaningful pair and group work activities. • Cognitive challenge. Students need considerable support to develop their thinking skills in an L2. They need to communicate the everyday functional language and the academic language of school subjects. Providing scaffolding is very important and a challenge to CLIL teachers. • Developing thinking skills. Teachers need to ask questions which encourage lower order thinking (LOTS) and higher order thinking skills (HOTS)
Impact of the activity	To help teachers teach history through English. To provide useful tips and guidelines on how to develop activities and resources in support of a CLIL approach.
Links and Photos	The lesson includes pictures and visuals.
Reference	University of Cambridge ESOL Examinations (2011). Applying CLIL to a history lesson. *Teaching History through English- A CLIL approach*. (15- 22).

Title/Name	Characteristics of Angles
School Author(s)	**Sydney Sioen**
Origin of the project/ activity	The activity is designed for second-grade secondary education students in Flanders, focusing on the characteristics of angles within the mathematics curriculum. The lesson is created as part of an internship.
Age of the students and level	13-15 years, second grade secondary education - Curriculum Flanders.
Degree of integration – explicit mention of the subjects/areas integrated	Math – CLIL (English)
Duration	1 lesson (50 minutes)
Place	Classroom
Short description of the activity	This activity focuses on teaching students the characteristics of different types of angles. It includes revision, theory, exercises, and a gamified learning experience through Mathopoly to reinforce understanding and prepare for assessments.
Cognitive aspects: Learning objectives of all the subjects	Content: • Recognize different types of angles. • Draw angles with specified measures. • Identify adjacent, vertical, and straight angles. • Understand the properties of adjacent, vertical, and straight angles. • Measure angles accurately. • Recognize supplementary and complementary angles. Language: • Use correct English terminology for angles.

	• Explain differences between types of angles in English.
STEM skills and crosscutting concepts addressed	Crosscutting Concepts: • Energy, Matter, and Objects: Understanding how different types of angles interact and their properties (e.g., adjacent angles sharing a common arm). • Cause and Effect: Analyzing how changing one angle affects the properties of adjacent or complementary angles. • Patterns: Recognizing patterns in angle measures and relationships (e.g., the sum of angles in a triangle). • Scale, Ratio, and Quantity: Measuring angles accurately and understanding their relative sizes. • Systems & Models: Using models to represent angles and their relationships, such as in the Mathopoly game. STEM Skills: • Asking Questions and Defining Problems: Encouraging students to ask questions about why angles have certain properties and how they relate to each other. • Mathematical Reasoning and Algorithmic Thinking: Applying logical reasoning to solve problems involving angles and their measurements. • Argumentation Based on Data: Justifying the properties of angles using measurements and observations. • Collecting, Evaluating, and Communicating Information: Recording measurements of angles and explaining findings in both English and mathematical terms.

Digital content/skills	Use of interactive content such as Mathopoly for gamified learning.
Contents addressed in STEM subjects	• Types of angles • Properties of angles • Measurement of angles
CLIL approach Language for learning	• Use of English terminology for types of angles and their properties. • Naming and explaining angles in English
CLIL approach Language through learning	• Communicative activities like games to practice language skills. • Group work to enhance collaborative learning in English
CLIL approach Language of learning)	• Specific vocabulary related to angles (e.g., adjacent, vertical, straight, supplementary, complementary). • Sentence structures used to describe and explain angles
CLIL Approach (subjects in L2; materials used; coordination among teachers, . .)	• Mathematics taught using English as a medium of instruction. • Materials include the Characteristics of Angles course and Mathopoly. • Coordination between Mathematics and English teachers for vocabulary and language support.
Materials / Resources / technical requirements	• Interactive whiteboard • Mathopoly game (digital or printed version) • Geometry tools (protractors, rulers) • Characteristics of Angles course material
Financial resources	Minimal, primarily for printing game materials if necessary.

Tips for educators / theoretical background or curriculum context	• Ensure students are familiar with basic angle concepts before starting. • Use visual aids and interactive content to enhance understanding. • Encourage the use of English throughout the lesson to reinforce language skills
Impact of the activity	• Improved understanding of angle properties and types. • Enhanced ability to use mathematical vocabulary in English. • Increased student engagement through interactive and gamified learning
Links and Photos	Mathopoly: Mathopoly Game

POSSIBLE EXTENDED PROJECT

PROJECT TITLE: SUSTAINABLE STRUCTURES AND ANGLES

Overview:

This project integrates the study of angles with sustainability and digital skills. Students will explore the role of angles in building sustainable structures, using digital tools to design and analyze their models. The project will help students understand the importance of geometry in real-world applications and sustainability.

Activities:

1) Introduction to Sustainable Architecture

- Research sustainable buildings and how their design utilizes angles for energy efficiency.
- Discuss the importance of sustainability in architecture.
- Identify different types of angles used in building designs.

2) Designing a Sustainable House

- Use a CAD software (like SketchUp) to design a model of a sustainable house.
- Incorporate various types of angles in the design.
- Ensure the design maximizes natural light and reduces energy consumption.
- Present the design, explaining the choice of angles and sustainability features.

3) Analyzing the Energy Efficiency of Designs

- Activity:
  - Use simulation software to analyze the energy efficiency of the designed house.
  - Calculate the angles of incidence of sunlight and their impact on heating and cooling.
  - Compare different designs and their energy efficiency.

4) Building a Prototype

- Activity:
  - Construct a physical prototype of the house using recyclable materials.
  - Measure and verify the angles used in the design.
  - Test the prototype for stability and energy efficiency features.

5) Digital Presentation and Collaboration

- Create a digital presentation of the project using tools like PowerPoint or Prezi.
- Include data analysis, design process, and sustainability features.
- Collaborate with classmates to review and provide feedback on each other's designs.

6) Reflecting on Sustainability and Future Applications

- Activity:
  - Reflect on how the project addresses sustainability.
  - Discuss potential future applications of the designs and concepts learned.
  - Write a report summarizing the project, the importance of angles in sustainable design, and potential improvements.

Integrating Sustainability Competences:

- Activity: Discuss the environmental impact of building materials used in prototypes.

Title/Name	Applying CLIL to a geography lesson
School Author(s)	**University of Cambridge ESOL Examinations**
Origin of the project/ activity	This lesson was developed as an example to explain how to apply CLIL to a geography and published in Teaching Geography through English- a CLIL approach (University of Cambridge). This book was written by experienced CLIL teachers and was designed to help CLIL teachers teach geography through the medium of English.
Age of the students and level	10-12 y.o
Degree of integration – explicit mention of the subjects/areas integrated	Geography + natural Sciences + CLIL (English) Natural Sciences and mathematics are complementary to Geography + English. Nevertheless, more emphasis can be developed in both (math and natural sciences) if desired. Crosscurricular links: biology and physics and chemistry and mathematics.
Duration	3 lessons 60 min plus the time to develop the fieldwork.
Place	Classroom and riverbank
Short description of the activity	It is an application of CLIL to a geography lesson about rivers. It begins with the introduction of the vocabulary; follows by discussion and diverse graphs interpretation about rivers. It continues with class demonstrations of the cycle of water, relating these concepts with the flow of rivers. Finally, it includes the possibility to do a fieldwork, inquiring about the erosion of the local river.
Cognitive aspects: Learning objectives of all the subjects	• To understand that equations explain the relationship between coordinate pairs. • To become familiar with the basic terminology of rivers.

	• To know how to explain and interpret a range of diagrams. • To understand the concept of the water cycle and understand that water changes its physical state within the cycle. • To observe, collect data and make notes about the features of a local river. • Learn vocabulary about the phenomena studied.
STEM skills and crosscutting concepts addressed	*STEM skills:* Asking questions and defining problems. Identifying issues related to rivers and water cycle. Planning and executing research. Explaning the process of water cycle. Planning the fieldwork. Analyzing, predicting and interpreting data. Interpret a range of diagrams. Colleting data and making notes about the features of a local river. Colleting data during the fieldwork. Argumentation based on evidence. Using evidence to support arguments about rivers and water cycle in the fieldwork. *Crosscutting concepts:* Energy, matter and objects: Understanding about rivers and water cycle process. Stability and change Understanding the change of water. Scale, ratio and Quantity: Comparing quatities of water in the world.
Digital content/skills	No mention, but can be introduced. For example, for presenting diagrams and the fieldwork through ICT or studying the bankriver from Google Earth application-
Sustainability competences;	No mention, but can be introduced if the problem is addressed, for example, like this. How does the city

	contribute to the actual river running? How does this actual running affect the life?
Contents addressed in all subjects	Geography: • Elements of the rivers and erosion and deposition Natural Science o Water cycle
CLIL approach. Language for learning	• Answering LOTS (lower order thinking skills) and HOTS (higher order thinking skills) questions, predictions, debating, chatting, enquiring, thinking, memorizing, guessing… • Describing the water cycle process. • Interpreting maps, diagrams,
CLIL approach. Language through learning	• Expressing their opinions. • Communicating feedback to partner.
CLIL approach. Language of learning	Key vocabulary and terms related to the topic (rivers, water cycle) : confluence, delta, estuary, meander,… Language structures for discussing and proposing ideas.
CLIL Approach (subjects in L2; materials used; coordination among teachers, . .)	• Language teachers work on structures and vocabulary necessary for the subject-content lessons. • English as the medium of instruction. • Use worksheets, visuals, timeline, maps… to support learning. • Coordination between language and geography teachers. • Use of L1 is accepted. • An extension activity is included with an investigate approach. A geography fieldwork will be very useful to include opportunities for experiential learning.
Assessment	Formative, ongoing classroom assessment by teachers and peers is a valued part of learning. One effective type of formative assessment is performance assessment that

	involves students demonstrating their knowledge of content and language. It can be used to evaluate development of communicative and cognitive skills as well as attitude towards learning. Maps can be used to evaluate by asking students to label them with the river's elements. Games can be used to consolidate and evaluate the learning process as a domino game.
Materials / Resources / technical requirements	Atlas maps, survey map, photographs, brainstorming, diagrams, ...
Tips for educators / theoretical background or curriculum context	Considerations when planning a CLIL geography lesson: • Activating prior knowledge. Teachers need to find out what students already know about the topic. • Teachers need to plan the students input and output. • Wait time refers to the time teachers wait between asking questions and students answering them . In a CLIL lesson, a longer time than usual is needed so that students can process new subject concepts in a new language. • Collaborative tasks involve students in producing key subject-specific vocabulary and structures in meaningful pair and group work activities. • Cognitive challenge. Students need considerable support to develop their thinking skills in an L2. They need to communicate the everyday functional language and the academic language of school subjects.Providing scaffolding is very important and a challenge to CLIL teachers. • Developing thinking skills. Teachers need to ask questions which encourage lower order thinking (LOTS) and higher order thinking skills (HOTS)
Impact of the activity	To help teachers teach geography through English. To provide useful tips and guidelines on how to develop activities and resources in support of a CLIL approach.

Links and Photos	The lesson includes pictures and visuals.
Reference	University of Cambridge ESOL Examinations (2011). Applying CLIL to a history lesson. *Teaching Goegraphy through English- A CLIL approach*. (16- 26).

Title/Name	**Reducing Plastics to Protect Our Oceans**
School Author(s)	**Jessica Morseau**
Origin of the project/ activity	The lesson was developed as an example lesson as part of the teacher training Howest (Belgium).
Age of the students and level	11-14 year-olds, First grade secondary education - Curriculum Flanders.
Degree of integration – explicit mention of the subjects/areas integrated	Natural Science – CLIL (English)
Duration	1 lesson (50 minutes)
Place	Classroom
Short description of the activity	Introduction (15 minutes) Show a short video on the impact of plastic pollution on marine life. • Ensure the video includes key vocabulary terms such as "plastic pollution," "marine life," "single-use plastics" "recycling," "biodegradable," "microplastics," and "waste management." (ex. https://www.youtube.com/watch?v=6HBtl4sHTqU&ab_channel=Seeker)

Discuss students' initial thoughts and feelings about the video.

Guided observation

- Provide some good comprehension questions, but also for example a vocabulary matching exercise. Make sure keywords are included in the activities with the video. Make sure the keywords are discussed before moving one.
- Example comprehension questions:
  - What is the Great Pacific Garbage Patch?
  - How does plastic pollution affect marine life?
  - What are some examples of single-use plastics mentioned in the video?
  - What can people do to reduce plastic pollution?
- Vocabulary matching: Gap fill activity to reinforce understanding of key vocabulary related to plastic pollution and environmental protection.

Research and Discussion (15 minutes)
Assign each group a specific question to research (e.g., "How does plastic pollution affect marine life?" or "What are some alternatives to single-use plastics?").

Provide graphic organizers such as Venn diagrams, cause-and-effect charts, or mind maps to help students organize their research findings.

- Venn diagram: to compare and contrast different types of plastics and their environmental impacts.
- Cause-and-effect chart: to outline the causes of plastic pollution and its effects on marine life.
- Mind map: to brainstorm and categorize alternatives to single-use plastics.

Groups present their findings using the graphic organizers to support their explanations and discussions.

Additional resources to support language output during research and discussion:

	Sentence starters and frames: Provide sentence starters and frames to help students construct sentences during discussions and presentations. For example: "One way plastic pollution affects marine life is..." "An alternative to single-use plastics is..." "We can reduce plastic use by..." Poster Creation (10 minutes) • Students create posters promoting ways to reduce plastic use and protect the oceans. • Display posters around the classroom or school to raise awareness. Conclusion and Reflection (10 minutes) • Summarize the key points discussed in the lesson. • Reflect on how students can implement the solutions in their daily lives. • Encourage students to share their posters and ideas with their families and communities.
Cognitive aspects: Learning objectives of all the subjects	Content: • Understand the impact of plastic pollution on marine environments. • Identify daily habits that contribute to plastic waste. • Propose actionable solutions to reduce plastic use and prevent water pollution. Language: • Use specific vocabulary related to plastic pollution and environmental protection. • Develop skills in discussing, hypothesizing, and proposing solutions in English. • Enhance reading, writing, listening, and speaking skills through various activities.

STEM skills and crosscutting concepts addressed	Crosscutting Concepts: • Energy, Matter, and Objects: Understanding the materials that constitute plastic and their impact on the environment. • Cause and Effect: Analyzing the causes of plastic pollution and its effects on marine life • Patterns: Recognizing patterns in plastic waste production and pollution • Scale, Ratio, and Quantity: Comparing quantities of plastic waste and its distribution. • Systems & Models: Using models to represent the impact of plastic pollution and potential solutions. STEM Skills: • Asking Questions and Defining Problems: Identifying issues related to plastic pollution and formulating research questions. • Mathematical Reasoning and Algorithmic Thinking: Analyzing data related to plastic pollution. • Argumentation Based on Data: Using evidence to support arguments about the impact of plastic pollution. • Collecting, Evaluating, and Communicating Information: Researching and presenting findings on plastic pollution. • Developing and using models: Creating models to demonstrate the effects of plastic pollution and solutions. • Planning and executing research: Conducting research projects on specific questions about plastic pollution. • Building Statements and Designing solutions: Proposing and designing actionable solutions to reduce plastic use.

Digital content/skills	• Browsing, searching, and filtering data, information, and digital content: Students search for and filter relevant information about plastic pollution.
	• Evaluating data, information, and digital content: Students critically evaluate the content and quality of videos on plastic pollution. (viewing and analyzing online videos)
	• Sharing through digital technologies: Students share their findings using digital tools.
	• Collaborating through digital technologies: Students work in groups to research and present their findings using digital organizers.
	• Developing digital content: Students create digital posters and presentations
	• Integrating and re-elaborating digital content: Students integrate information from various sources into their posters and presentations.
	• Safety **(**Implicit**):**
	  ○ Protecting devices: Ensuring safe and secure use of digital devices during research and content creation.
	  ○ Protecting personal data and privacy: Understanding the importance of protecting personal information while researching and sharing content online.
	• Problem Solving:
	  ○ Identifying needs and technological responses: Students identify and use the best digital tools to meet their research and presentation needs.
	  ○ Creatively using digital technologies: Employing creative methods to present their findings and solutions for reducing plastic pollution.

Sustainability competences;	• Understanding the importance of sustainability in daily life. • Promoting sustainable habits to reduce plastic pollution. • Encouraging community involvement in sustainability initiatives.
Contents addressed in STEM subjects	Environmental Science: • Impact of plastic pollution on marine environments. Types of plastics and their properties (e.g., biodegradable vs. non-biodegradable). Effects of plastic on marine life and ecosystems. Waste management and recycling processes. Chemistry: Composition of plastics and chemical properties. Degradation processes of different types of plastics. Biology: Effects of plastic pollution on marine organisms. Food chain disruptions caused by plastic ingestion. Geography: Global distribution of plastic pollution in oceans. Ocean currents and their role in the spread of marine debris. Mathematics: Analyzing data related to plastic waste quantities and distribution. Using statistical methods to understand the scope of plastic pollution. Technology: Researching and evaluating digital information.

	Creating digital content (posters and presentations) to communicate findings.
CLIL approach Language for learning	- Specific vocabulary related to plastic pollution and environmental protection. - Sentence starters and frames for constructing sentences during discussions and presentations
CLIL approach Language through learning	- Enhancing language skills through research, discussion, and presentation activities. - Using language to explore and understand content related to plastic pollution.
CLIL approach Language of learning)	- Key vocabulary and terms related to the topic: plastic pollution, marine life, single-use plastics, recycling, biodegradable, microplastics, waste management… - Language structures for discussing and proposing solutions.
CLIL Approach (subjects in L2; materials used; coordination among teachers, . .)	- English as the medium of instruction for Natural Science. - Use of videos, graphic organizers, and digital tools to support learning. - Coordination between language and science teachers to ensure language support in the content.
Assessment	- Participation in group discussions and activities. - Quality and creativity of posters. - Ability to use key vocabulary and language structures correctly.
Materials / Resources / technical requirements	- Videos on plastic pollution (e.g., marine life affected by plastics) - Substitution tables for sentence construction - Worksheets for categorizing plastic items - Poster-making supplies - Internet access for research - graphic organisers, vocabulary / definition list
Financial resources	Minimal, primarily for poster-making supplies and internet access
Stakeholders	- Teachers, students, and their families.

	- School community for displaying posters and raising awareness.
Tips for educators / theoretical background or curriculum context	**Some tips to do more with voc:** Plastic pollution: Show images of polluted beaches and oceans Marine life: Display pictures of sea creatures affected by plastic waste Single-use plastics: Show common items like plastic bags, straws, and bottles Interactive activity: Use a matching activity where students match the new vocabulary words with their definitions or images. This can be done using flashcards or an interactive whiteboard. **Add a list of translated or explained words** (a gloss) when necessary, or provide this useful list at the end of the handout. Provide clear definitions and examples for each key term. Use visual aids, such as images or diagrams, to reinforce understanding. **Tip for developing materials:** provide language support on the handout with the graphic organiser (see example social studies, J. Morseau)
Impact of the activity	- Increased awareness of plastic pollution and its effects. - Development of language and STEM skills. - Encouragement of sustainable habits among students and their communities.

POSSIBLE EXTENDED PROJECT

Organize a school-wide campaign to reduce plastic use, involving students in creating informative materials and leading initiatives.

Title/Name	**Je travaille pour mon compte. Je travaille pour mon patron.** **(I work for myself. I work for my boss)**
School Author(s)	**Charlotte Vanderstuyft** **IVG School Gehent**
Age of the students and level	Economics (Modern Sciences). First grade - secondary education curriculum (second year) Age: 13-14
Degree of integration – explicit mention of the subjects/areas integrated	Economics + CLIL (L2 = French)
Duration	Two lessons (100 minutes)
Place	Classroom
Short description of the activity	Part 1 (Appetizer) • Expressing opinions and agreeing. Think-Write-RoundTalk: - "Quels metiers voudriez-vous faire plus tard ? Pourqoui ?" - "Quels metiers ne voudriez-vous jamais faire plus tard ? Pourqoui ?" Part 2 (Main course) • Different statutes Roundtabele in pairs. Using 1 whiteboard and marker per pair (shoulder partners). o « Quels metiers connaissez-vous en français ? » o Student A writes 1 example on the whiteboard and passes the board and marker to student B.

	○ Student B writes 1 example on the whiteboard and passes the board and martker to student A. ○ This process reapeats until the teacher says stop. • Individual exercise in syllabus. Students try to recognize the professions in the photo and write the correct name next to it. • Review and correct as class. Difficult words go into the 'word list'. • The teacher asks the students to give examples of professions and classifies the professios on the board into 3 columns. The students guess what the difference is between the 3 professions. The teacher explains that there are 3 types of professions and writes them on the board. The vocabulary also goes into the 'word list'. • Each student in each group (of 4) delves into one type: #1 and #4 research what "un independent" is, #2 research what "un salarié" is, #3 research what "un fonctionnaire" is. • Students look for answers to the following questions in the texts in the syllabus and highlight their answer: ○ Who do they work for? ○ What are their income called? Then they fill in their found answer in the mindmap in the syllabus. • Each student explains to their group what they have found about their type of profession. • Whole-class teaching conversation: discuss together what the differences between the 3 professions are. The found keywords are written on the board. Students complete their mindmap. • Students work individually and match given professions to the correct type. • Students explore the pros and cons of 'un independent' et 'un salarié'.

	○ Each student looks for an advantage or disadvantage of 'un independent' or 'un salarié'. ○ The pros and cons are discussed in the groups. To form sentences, they use the 'toolbox' (= parts of sentences). • Whole-class teaching conversation: discuss the pros and cons as a class and write them on the board. Difficult words go into the 'word list'. • Students complete the mindmap with pros and cons. • Each student gets 3 cards. Each card has something different written on it: un indepent, un salarié, un fonctionnaire. • (There are 12 cards in each group). • Students do a RoundTalk. ○ The first student takes one of their 3 cards and gives an example of this category. They use the toolbox to make sentences. ○ Other team members express their opinions using the sentences in the 'toolbox'. If they agree with the example, the student writes their example on the back of the card. The student must also orally add one characteristic: how the income is called in what employement relationship they work, a(n) (dis)advantage... The student may use their mindmap. ○ This is repeated until all cards have an example of a profession. • When all groups are ready, the stack of cards are exchanged with another group's card (so students do not know which examples are on the cards). The game now involves playing a kind of Pictionary. ○ The first student takes a card from the stack and shows what type of profession it is. This is a kind of hint to their teammates.

	○ The student then draws the profession on the mini-whiteboard. ○ The goal is for the other students to guess the profession and if correct, they must list characteristics (how the income is called, in what employment relationship they work, or a(n) (dis)advantage. ○ This process repeats. (You can also do the same exercise but act out instead of drawing). ○ Students individually match jobtypes and professions and the type of revenue. ○ Whole-class review of these exercises. Part 3 (Dessert) • To conclude the lesson, refer back to the first questions of the lesson. Think-Write-RoundTalk: ○ Students write down their answer (must use the 'toolbox') ○ RoundTalk: students take turns answering.
Cognitive aspects: Learning objectives of all the subjects	<u>GENERAL LESSON GOAL</u> Content: Students know the different statuses in the labor market and can compare them based on advantages and disadvantages. Language: • Students use the vocabulary of 'les métiers' (language goal 1). • Students can express their opinion and use arguments to support their opinion (language goal) SECONDARY LESSON GOALS • Students explain the difference between 'un indépendant', 'un salarié', and 'un fonctionnaire':

	they name the income and clarify the type of employment relationship. • Students list the advantages and disadvantages of 'un indépendant' and 'un salarié' (not of 'un fonctionnaire').
STEM skills and crosscutting concepts addressed	Crosscutting concepts: Systems and models Skills: • Argumentation based on data/evidence (investigation – debating the (dis)advantage of different job types. • Developing and using models (creating the mindmap helps students model the different job types and their characteristics) • Asking questions and defining problems (Think – write – RoundTalk questions prompt students to explore their career preferences and reasons, defining their criteria for job satisfaction).
Digital content/skills	Not indicated, but can be addressed.
Contents addressed in STEM subjects	Students can demonstrate through examples and/or surveys that some people prefer to work for an employer while others prefer to work as self-employed.
CLIL approach Language for learning	Emphasized through structured activities like Think-Write-RoundTalk, debates, and group discussions where students use functional language to express opinions, agree, and disagree. • Classroom Toolbox: Students use specific phrases and structures to express opinions and agree or disagree during discussions and debates. Examples include phrases like "I think...", "Do you agree...?", and "What do you think about...?". • Think-Write-RoundTalk: This activity requires students to use structured language for expressing their thoughts and engaging in discussions.

	• Debate and Group Discussions: Functional language for debating and discussing the advantages and disadvantages of different professions is emphasized. • Instructions and Procedures: Language needed to follow and give instructions, such as "Write your answers in the syllabus", "Discuss in pairs", and "Explain to your group".
CLIL approach Language through learning	Facilitated by engaging students in research, presentations, and interactive activities like Pictionary, where they incidentally acquire new language while focusing on the content. • Group Discussions and Debates: Through collaborative activities, students acquire new vocabulary and language structures as they listen to peers and participate in discussions. • Research and Presentation: While researching and presenting their findings, students are likely to encounter and use new language related to professions and their characteristics. • Pictionary and Acting Activities: These activities encourage spontaneous use of language, helping students learn new terms and expressions in context.
CLIL approach Language of learning	Focused on through the introduction and use of subject-specific vocabulary and grammatical structures related to professions, employment types, and job characteristics. • Vocabulary Lists: The lesson includes specific vocabulary related to professions (e.g., independent worker, employee, civil servant) and terms for income and employment relationships (e.g., salary, earnings). • Mind Maps and Text Analysis: Students learn and use specific terminology while creating mind maps and analyzing texts about different professions and their characteristics

Materials / Resources / technical requirements	• Boîte à outils • Syllabus • Whiteboard • Cards for Pictionary
Tips for educators / theoretical background or curriculum context	<u>INITIAL SITUATION</u> <u>Content:</u> • Previous topic: 'Income from work': students have learned how to calculate a salary from gross to net. Therefore, students already know the following words: le salaire net, la cotisation ONSS, le salaire imposable, le précompte professionnel, le salaire brut, les charges patronales, l'employer, l'employeur. • Students have also seen how people with different professions earn an income (e.g., athletes earn a salary but also money through sponsorship and advertising, etc.) <u>Language:</u> • Vocabulary of 'les métiers': students have learned the following vocabulary at the beginning of this school year in French class: un comédien, un acteur, un sportif, un couturier, un chanteur, un écrivain, un politicien, un mannequin, un professeur, un avocat, un cuisinier, un pilote, un pompier, un homme d'affaires, un mécanicien, un journaliste, un peintre, une infirmière. • Vocabulary of 'les métiers': students have also learned 'le féminin du substantif' in French class. • 4 French-speaking students in the class (these students are spread out to provide support to other students if needed).
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