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CLILNetLE

Assessing disciplinary literacy with CEFR descriptors: History, Mathematics and Science

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Table of Contents

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1. INTRODUCTION

The role of language competence in school disciplines has been traditionally neglected despite the obvious fact that knowledge depends on language understanding. Even if language as a system is hard to conceptualize, it is simply wrong to assume that it has minimal importance in areas like history, mathematics, or science.

Lack of competence in a language interferes with the acquisition of content learning. For that reason, official curricula are dotted with language considerations which, nonetheless, are often random and groundless in their lack of reference to language theories. For political, social and educational reasons, learning takes place, now more than ever, in a second language; a factor which increases the need for language awareness in the disciplines.

Language deficits have been a matter of educational concern for some time with research lines like languages of schooling, language across the curriculum and several approaches like Content and Language Integrated Learning (CLIL) or English Medium Instruction (EMI). Multilingual education can be an institutional decision as is the case in the traditional European bilingual models, or rather a fact of life, an end result of mobility, migration or refugee populations, which bring with them not only heritage languages but also the need to develop the majority society language; usually the national language used as a means of instruction.

The concept of disciplinary *literacy* raises as a practical solution to language deficits in connection with other school areas. As a new term, it emphasizes two major ideas: a) the fact that language competence is gradual–absolute zerolingualism or perfect bilingualism are simply language myths–and b) the fact that general language competence can be conceptually refined with descriptors which connect communication experiences with a particular subject. This may happen because the discipline incorporates other semiotic systems as in mathematics or simply because they make use of structural and functional patterns which occur more often in one discipline: causal explanations in history, for instance.

The description of disciplinary literacy competence is the endeavor of this work. For this, we launch this exploratory study, its main objective being to establish a relationship between disciplinary discourse and the L2 competence levels formulated in the Common European Framework of Reference for Languages (hereinafter CEFR) (Council of Europe, 2001). To this end, a set of B1 and B2 descriptors for disciplinary literacy is proposed, which may be useful as a tool for gradating language competence in various disciplines and to detect the presence or absence of language features that could help to identify gaps and thresholds in academic language skills which interfere with *second language instructional competence*. Such is the term which marks the level when the vehicular language is acquired sufficiently to participate successfully in school subject matter instruction (see Rolstad, 2015, on ‘second language instruction competence’).

This will be done in three major areas: history, science, and mathematics in the belief that they may represent the major features of academic discourse.

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History is unique in its relation to language. The language of history is characterized by the presence of causality and interpretation (Achugar & Schleppegrell, 2005; Martin & Rose, 2003), which gives rise to linguistic representations such as nominalizations, cause-effect relationships within clauses, the ambiguous use of conjunctions and implicit causal and temporal organizations (Achugar & Carpenter, 2014; Lorenzo, 2017; Lorenzo & Dalton-Puffer, 2016; Coffin, 2006, 2009; Schleppegrell & Colombi, 2002). These language adjustments reflect more elaborate knowledge structures and, if used by school-level learners, indicate that students have gone beyond naïve historical perspectives, such as presentism (i.e., the belief that events only happen in the present time, with complete oblivion of the past) and dogmatism (i.e., being categorical in opinions and stances, without paying attention to nuances or other options).

Science uses expository language. It aims at the description of reality; which demands the use of complex structures and specific vocabulary, which puts heavy burden on language processing mechanisms and strains cognitive resources. Scientific communication needs to be precise, denotative, and without double meanings, elaborate figures of speech or rhetorical artifacts which blur the rendition of reality. Even if "science is not a pure form of rationality" (Lemke 2002:38), its aspiration is to provide a representation of the world. So, we need to have accurate descriptors of how cognitive discourse functions are expressed in natural languages and the difficulties which arise in multilingual situations when the language of instruction is not mastered.

Likewise, Mathematics is particular in its approach to its language requirements: Mathematics integrates multiple channels of communication and the use of multiple systems of semiotic resources. Mathematics is a purely logical system, apparently independent from our experience of the world; however, it describes worldly forms and processes. To the combination of all those systems from which a meaning making experience must result they have called *intersemiosis*. Mathematics may even do without spoken or textual modalities. Scholarly accounts exist of casual academic get-togethers of mathematicians of all nationalities who without words scribbled operations on a blackboard without the need of speech. Only laughter ensued when the solution of the mathematical challenge on the board appeared: mathematics and visual semiotic resources without verbal language had been sufficient.

Disciplinary languages are very different from one another in how they are represented in language forms. CLILNETLE members sketched an epistemological framework of content and language which started with the concept of knowledge structures of the disciplines (content) and ended with a sequence of language features at three levels (genres, cognitive discourse functions, and lexicogrammar). We applied this framework to History, hence content schemata like secession, revolution, liberation, warfare, etc, were put in relation to language units at different levels: narrative genres, functions and sentences and subclause units (Lorenzo & Dalton Puffer, 2016). The framework intends to represent the thread running from content to language which the acronym CLIL refers to. The present report fleshes out the original framework with cognitive discourse functions as they may appear in different learning situations of different disciplines. These and other elements will be discussed in turn over the next few pages.

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PRECEDENTS OF DISCIPLINARY DESCRIPTION IN EUROPEAN LANGUAGE POLICIES

In the second half of the 20th century, the European Cultural Convention committed itself to facilitating communication among citizens through the promotion of each other's languages. This venture was influenced by the rationality principle that language competence can be benchmarked and is not helped by folk theories like native accent or error-centeredness. The *threshold level* was described; a level which enables the learner to 'establish and maintain social relations with speakers of the majority language[...] to cross the threshold that separates him/her from that speaking community'. From the large-scale migration of workers from one European country to another, what the European Cultural Convention had in mind in 1971 was to establish a European framework of reference in the field of adult language teaching. (Van Ek & Trim, 1990).

This was later followed, and we rely heavily for this recount on past work of CLINETLE members, by the widely known *Common European Framework of Reference for Languages: Learning, Teaching, Assessment* was published in 2001 (Council of Europe, 2001). The CEFR is based on a communicative view of language that conceives language proficiency as comprising both linguistic competence and socio-linguistic and pragmatic competence (Bachman, 1990). A major principle in CEFR is that communication is context-dependent; therefore, the general descriptors with six competence bands described the ability of users to employ language in different situations for individual language skills: written and oral comprehension, written and oral production, and interaction (A1 and A2 for basic users, B1 and B2 for independent users and C1 and C2 for proficient users).

Certainly, a context where communication is of paramount importance is school and it is most at risk when, as is often the case, the language of instruction is not the student's first. Almost from the outset, European institutions and research in general have undertaken the project of extending the principle of CEFR to an account of discipline-related language competence in the curriculum. The Language Policy Division of the Council of Europe promoted this research under the new notion of *languages of schooling*. With that principle in mind, the language that adolescent learners needed to succeed in history, mathematics, literature, and science started to be described, see respectively, Beacco (2010), Linneweber-Lammerskitten (2010), Pieper (2010) and Vollmer (2010). Further to that, languages of schooling–as a paradigm of multilingual research–inspired many descriptions of classroom learning (see monographic volumes with the participation of CLILNETLE members in *European Journal of Applied Linguistics* in 2016 and 2017). A key aspect in the approach of the Language Policy Division is the identification of discipline-related notions for the analysis of multilingual classroom discourse, which relies on a taxonomy of discourse functions, cognitive operations, and verbal performances. The list included up to twenty-three notions, with elements far apart from one another in their discourse nature as *argue, discriminate, correlate, name, summarize,* or *quote.* Beacco (2010: 12) asserted that 'social activities involving historical knowledge can in fact be described in terms of discourse types and linguistic capacities', referring openly to the CEFR as the ideal frame for describing historical discourse.

Building upon this former work, the ECML started a research agenda to further explore descriptors. Moe et al. (2015) subsequently addressed the combination of CEFR levels (only for A2-B2) and discourse functions in the disciplines of history/civics and mathematics. Table 1 shows their descriptors for reading comprehension skills in history/civics and mathematics.

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	B1	B2
Describe	Can pass on information and briefly describe events, observations and processes. Can briefly describe a visual representation (a graph, a figure, a table, a drawing, etc.), pointing out important features. Can describe how s/he is thinking when solving a task in a straightforward way	Can pass on detailed information. Can give clear, detailed descriptions of events, observations and processes. Can describe a visual representation (a graph, a figure, a table, a drawing, etc.) in detail, pointing out both important features and significant details. Can describe in detail how s/he is thinking when solving a task
Explain	Can explain and give reasons for why things, related to history/civics or mathematics, are the way they are, and why something is a problem in a straightforward way	Can explain different phenomena (for instance, historical or mathematical processes), results or views on topical issues clearly. Can give the advantages and disadvantages of various solutions and options
State facts, outline, give an account of something	Can give a short account of plans and actions. Can give a brief outline of an issue or a problem	Can give an account of or outline an issue or a problem clearly
Express opinions, discuss	Can explain in writing why s/he is for or against something in a straightforward way	Can discuss subject-related concepts and issues in detail, for instance, democracy, the relationship between love and sexuality (history/civics) or solutions to mathematical problems or different ways of presenting data
Summaries	Can paraphrase short written passages in a simple fashion, using the original text wording and ordering. Can collate short pieces of information from several sources and summaries them in writing	Can summaries a wide range of information and arguments from a number of sources
Define	Can define mathematical or historical concepts in writing in a straightforward way	Can define mathematical or historical concepts in writing in a detailed way. Can support a definition with detailed illustrations and examples
Organize	Can organize the text with an introduction, main part and an ending	Can produce continuous writing which is generally intelligible throughout and organize the text in a structured and logical way
Evaluate, interpret	Can give some reasons for why a source is reliable, or why something is an advantage or a problem	Can evaluate different sources or ideas and solutions to a problem. Can make hypotheses about causes, consequences and hypothetical situations
Compare and contrast	Can compare and contrast different alternatives and solutions in a straightforward way	Can compare and contrast alternatives, solutions, views, sources, etc. in a thorough way

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Work with forms, tables, charts, graphs	Can fill in forms and charts with relatively detailed information responding to subject tasks. Can create tables, charts, etc. and organize information in a straightforward way	Can create tables, charts, etc. and organize information (for instance, comparing and contrasting information) with recipients in mind

Table 1. Moe et al.'s (2015) descriptors for reading comprehension skills in history/civics and mathematics at B1 and B2

For all its virtues, this table cannot represent a final proposal. The first limitation is that the descriptors are not sensitive to disciplinary literacy, as history is blended with mathematics. This, we believe, overlooks the linguistic structure of discourse in that they do not mention any disciplinary information on the language features most frequently employed in each competence band. This limitation also means that parallels with curriculum are less likely. Finally, the conceptual basis of the function listed is very doubtful since they mix academic skills like descriptors for *work with forms, tables, charts, graphs*; information management dexterities (summarize) and actual cognitive discourse functions (explain).

What CLILNETLE intends to offer now is a precise characterization of disciplinary language which links up with a comprehensive taxonomy of discourse functions as provided by Dalton-Puffer (2013). This author set out to bring some order and create a shared basis of labels, systematizing and condensing previous constructs into a manageable number of prototypes (See also a revision of her work in Bauer-Marschallinger, 2022). She reviewed fifteen different frameworks, accounting for 57 academic language functions, and proposed a construct for cognitive discourse functions (CDFs). She conceived CDFs as language patterns "which have crystallized in response to recurrent situative demands in a context where participants have recurrent purposes for communicating" (Dalton-Puffer, 2013:231). The CDFs construct was based on only seven types of functions, each of them resting upon a communicative intention regarding content knowledge. Table 2 displays the construct of CDFs (Dalton-Puffer & Bauer-Marschallinger, 2019), also providing examples of CDF verbs.

communicative intention	**type**	**examples of CDF verbs**
I tell you how we can cut up the world according to certain ideas	**CATEGORIZE**	classify, compare, contrast, match, structure, categorize, subsume
I tell you about the extension of this object of specialist knowledge	**DEFINE**	define, identify, characterize
I tell you details of what I can see (also metaphorically)	**DESCRIBE**	describe, label, name, specify
I tell you what my position is vis a vis X	**EVALUATE**	evaluate, judge, argue, justify, take a stance, critique, comment, reflect
I tell you about the causes or motives of X	**EXPLAIN**	explain, reason, express cause/effect, deduce, draw conclusions

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I tell you something that is potential (i.e., non-factual)	**EXPLORE**	explore, hypothesize, predict, speculate, guess, estimate, simulate
I tell you sth. external to our immediate context on which I have a legitimate knowledge claim	**REPORT**	report, inform, recount, narrate, present, summarize, relate

Table 2. The CDF construct (Dalton-Puffer & Bauer-Marschallinger, 2019)

This frame had great epistemological and practical value, and is becoming the default construct for the analysis of learner productions (see Breeze & Dafouz, 2017; Doiz & Lasagabaster, 2021; Llinares & Nikula, 2023.

Further to that, Alba-Quiñones et al. (2018) created for Spanish, a set of B1 and B2 descriptors for historical literacy in heritage learners of Spanish and they were later adapted for students of history through English in bilingual programs. Therefore, as in a chain of academic events, these milestones mark the evolution of educational language policymaking on the continent, bringing to light the many approaches to literacy, biliteracy and multiliteracies in the school setting and in social life in general. This CLILNETLE work makes a humble contribution in that sense, proposing a set of B1 and B2 descriptors for historical, mathematical, and scientific literacy in relation to CDFs.

THE ORGANIZATION OF THE GRID

This work intends to make progress in the linguistic mapping of the disciplines across language levels. It links language factors with content factors and hence may contribute to a better understanding of language as a mediator of learning. It cannot possibly be a comprehensive map of the terrain of content and language integration, which would need the consistent (automated) analysis of language features of subject-specific corpora. However, it can offer insights into commonalities across languages, disciplines and educational traditions.

Prior to the presentation of the grids in the following chapters, the following must be considered. What follows constitutes the theoretical underpinnings of the charts.

- ***Disciplines***: As was mentioned, previous attempts of disciplinary language description stemmed from the principle that "language requirements are the same in history and mathematics" (Moe et al., 2015: 26); an appreciation later complemented by their stance that some functions are of different relevance across disciplines. As an example, they signal that the expression of arguments may be more relevant for mathematics than for history or a discussion more relevant for history and civics than for mathematics. The present work, though, considers that each discipline engages with language in its own different manner. History relies on language to the extent that discipline is said to come to nothing in the absence of narration. Without language there is no history and without the right language resources to convey the past (structures and functions), an account of reality cannot be provided. Unlike that, mathematics as was mentioned earlier can manage without language of any kind in many tasks to the extent that mathematics constitutes an autonomous semiotic system. Each discipline performs CDFs in its own prototypical form.

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Likewise, a principle in multilingual education is that content comes first. It is the area content which maps the language needed for the expression of facts (in history) or operations (in mathematics). Some content experts in the field of mathematics have provided a full framework for mathematical content and language correspondences at CEFR B1 and B2 (Fedriani et al. 2023. See also http://mathlanguagelevel.com/). They hold that key B1 language skills are needed for algebra and mention expressions such as for *all, exists, such that, implies, then, if and only if, commas and other connectors*, etc. Other mathematical concepts operate at B2 level and demand language resources. For *Fundamentals of Logic and Set Theory* certain words are needed: expressions like union, intersection, included, included or equal, necessary condition, sufficient condition, etc.
Of course, this needs to be put to the test by means of language screening of disciplinary input but the awareness that content even in the autonomous discipline of mathematics is supported partly at least by language structures is a step forward in mathematical multilingual education.

- ***Levels***: The CEFR distributes language learners into three groups according to their language competence. Basic users (A1 and A2), independent users (B1 and B2) and advanced users (C1 and C2). This work proposes a description of independent students; at B1 and B2. The tenet is that there exists a watershed between B1 and B2 regarding their ability for content learning through an L2. At the lower level of independent users, students have less control of the language for learning and more serious limitations to absorb elaborate content of a discipline as it usually occurs at school. By setting on B1 and B2, this work intends to focus on a major transition in school life; when narrative language becomes expository language; that is, when the *learning to read* stage is mastered and now, they need to *read to learn*. Or in other words, learning *to use the language* as opposed to *using the language to learn*. As a reference –drawing on the ECML publications cited above– B1 is the level required in history/civics and mathematics for 12/13 and B2 for 15/16-year-old learners. To frame these two levels in the context of educational linguistics, B1 level has just passed the *restricted code* and B2 marks the entrance in the *elaborate code* (Moe et al. 2015 refer to BICS as in Cummins, 2003 vs CALP, which is fine too). These two levels operate therefore at different stages of the threshold that European language policies aimed for. Then and now the reason is similar; it is at this level when students can use texts to function in social life and can navigate the language challenges to succeed in education.

- ***Process***: In the words of one of its creators, "the CEFR is context neutral – it needs to be applied to and interpreted with regard each specific educational context in accordance with the needs and priorities specific to that context" (North et al. 2020: 13). For disciplinary literacies, the specificities relate to the curriculum as it operates in school planning. The Council of Europe invited the application of CEFR to other situations; especially those with a clear social significance for integration such as school success. Therefore, the creation of disciplinary literacy descriptors is appropriate.

For the construction of the grids, a full validation cycle was followed. It started with the creation of a mixed research team of historians and linguists. Next, there was familiarization with the CEFR general descriptors and the *specifications of descriptors* for the said discipline. To this followed a *standardization by expert judgments* with samples of students' narratives and the *empirical validation* with samples of a historical corpus constructed to that effect. A full account of the procedure appears in De Alba-Quiñones et al (2017). The population sample was heritage learners of Spanish at tertiary level with L1 English as part of a study abroad course taking courses of Hispanic Culture and History. The same grids were put to the test and proved to be consistent in a different population as described

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in Granados & Lorenzo (2024); this time learners of secondary education in a mainstream English CLIL program. Even though the total validity, consistency and stability of the constructs depends on their consistency with larger corpora, this work constitutes a first step within the remit of the levels and disciplines described.

THE COMPONENTS OF THE GRID

Now the different components of the table will be considered with comments on each column at a time.

- ***Cognitive discourse functions:*** the present work –which heavily relies on Dalton Puffer's characterization – presents CDFS linked to cognitive domains which originally were meant to encompass all possible learning experiences as they are anchored in discourse. As the original author has explained, it is a comprehensive reduction of all possible functions to a set number of working categories; actually: CLASSIFY, DEFINE, DESCRIBE, EVALUATE, EXPLAIN, EXPLORE, REPORT. The present work embraces this classification for the simple reason that it includes all forms of cognitive engagement as they appear in discourse.

However, the classification consists not of categorical components. There may be semantic overlapping between some functions and the exemplifications in some areas may present serious problems; for instance, some assessors hesitated between report and description for some samples. We adhere here to the cognitive notion of *family resemblance*; there may be blurred features but essentially, the categories are distinct from one another. In matters of discourse, full categorization is difficult. Sometimes a statement may have a prototypical structure. A sentence like "life is a quality that distinguishes matter that has biological processes" follows the classical rhetorical structure of definitions: (definiendum + definiens). Sometimes the mere presence of an adjective in front of a noun in a sentence which recounts a historical fact implies that the statement doubles its functionality and becomes a report and an explanation at the same time. Consider for instance the following statement where the expression of causation and the report of a historical fact coalesces "Napoleon developed an insatiable lust for power that caused ceaseless demands on the resources of France". This merging of functions in a single statement we have called *functional stress*. However, the table presents clearer more categorical instances which facilitates its alignment with the descriptor and the rest of the components of the columns.

A practical solution for the identification of CDFs in the grids was to neutralize the multiple meanings of the keyword by adding a complement. This could give a clue as to the actual mental process represented by the verb and its instantiation in a classroom context. So, we referred to classify data, define concepts, describe a process, evaluate results, explain causes, explore phenomena or report facts. With this, authors could more easily visualize the communicative classroom Maths/Science/History situation and identify the discourse functions within.

- **Descriptors**: a key component of the grid is the descriptors themselves. A series of guidelines were followed to harmonize their composition. As was said, the work is the result of mixed-discipline experts. The fact that content specialists have participated in the wording of descriptor has led to using specific language of the disciplines which particularize the items and make them more accessible to future content experts. This implies the use of words with precise meanings in their field of specialization: simple/complex in Maths; monocausal/multicausal in History or empirical/non-empirical in Science. Authors were requested also to avoid linguistic jargon which made the tool less user-friendly. Terminology, if necessary, was mostly paraphrased for a better understanding of descriptors. Terms like *existentials*, *copulative*, *passives*, *conjunctions* may be barely understood by content experts. So paraphrases were used instead. For instance, instead of saying: “they can express ideas in the passive voice” the form preferred was: “they can express ideas in an impersonal manner”. Finally, in this regard, the accurate expression of descriptors relies on words which refer to different degrees of complexity. As is well known complexity along with accuracy and fluency characterize competence. Based on the watershed referred to above between B1 and B2, a series of proposed dyads which could make consistent references to the different competence levels analyzed -B1 and B2- were devised. Among others, the following were referred to respectively for B1 and B2: familiar/precise; colloquial/specific; casual/detailed; story like/expository; general/technical; congruent/incongruent; loose/tight; subjective/objective; random/consistent or plain timeframe/multiple timeframes. All these words have a conceptual basis in linguistics and refer to precise different degrees of verbal performance.

- ***Learning situation***: by including a description of a learning situation we want to emphasize that learning is highly contextualized and it is the classroom context which places necessary conditions on its verbal resolution. Also, the learning situation works as a prompt for the actual performance of students and fleshes out the descriptors, which otherwise, would remain rather abstract. A learning situation places content at the forefront of the decision-making process and follows the well-known concept that in multilingual situation, even if language sensitiveness is necessary, content always comes first. The learning situation visualizes the act of learning. If a comparison is proposed between dry or humid ecosystems; as in between the Arctic Polar Circle and the Atacama Desert, the context clearly sets the scene for a rhetorical plan and a series of language aspects; many of which must be present.

- ***Examples:*** another major component of the table is the actual instances of language production of students in their resolution of the tasks at hand. The grid features excerpts at two competence levels. The competence classification is the result of the subjective assessment of experts. Excerpts were subjected to inter-rater agreement, which involved both language and content specialists and resulted in significant competence differences which allegedly tallied the descriptors. The document acknowledges limitations in this regard, though. Unlike in previous work of CLILNETLE members, authors have not collected a corpus ad hoc. Excerpts derive from different published sources – mostly from past Ph.Ds. Dissertations of CLILNETLE members– of which the research team is not short. Excerpts are therefore quotations from acknowledged sources which are not the original result of the present project. Excerpts add new meanings to the descriptor as a real rendition of the different competence levels. They are real instances, so they feature the original solecisms, inconsistencies or simply errors of students.

Likewise, unlike the previous works of Moe et al. (2015) where all skills were represented, this work centers on one skill only: writing. Future revisions of the work will explore other skills; but there was some consensus that written expression should be the first aspect if one only was to be chosen. There are cognitive reasons for this. Disciplinary literacy features at its best in written discourse, in the sense that the purpose of disciplinary communication is to remain as a stable source of information; also, for the well-formedness that writing imposes on academic prose in the complex mostly long sentences

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and genres (Hüttner, 2007, 2008). Finally, it is because writing is well known in second language acquisition for its composition in two stages: planning and execution. Students in a second, non-dominant language use planning for making the most of their linguistic capabilities. Writing, therefore, features competence at its best.

- ***Curriculum:*** the grid intends to explore completely the thread running between content and language at all institutional and instructional level and therefore cannot lose sight of the fact that official curriculum set principles where content and language factors coalesce. After serious consideration on curriculum positions on multilingualism in the past work of CLILNETLE members, a working group of the network will explore national curriculum in full to find curricular regularities across nations (see wg3). While the results see the light, and in the absence of research which proves otherwise, the tenet here is that most national curriculum lacks a solid framework for language and content integration which structures curriculum guidelines. Therefore, most of the guidelines simply feature instances which dot the curriculum randomly with language consideration which may refer to language academic skills (summarizing, sketching) aspects of language skills (writing, speaking, listening or reading) or genres known in the disciplines which, as all genres, have a set rhetorical structure (biographical notes or historical recounts in History; theorems or demonstrations in Maths; fieldwork notes and lab reports in Science). However, given the institutional dimension of curriculum as an official document and the permanent influence on educational decisions, the grid needs to make precise references to the fact that they regularly –albeit randomly– incorporate language guidelines.

- ***Key language:*** an important element in multilingual education is language as a system of communication articulated at least in two different levels: lexicogrammar and discourse. Certain disciplinary content liaises consistently with certain language units. A lesson in genetics most likely triggers reciprocal pronouns, a description of a WWII battle will surely combine with cumulative adjectives, geometric reasoning in Maths implies spatial references in language in the form of adverbs, for instance. This is what the literature has often called *language muscles*; a metaphor expressing the idea that certain structures are activated by certain content. This is more clearly seen in vocabulary or terminology and even at discourse level where the stages of composition of area genres are known by content teachers. But the consistent occurrence of syntactic patterns and set formulas are continuous in communication for specific purposes. Usually, it is these patterns which are or should be focused on for scaffolding in multilingual classes.

The table features elements of language which are based on the probabilistic observation of teachers: on the fact that occurrences for some content lesson in a certain discipline is larger than in regular speech. It will be future corpus studies which can provide a proper map of the terrain of the language of the disciplines, but the present work needed to highlight the regular occurrence of certain forms and structures in a clear manner. When referring to language, we tried to avoid metalanguage as much as possible so as not to present concepts which may be alien to ordinary language users without a proper grasp of language and linguistics.

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FINAL THOUGHTS

What is the purpose of this document, then? It intends to be a language sensitive tool for the proper organization of languages in relation to subjects; of disciplinary literacy. We have developed this work in progress with the intention not of providing a full map of that interface. Language is not fully predictable nor fully meaningful; in the words of the philosopher, its limitations are the limitations of the self. However, descriptive linguistics has gone a long way into the accurate description of specific languages; more intensely now with digital language corpus or language automated software. This work does not claim to be a comprehensive description of the language units for CDFS or topic nor a full list of curriculum prompts with language sensitivity. But, for all the limitations the present work in its present state may have three major purposes:

A) It may establish a platform for language and content experts to sit together and develop a crosscurricular way of thinking where language diversity takes a central role. As convenient as teamwork is in education, it does not occur that often. The walls that disciplines have traditionally built around themselves with little communication across the subjects runs against disciplinary literacy.

B) It may be an instrumental document useful for developing new tools now restricted to areas in isolation and produce integrated curriculum or integrated lesson plans. There are few organizational activities at schools which demand the cooperation of teachers of different areas. With these grids in mind, the outcome is not completed unless both content and language specialists plan their content together. The composition of this work attests to this.

C) It may establish a way of thinking of language and education with a European tinge. Babel is known as the spiritual monument of Europe, and it will remain so for mobility reasons and for the respect of multilingual rights. Interferences in learning due to language diversity should be kept to a minimum in a continent where respect for tongues is high. (Eurobarometer, 2024).

We want to highlight the centrality of the conflation of CDFs with CEFR levels. CEFR descriptors have transformed language description and are now very useful for making assessment more transparent. For more elaborate functions like integrated curriculum development and assessment tools, however, the creation of school genre maps and any other type of language-across-the-curriculum policy, a CDFs-sensitive proposal makes a lot of sense. This is facilitated by the present work.

We are aware though that this will need further expansion; hopefully within CLILNETLE; and most likely beyond. Some of the possible follow-ups are already mentioned: more language levels, more disciplines with their own preferred formulaic patterns and structures; and more skills too. Reliability of descriptors will also need to increase. The hope is to provide a solid foundation in the form of an integrated content and language platform ready for completion with future components.

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2. HISTORY DISCIPLINARY LITERACY DESCRIPTORS

History literacy implies developing the meaning-making potential and complex thinking processes of students (Gómez & Sáiz, 2017). They are expected to learn how to present, explain, critically interpret and connect historical facts, events, and social actors, establish their significance, analyze causes and consequences, and take a stance, all this as an integral part of historical enquiry (Champagne, 2016; Del Pozo, 2019). These demanding cognitive processes are usually expressed linguistically though the use of present and past tenses, descriptive and evaluative adjectives, nominalizations, cause-effect relationships within clauses, conjunctions, conditionals (Achugar & Schleppegrell, 2005; Coffin, 2009; De Oliveira, 2011; Granados & Lorenzo, 2024; Moe et al., 2015). The notion of Cognitive Discourse Functions (CDFs) allows to connect academic language used by teachers and students in CLIL history classrooms to key historical competences underlying current history curricula in many countries (see, e.g., for Austria, Dalton-Puffer & Bauer-Marschallinger, 2019; for Spain, Evnitskaya & Dalton-Puffer, 2023).

In the grid below, we established the difference between B1 and B2 descriptors for each CDF as corresponding to a low secondary level (grades 7-8) vs upper secondary level (grade 10). This distinction reflects the essential difference in the **complexity of history content** and the **cognitive maturity of students**, i.e., as students develop cognitively and academically, and a priori linguistically, history learning becomes increasingly complex and abstract, both in terms of content and language. This is evidenced in a gradual shift from the concrete (specific facts, objects, events, and people) to the abstract (concepts, ideas, institutions, periods).

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HISTORY DISCIPLINARY LITERACY DESCRIPTORS

CDF	B1 Descriptor	B2 Descriptor	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
CATEGORIZE	Students can identify simple categories to establish differences or similarities between different historical phenomena (facts, objects, social actors, periods and processes).	Students can identify more complex categories, including creating their own, to establish differences or similarities between historical phenomena (facts, objects, social actors, periods and phases of processes, entities, institutions, events, and abstract concepts). They can include additional information to exemplify the established differences or similarities.	B1 - Number the hominids in chronological order (1-6 from oldest to youngest) and match their features using letters (a-f) B2 - Compare buildings in ancient Egypt and mention their uses.	*(Neanderthal, Sapiens, Habilis, Australopithecus, Antecessor, Erectus)* *(The first to colonise the American continent, The first Europeans, The first to make tools, The first to bury his deaths, The first to make fire, The first to walk upright)*	*The funeral rites could be with 3 monuments: the pyramids, the hypogeos and the temples. They buried their deads in pyramids and mastabas, they were like temples with several levels.*	**B1** - **Compare** the conditions that led to the causes of the First World War with the conditions of today through discussion. **B1** - Examine written and visual sources related to the reforms made during Atatürk's era and **categorise** them according to political, legal, and social fields; as well as in the areas of economy, education, and culture. **B2** - **Compare** historical research and writing processes before and during the digital era. **B2** - **Classify** the effects of past migrations, pandemics, wars, and inventions on state and societal life with the present day.	**B1** - Students can produce classifications using ordinal numbers (e.g. *the first* vs *the second* group) and adverbials (e.g. the people *in the North* vs the people *in the South*). They employ simple cohesive mechanisms (e.g. additive connectives such as *and* or *moreover*). **B2** - Students can produce classifications employing comparative and superlative forms of nouns and adjectives (e.g. *the bigger pyramid*, *the least developed*). They also use lexical expressions for comparison and contrast (e.g. *on the other hand, whereas, in accordance with*, etc.)

DEFINE	Students can provide simple definitions of concrete historical phenomena (facts, objects, events, social actors, periods and processes), providing the class to which the term belongs, basic characteristics and simple examples.	Students can provide complex and more detailed definitions of both concrete and abstract historical terms and phenomena (facts, artefacts, events, social actors, periods and processes), providing the class to which the term belongs, essential and secondary characteristics. Students can support definitions with detailed examples and expand definitions as required by the task.	B1 - Define what is a ziggurat. B2 - Define what is the tithe.	*A ziggurat is a doble shaped pyramid. It was the Mesopotamian ancient temples. They used to have one in each city. They were used to talk to gods. They have outside some stairs and then on top of the pyramid they had an observatory*.	*It is a horrible tax that makes us pay the ten percent of our money to the church.*	**B1** - **Identify** the Ottoman Empire borders in the XIX-XX centuries on the map. **B2** - **Define** the governance and military characteristics of different civilizations in ancient times.	**B1** - Students can make frequent use of the historical present tense and the verbs "to be" and "to have". They employ concrete nouns and noun phrases. They use mostly everyday, evaluative and subjective language. They can provide examples, using synonyms and simple enumerations. **B2** - Students make frequent use of the historical present tense and the verbs "to be" and "to have". They can employ abstract nouns and complex noun phrases. They also make use of objective and precise language.
DESCRIBE	Students can identify concrete historical phenomena (facts, objects, places, events, social actors, and periods),	Students can identify concrete and abstract historical phenomena (facts, objects, places, events, social	B1 - Describe some of the habits of one of the pre-Columbian civilizations.	*We conquer the Aztecs, the city Tenochtitlan, the capital. There is a large lake that we need to cross. The problem is that we*	*The astrolabe was the instrument to calculate the shortest distance to reach America. It was the Admiral*	**B1** - **Describe** an important problem of the Ottoman Empire in between the ends of the XIX and the beginnings of the XX century.	**B1** - Students use mostly the verb "to be" and "there be". They employ temporal deixis (e.g., *then, later*) and spatial deixis (e.g., *here,*

	with or without the aid of a visual representation (timeline, map, table, drawing, etc.), and provide simple descriptions of their characteristics.	actors, and periods), with or without the aid of a visual representation (timeline, map, table, drawing, etc.), and provide significant details and accurate descriptions of the important characteristics.	B2 - Describe some of the technological innovations that facilitated overseas expeditions.	*need money to build ships, workers to do them and more soldiers because the emperor Moctezuma have a great empire and it's difficult to defeat it.*	*who used the astrolabe.*	**B2** - **Describe** the positive and negative aspects of using archived personal digital photographs as sources for understanding the past.	*there*). They make frequent use of relative clauses, especially defining relative clauses (e.g. *the country which declared war*). **B2** - Students use compound sentences. They can employ more advanced temporal and spatial deixis (e.g. *in the Middle Ages*, *on the upper-left corner, etc.*). They also make frequent use of relative clauses.
EVALUATE	Students can give an opinion or take a stance for or against historical phenomena (objects, places, events, social actors, and periods), providing reasons or examples to support their views, in a simple and straightforward way.	Students can give an opinion or take a stance for or against historical phenomena (concepts, objects, places, events, social actors, and periods), providing detailed assessments, examples or information in a structured and logical way from a number of sources	B1 - What did the appearance of writing mean for the evolution of societies? B2 - How do you think the invention of cheques and bills of exchange affected the trade with America?	*The people could communicate and understand others, they could calculate things and also they left essays and now we know about other generations and investigate about them. We also write thanks to them.*	*The invention of cheques and bills of exchange affected in a positive way because the merchants that were travelling from Europe to America could use them and transactions happened so the buying and selling was much easier. It also affected the peasants or the people who bought products because*	**B2** - **Evaluate** and provide evidence that history encompasses social, economic, and cultural fields in addition to political and military events. **B2** - **Make a judgement** about the impact of the Agricultural Revolution on settlement and economic activities in ancient civilizations and critically explain the reasons.	**B1** - Students use qualifying adjectives expressing basic value judgements (e.g. *this is sad or important*) and deploy explicit counterarguments structure (e.g. *it is true that, however*). **B2** - Students can assess facts implicitly, through adjectives denoting historical appraisal and disguising subjectivity (e.g. *in a brilliant move*). They can also

		to support their views.			*they could pay during a large period of time. It also made the rich richer and the poor poorer.*		use a wide range of lexical units with positive and negative connotations (e.g. *conquest-invasion dominance-subjugation*).
EXPLAIN	Students can explain how and/or why concrete historical phenomena (facts, objects, places, events, social actors, and periods) are the way they are, establishing cause-effect relationships in a straightforward way and providing reasons.	Students can provide reasons and establish cause-effect relationships to draw conclusions about how and/or why concrete and abstract historical phenomena (concepts, facts, objects, places, events, social actors, and periods) are the way they are.	B1 - Why did Columbus decide to sail West? B2 - Why was Santiago de Compostela a popular destination for Christians in the Middle Ages? .	*His objective was to sail West in order to prove that the Earth is round.*	*It was at the end of Saint James road which was a very long and transit road and because there was an important church where Saint James was supposed to be buried.*	**B1** - **Establish a cause-effect link** about how the colonial competition and conflicts of interest that emerged after the Industrial Revolution might have affected inter-state relations. **B1** - **Explain** the general characteristics of the fronts where the Ottoman Empire fought during the First World War using various given sources. **B2** - **Explain** how to show sensitivity in preserving and perpetuating humanity's common heritage. B2 - Use concepts such as 'past,' 'time,' 'historian,' 'social	**B1** - Students can employ mostly adverbial subordinate clauses introduced by explicit conjunctions (e.g. 'since', 'as', 'because', etc.) to indicate cause-effects relations. The passive voice is only occasionally used as a resource to remain objective. **B2** - Students use a range of verbs from the semantic field of 'cause' (e.g. *provoke, lead, produce, initiate*,etc.). Multicausality is expressed by means of complex noun phrases. The passive voice is employed as a resource to remain objective.

						science,' 'big data,' 'artificial intelligence,' and 'algorithm,' and **establish a cause-effect relation** between them. B2 - **Draw conclusions** about the place and significance of nomadic life in Turkish culture.	
EXPLORE	Students can hypothesise about possible functions or scenarios of historical phenomena (facts, objects, places, events, social actors, and periods) based on concrete information or evidence.	Students can speculate about potential alternative functions or outcomes of historical phenomena (facts, objects, places, events, social actors, and periods), building on existing evidence.	B1 - What difficulties would you encounter if you were a general of Queen Isabel planning the capture of Granada? B2 - What do you think would have happened if the outcome of the Reconquest had been different? [the Christians lost the wars and the Muslims succeeded]	*It is difficult to reach Granada because we have to cross the mountains. Granada is protect by the mountains and the sea. When we take away the Muslims from Granada probably they will go to Africa with their cousins of Africa: the almoravids and almohads.*	*Spanish people would live like in a Muslim country such as Iran and probably America won't be discovered by Columbus, and another possibility would be that America would be Muslim.*	**B2** - **Predict** the impact of digitalization on society and provide examples from experiences. **B2** - Analyse the process of the formation of national identity and **hypothesise** it accordingly.	**B1** - Students can indicate the hypothetical nature of processes by means of lexical items. For example, they use adverbs (e.g. *possibly, probably, maybe, unlikely*) to express probability and possibility. **B2** - Students can indicate the hypothetical nature of processes by means of syntax. For example, they employ second and third conditional forms, and concessive connectives (*even if*, *in spite of*, etc.)

REPORT	Students can give a short account of events, using the original text wording from several sources and summarising the events by specifying the place, concrete actors ("doers" of the action and "receivers"), relating actions and establishing definite and indefinite time intervals, still following a linear chronology.	Students can provide a wide range of information and arguments from a number of sources, giving an account of events by specifying the place and concrete actors ("doers" of the action and "receivers"), using abstract concepts, moving between time intervals and establishing connections between different events.	B1 - Report, providing as many details as possible, the religion and funeral rites in ancient Egypt B2 - Imagine you are one of the officers of the Christian army in the conquest of Granada. Write the campaign diary including every detail you can think of.	*They mummified the deaths in order to have a body in the afterlife. The relatives used to put many objects, tools, and a wide range of materials in the dead Egyptian mummy, because they thought that these things were the materials that they would need to use in the afterlife.*	*The Christian army is preparing the first siege to the city of Granada. I have to lead my crew to the battlefield (..) we have reports of our explorers. They inform us about Muslim military power. We need to join our forces to make them surrender.*	**B1** - **Summarise** the leader Mustafa Kemal Atatürk's life via visual and audio ways. **B1** - **Report** the political and diplomatic developments that occurred during the process leading up to the proclamation of the Republic. **B2** - Create posters via interpreting the benefits of learning history for individuals and societies and **give an account** of it in being an active citizen.	**B1** - Students use basic values of the past simple and past continuous, although they favour the use of the historical present as a narrative strategy. They use demonstrative pronouns to indicate deixis (e.g. *those are*…). **B2** - Students use past tense verbs and temporal and spatial deixis, hardly ever employing the historical present as an avoidance strategy.

3. MATHEMATICS DISCIPLINARY LITERACY DESCRIPTORS

Descriptors for Mathematics developed within this project should be taken as a starting point for further work, discussions, and development; they are certainly not a final product at this stage. During the process of developing the math descriptors, the authors had in mind: (a) the cognitive aspect, which is very important for acquiring mathematics concepts (e.g., student age, prior knowledge in mathematics, cognitive functions, etc.), (b) the language aspect, which significantly impacts learning of mathematics (e.g., language competency, B1/B2 levels, literacy, etc.), and (c) the development of specific mathematics language as a separate language, which is strongly connected to factors (a) and (b). These three factors are all mutually intertwined. For that reason, math learning situations and examples are provided for two levels of education: lower secondary (L) and higher secondary level of education (H).

The development of math descriptors revealed several issues and dilemmas. Namely, from the aspect of mathematics education, there is not always a strict line among the seven cognitive discourse functions, they often overlap and through one CDF it may be that some other is partly or fully accomplished. Also, some CDFs refer to more frequent utilization in mathematics education (e.g., explain, categorize), while others have been less used in traditional teaching (e.g., report). It is important to mention that CDF do not correspond to the names and notions in the field of mathematics. For example, the term DEFINE in mathematics refers to making definitions, which is different from stating theorems. However, here, the cognitive discourse function DEFINE encompasses stating definitions, theorems, formulas, and other rules. Also, the linguistic aspect suggests that higher competence in language refers to more complex expressions, details elaborated, comprehensive explanations, etc. On the contrary, higher levels of mathematical competence often aim to more concise (but precise) linguistic expressions, with as few as possible words. This is highlighted as another challenge in detecting and developing disciplinary literacy, both for language and mathematics education experts. In order to illustrate the use of CDFs in existing Math curricula, links to two national curricula are provided: the *Curriculum of the school subject Mathematics for compulsory education and grammar schools* from Croatia (MZO 2019) and *High school mathematics course (9th, 10th, 11th and 12th grades) curriculum* from Türkiye *(*MEB 2019), given in English translation by the Math group members for the purpose of this project.

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MATHEMATICS DISCIPLINARY LITERACY DESCRIPTORS

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
CATEGORIZE	Students can express similarities and/or differences in mathematical structures and match them with the categorization criteria, giving a simple explanation in a colloquial language, sometimes helped with drawings.	Students can express similarities and/or differences in mathematical structures and organize them by explaining in detail the categorization criteria, using the precise mathematical terms.	L: What are the types of triangles? H: What are the types of functions?	L: Types of angles are the right triangle, the triangle with obtuse angle, and the triangle with all angles smaller than the right angles. The triangles can also have all sides with equal length, two sides with equal length, and with no equal sides. H: Types of functions are one to one, onto, into, constant, identity functions. These types are originated from the characteristics of domain, codomain and range of the function.	L: The triangles may be classified according to their angle measures, or according to the side length. Based on their angles, the types of triangles are acute, obtuse, and right-angled triangle. Based on their sides, the triangles are classified as equilateral, isosceles, and scalene triangles. H: Since a function is a relation between the sets a domain and range, functions are differentiated by that relation. According to mapping type from domain to range, functions can be classified as	L: The student distinguishes between different triangles according to the side length. The student classifies triangles according to the angle measures. (MZO, 2019) H: Can classify functions as one-to-one, onto, into, constant, identity, linear, odd and even. (10th grade, Functions) (MEB, 2019)	**B1:** Students can express similarities and/or differences using a general noun with a qualificator and frequent adjectives to describe characteristics or appearance. Students can use comparative form of adjectives and adverbs. Students can express comparison using: *such, like, (the) same (as)…* **B2:** Students can express similarities and/or differences using subject specific nouns for categories, and lexical phrases: *similar to, in contrast…*

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
					injective, surjective, bijective, constant and identity.		
DEFINE	Students can state the definitions and theorems, using simple language, sometimes with the help of visual information. The definitions and theorems with respect to mathematical terminology may not be fully precise, but they do convey the proper mathematical idea with terms and notations.	Students can state the definitions and theorems, using precise subject specific language (including mathematical terminology and symbols).	L: State the Pythagorean theorem. H: State the Cosine Rule and its relation with the Pythagorean Theorem.	L: The formula for Pythagorean theorem is $a^2+b^2=c^2$. (Sides a and b make the right angle, and side c has a position across the right angle.) H: Let a, b, c be the sides of a triangle. Cosine rule is $a^2 = b^2 + c^2 - 2.b.c.Cos (A)$. The Law of Cosines is a more general formula that works for all types of triangles, not just right triangles.	L: The sum of the squares on the legs of a right triangle is equal to the square on the hypotenuse. H: In trigonometry, the **Cosine Rule** says that the square of the length of any side of a given triangle is equal to the sum of the squares of the length of the other sides minus twice the product of the other two sides multiplied by the cosine of angle included between them. It doesn't rely on creating an "imaginary" right triangle, but rather generalizes the relationship between side	L: The student states the Pythagorean theorem. (MZO, 2019) H: Can obtain the cosine theorem by using the Pythagorean theorem and solve problems using the cosine theorem. (11^{th} grade, Trigonometry) (MEB, 2019)	**B1**: Students can state definition using verbs such as: *is, has parts, consists of* + noun phrases (e.g, *X consist of …*), relative pronoun *that* and indefinite pronouns: *all, any, both…* **B2:** Students can state definition using verbs such as: *is, has parts, consists of* + NP (e.g, *X consist of …*) and an enhance specificity by incorporating adverbs such as: *only*, *solely, just*...

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
					lengths and angles in any triangle. In other words, we can say that the Pythagorean Theorem is a "special case" of the Law of Cosines.		
DESCRIBE	Students can convey information and *briefly* express components of mathematical structures (concepts, processes, and calculations). They can label / highlight important components of visual mathematical representations (graph, figure, table, drawings, etc.) Students can express in a simple way the steps they	Students can convey *detailed* information and express components of mathematical structures (concepts and their relations, processes, and calculations) using subject specific language. They can *specify* components of visual mathematical representations (graph, figure, table, drawings, etc.). Students can express in detail how they think when solving a task.	L: Describe how you know that two triangles are congruent. H: Describe the geometrical meaning of derivation.	L: If I have two triangles, I can cut them out and put on each other. If they match perfectly, they are congruent. H: The tangent line is the geometrical or graphical representation of the derivative. The derivative of the function y = f(x) at the point P(x, y) is equal to the slope of the tangent line to the curve y = f(x) at P(x, y).	L: Two triangles are congruent if they meet one of the following criteria: - All three pairs of corresponding sides are equal. - Two pairs of corresponding sides and the corresponding angles between them are equal. - Two pairs of corresponding angles and the corresponding sides between them are equal. H: Geometrically, the derivative of a function can be interpreted as the	L: The student describes the triangle congruence. (MZO, 2019) H: Can describe the relation between the derivative value of a given function at a point and the slope of its tangent at that point. (12^{th} grade, Derivative) (MEB, 2019)	**B1**: Students can convey information in simple declarative sentences, using phrases such as: *you can… with it*; it *is like…, it has … like, as+adjective+as*. **B2:** Students can convey information in coordinative and subordinative sentences, using phrases such as: *the (adj) one (that)…*; *there is + NP.*

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
	undertook when solving a task.				slope of the graph of the function or, more precisely, as the slope of the tangent line at a point. Its calculation derives from the slope formula for a straight line, except that a limiting process must be used for curves. Different functions have different derivatives. But regardless of the function type and its derivative, one thing is common in all the derivatives and that is they take the form of a tangent line to the function graph or we can say that derivatives are equal to the slope of the tangent line.		
EVALUATE	Students can express simple arguments pro or contra the given	Students can express more complex arguments pro or contra the given	L: A student would like to draw a triangle with two right angles. What	L: It is impossible. Try to sketch a triangle with two right angles. The two sides	L: It is impossible to draw a triangle with two right angles. The sum of the	L: The students design and evaluate the chains of	**B1:** Students can express stance using verbs such as: *I believe, I think; I*

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
	statement or the solution of a problem using different linguistic means to express their stance ("I think, I believe, I conclude… because of", etc.). These arguments and their conclusion may contain colloquial language and visual representations as a help.	statement or the solution of a problem using a content specific language and a wide range of lexical units. Clear justifications are used in a structured and logical manner that supports the conclusion.	would you say to this student? H: Interpret the signs of the first derivative of a function in terms of the shape of the function's graph.	will be parallel, and this is not a triangle. H: The function is increasing on intervals where the first derivative of the function is positive, and decreasing on intervals where it is negative. If the sign changes at the roots of the first derivative, there are local maximum or local minimum points.	angles in each triangle is 180 degrees. Each of the right angles has 90 degrees, and two of them make 180. This means that the third angle should have 0 degrees, which is impossible: that wouldn't be a triangle. H: The derivative of a function can be used to determine whether the function is increasing or decreasing on any intervals in its domain. If f'(x) > 0 at each point in an interval I, then the function is said to be increasing on I. f'(x) < 0 at each point in an interval I, then the function is said to be decreasing on I. If the derivative of a function changes	mathematical arguments, they use inductive and deductive reasoning, analyze, and use analogy, generalization and specialization. (MZO, 2019) H: Can express the intervals where a function increases or decreases and extremum points of graph of a function with the help of derivatives. (12th grade, Derivative) (MEB, 2019)	*conclude*. Students can express preference with *rather…than…* **B2:** Students can express stance using phrases such as: *in my opinion; my understanding is; we/I can draw a conclusion that…* Students can use verbs such as: *appear/seem/look (calculations seem/looks right).*

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
					sign around a critical point, the function is said to have a local (relative) extremum at that point. If the derivative changes from positive (increasing) to negative (decreasing), the function has a local (relative) maximum at the critical point. If, however, the derivative changes from negative (decreasing) to positive (increasing), the function has a local (relative) minimum at the critical point.		
EXPLAIN	Students can give reasons why things, related to mathematics, are the way they are, using a colloquial language, causal connectives	Students can give multiple causes of different mathematical relations, properties, processes, results, etc. These explanations	L: Explain how Thales measured the height of the Great Pyramid. H: Explain how to find the area under a curve by using Riemann sum.	L: Thales waited until his own shadow was equal to his height. In that moment, the pyramid's shadow was equal to its height, because then the Sun rays fall on	L: Thales measured the height of the Great Pyramid by observation of the length of its shadow at the moment when his own shadow was equal	L: Students apply the Thales' theorem on proportionality and the similarity of triangle. Example: Explain how Thales	**B1:** Students can give explanation using subordinating conjunctions: such as temporal (*after, before, since, until*), causal (*because, since*), consequence

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
	("because, since…"), and adverbial clauses.	are expressed in a coherent way using subject specific language, causal connectives ("because, since…"), and adverbial clauses.		the Earth in 45 degrees. So, he just measured the length of the pyramid shadow, and that was the pyramid height. H: The Riemann sum is used to estimate the area under a curve by dividing it into rectangles. The area of these shapes is then added to estimate the area under the curve. Since the shapes used will not fit the shape of the region exactly, some errors will occur. This error can be reduced by using a larger number of rectangles with smaller widths. The smaller the width of the rectangles, the more closely they can represent the shape of the area and the more accurate the	to his height, because these triangles are similar. Namely, in the moment when the Sun rays fall on Earth in 45 degrees, they form right triangles with two equal legs, all of which are similar. In that moment, all the shadows have the length of their original objects, since the rays with objects form 45-90-45 triangle, which is isosceles one. H: Riemann sum is a mathematical concept used in calculus to approximate the area under a curve. The idea behind the Riemann sum is to divide the area into smaller subregions, approximate the area of each subregion, and then	measured the height of the pyramid using a shadow. (MZO, 2019) H: Can approximately calculate the area of the limited region between the graph of a function and the x-axis with the help of the Riemann sum. Can explain that areas encountered in real life and whose values cannot be calculated with area formulas can be expressed as the limit of suitable sums. (MEB, 2019)	(*so*), and relative conjunctions (*what, who, that*). **B2**: Students can give explanation using verbs such as: *cause, result in, contribute to, impact…* etc. or nouns (*reason, consequence, result…*) to express cause and effect. By using subordinate and coordinate sentences students can express multicausality.

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
				estimate of the area will be.	add these approximations to obtain an estimate of the total area. To use the Riemann sum, you start by dividing the region of interest into smaller subintervals. The more subranges you use, the more accurate your approach will be. Each subinterval is represented by a rectangle whose height corresponds to the function value at a particular point within that subinterval. There are different methods of selecting points in each subrange. Three common approaches are: left Riemann sum, right Riemann sum, midpoint Riemann sum. As you increase the number		

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
					of subintervals and make them infinitely small, the Riemann sum becomes more accurate and approaches the area under the curve.		
EXPLORE	Students can investigate the mathematical properties by giving assumptions and giving estimations using simple language. Also, students can investigate relationships of mathematical rules, formulas, processes with other fields or real-world situations and predict different outcomes.	Students can investigate the mathematical properties by giving assumptions and giving estimations using precise subject specific language. Students can investigate how mathematical rules, formulas and processes are used in real-world situations. They can investigate their relationship with other fields and predict different outcomes.	L: Using the dynamic geometry software, explore the relationship between two interior and the opposite exterior angle of the same triangle. H: Explore how sound intensity is calculated.	L: In a triangle with angles 30-60-90, two interior angles are, say, 30 and 60. Their sum is 90, which is also the opposite exterior angle. If I try it with two other angles of this triangle, say, 60 and 90, I will get their sum of 150 degrees. And the exterior opposite angle is 150, because 180-30=150 degrees. It works for other triangles as well. H: The smallest sound level that the human ear can hear is $I_0= 10^{-12}$ watt/m^2. The intensity of the sound source is	L: Applying the dynamic geometry software on many triangles, I can see that the measure of an exterior angle of a triangle is always equal to the sum of two remote interior angles. H: The sound energy delivered by sound waves to a 1 cm^2 surface in a plane perpendicular to the direction of sound propagation in 1 second is called sound intensity. While the highest sound intensity that the human ear can hear without being damaged is 1	L: Students investigate the relationship between two interior angles and the opposite exterior angle of a triangle. (MZO, 2019) H: Can model real-life situations (population growth, bacterial population, decay of radioactive substances (half-life), determination of fossil ages, earthquake intensity (Richter scale), pH value, sound intensity (decibels)) using	**B1**: Students can make prediction using verbs such as: *I expect, I assume*, and adverbs for certainty (*certainly, probably, possibly…),* degree (*very, quite*…) and time (*before, afterwards, fist, secondly, lastly…*). Students can use future tense to make prediction. **B2:** Students can make prediction using phrases such as: *the assumption is that, according to (our/mine) expectation*. Students can express different

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
				found by the I/Io ratio, where the sound level is I. The value of sound intensity in decibels is calculated with the formula L=10.log (I/I_0).	watt/m^2, the lowest sound intensity to which it is sensitive is 10^{-12} watt/m^2. That's why people cannot hear the footsteps of an ant or the sounds of the movements of planets or stars in space. I= Sound intensity of the source I_0= 10^{-12} watt/m^2 L : Volume The sound level in dB (decibel) is calculated with the formula L=10.log(I/I_0)	exponential and logarithmic functions. (12th grade, Exponential and Logarithmic Functions) (MEB, 2019)	level of probability: *(absolutely) certain, (most) probably; is (not) likely…* Students can use modal verbs (could, might, may…) to make predictions.
REPORT	Students can present a mathematical idea, real-world scenario, mathematical problem and its solution, or the research result using simple language	Students can present a mathematical idea, real-world scenario, mathematical problem and its solution or the research result using a more detailed and subject specific language in a coherent text.	L: Write a report on your exploration of the number Pi.			L: Students present the history of the number Pi. (MZO, 2019) H: Can research and present examples of polygons in motifs used in Turkish traditional architecture. (10th	B1: Students use present and past simple tense for reporting. Report in a sequence of simple sentences, using temporal adverbs for sequence (*than, after..*).

CDF	B1 descriptor	B2 descriptor	Learning situation*	B1 - example	B2 - example	Link to curriculum	Key language
	(including mathematical terminology and the sequence of shorter, simple sentences) and visual aids.					grade, Polygons) (MEB, 2019)	B2: Students use discursive markers to structure report: to introduce the theme/topic (*to begin/start with..*, *I'd like to talk about / tell you about …I*), to exemplify (*for example, for instance*), to structure order (*firstly, secondly, in the first place…*), to summarize (*all in all, to sum up…)*

* L=lower secondary level, H=higher secondary level

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4. SCIENCE DISCIPLINARY LITERACY DESCRIPTORS

In order to fully understand the proposed descriptors, a few aspects need to be clarified. The term "concept" is used throughout the descriptors to include facts, phenomena, objects and processes related to scientific disciplines such as Biology, Chemistry, Physics or Earth Science. In this respect, there is a need to make sense of what science literacy is. The well-established understanding states science literacy as "the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity" (NRC, 1996, p.22). More recently, the Program for International Student Assessment (PISA) conceptual framework described science literacy as "the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen" as well as being able to engage in reasoned discourse about science utilizing the competencies, such as explaining natural phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and evidence scientifically (OECD, 2016, p.20). As a common ground across such understandings, the notion of science literacy seems to be mainly structured around the utilization of science *concepts* in everyday sociocultural *contexts* in a meaningful manner, as well as reasoning about socio-political problems as being able to actively operate the *processes* of science (Haglund & Hultén, 2017; NRC, 1996; OECD, 2016; Roberts, 2007).

It is important to mention that students need to acquire a minimum level of conceptual understanding before producing CDFs at certain levels, as all (successful) production of CDFs requires students to have developed their scientific knowledge. Therefore, we would like to make clear that much of the difference between B1 and B2 descriptors might, in part, reflect two important factors: **content complexity** and **cognitive maturity**, i.e., as students mature cognitively and academically, science learning becomes increasingly complex and abstract. This is characterized by a move from the observable to the abstract – from the macroscopic level to the submicroscopic. There is, consequently, an advancement or development in scientific literacy (epistemology) which might, in turn, reflect on language production, or not.

Two further observations need to be addressed in order to fully understand the science descriptors. In the case of "EXPLAIN", we have included sequential, factorial/consequential (monocausal and multicausal) and theoretical explanations, as proposed by previous studies (Polias, 2016; Trimble, 1985). According to Polias (2016), sequential explanations are concerned with the cause and effect flow through a series of sequenced-chronological events constituting the phenomenon, whereas factorial and consequential explanations are oriented, respectively, to the causes and factors and to the effects or consequences responsible and brought in the phenomenon. Both can be monocausal and multicausal. Theoretical explanations are aimed at illustrating scientific theoretical laws and principles. Finally, we would like to mention that, as previously suggested by Dalton-Puffer when proposing the CDF construct (2013, 2016), the boundaries between CDFs are not always clear. This is the case of "REPORT", which, in science, includes instances of both "DESCRIBE" and "EXPLAIN", as much of what is *reported* is actually based on experimental-causal relationships, which might lead to theory descriptions. Consequently, in this descriptor grid, our understanding of "REPORT" is one that focuses on recounting scientific (experimental) procedures and their results.

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Examples from B1 are translations from excerpts written in Basque by Year 8 students (13-14 years old) after explicitly eliciting them to do so by using the B1 prompts. Examples and learning situations from B2, in contrast, are taken from Polias (2016).

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Science disciplinary literacy descriptors

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
CATEGORIZE	Students can group scientific concepts into categories based on a given set of criteria (according to observable characteristics), and they can express some of the components of the aforementioned concepts and/or specific characteristics.	Students can build up groups of scientific concepts by justifying specific criteria and expressing similarities and differences between concepts/groups based on observable and non-observable/abstract features.	**B1.** What are the differences and similarities between vertebrates and “invertebrates”? Give examples. (based on Gerns, 2023) **B2**. What are the differences and similarities between animal and plant cells?	*The main difference between invertebrates and vertebrates is that vertebrates have bones and invertebrates do not. A similarity between them is that they are both animals.*	*On comparing animal and plant cells, we find that there are some major similarities and some critical differences. These differences are linked to the different functions that cells have in the different organisms. Both animal and plant cells have three major structural elements: a defined nucleus, cytoplasm which surrounds the nucleus, and a cell membrane. Plant cells also have chloroplasts and a large vacuole. A significant structural difference between the two kinds of cells is that the plant cell has a wall consisting of cellulose. (Polias,*	**Compare** the basic morphological features of different groups of invertebrates and vertebrates (3rd year of high/ secondary grammar schools, *Slovakia*) **Distinguish** eukaryotic cells from prokaryotic cells in microscopic observations (Natural Sciences, 8th grade, 3rd cycle of PE, *Portugal*) **Classify** solutions with respect to the amount of solute it contains and the electrolytic characteristic. (Chemistry, Grade 10, *Turkey*) **Classify** and **compare** organisms in the evolutionary tree according to different criteria (organic systems,	- Comparative and superlative structures (more/less than, the biggest…) - Nouns for categories (hypernyms: animals) and members (hyponym: dog) - Synonyms and antonyms - Connectives for comparison, contrast and similarity (*similarly, in contrast…*) - Mainly present simple (*there is/are*)

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
					2016)	adaptations, development) with typical representatives (Biology 8th grade lower secondary/Biology 2nd grade higher secondary *Croatia*).	
DEFINE	Students can create simple definitions of scientific concepts based on their essential characteristics using informal or everyday language/without using scientific-specific terminology.	Students can create complex definitions based on evidence, providing details on a concept's essential and secondary characteristics. Moreover, the units of measure of the concept are clearly established (by using formulas), and definitions are presented with science-specific terminology.	**B1.** What is the ozone layer? **B2**. What is the moment of inertia?	*It is a layer of gas surrounding the planet Earth, which helps to protect the planet from the ultraviolet lights of the Sun.*	*The moment of inertia of a body is a measure of the resistance to changing the rate of rotation. The equation for moment of inertia is given by I = mr2. (Polias, 2016)*	**Define** the conditions of photosynthesis (2nd year of high/ secondary grammar schools, *Slovakia*) **Distinguish** between the Earth system and its subsystems, identifying their potential for generating life on Earth (Natural Sciences, 8th grade, 3rd cycle of PE, Portugal) **Use** basic physical concepts such as pressure, volume, velocity, weight, specific gravity, force, temperature,	- Copulative verbs (*be, seem…)* Present simple - Defining relative clauses (*that, who, which…*) - Adjectives in the relative clause - Synonyms

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
						heat, electric charge, etc. [...] (learning objectives for the 8th grade Science-CF curriculum, SS of I level, Italy) **Operationally define** the concept of mole (Chemistry, Grade 10, Turkey) **Recognize (identify**) the basic functions of cell organelles (Biology 7th grade lower secondary *Croatia*).	
DESCRIBE	Students can describe observable and functional characteristics of a scientific concept, also by using graphical representations. In addition, students can simply present phases of phenomena or procedures. Students can	Students can describe observable and non-observable/abstract characteristics of a scientific concept, also by using and creating graphical representations at an abstract level, expressing objective and abstract properties/processes. Moreover, students can express and	**B1/B2.** What happens in each phase of the water cycle? How does it happen?	*The water cycle has four main phases. First, evaporation occurs. When it heats up, the water from the sea evaporates, and that evaporated water goes upwards. Then, condensation occurs: as temperatures drop, the previously evaporated water condenses into clouds,*	*The cycle begins when solar energy evaporates water from the oceans, lakes and rivers. The water vapour rises into the atmosphere. This process is called evaporation. The water vapour rises and is typically pushed over the land by winds and*	Draw, schematically represent, and **describe observed** biological objects (1st - 4th year of high/ secondary grammar schools, *Slovakia*) **Recognize** the cell as the basic unit of living beings, identifying the main components of eukaryotic cells	- Descriptive adjectives for observable and non-observable features (*liquid, solid, gas, sub-atomic, electric*) - Present, past and future tenses - Comparative and superlatives - Synonyms and antonyms - Sequential connectives (*first,*

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
	express objective properties for the descriptions.	characterise the interrelations between concepts and/or elements.		*forming clouds. Then, precipitation comes, that is, it rains. Finally, the rain goes to the rivers (either directly or through infiltration from the ground, the water is absorbed by the soil), and the water from the rivers returns to the sea. This is what we call runoff.*	*forced up because of mountains. As the water vapour rises. it cools and turns back into tiny water droplets. This change from vapour to liquid droplets is termed condensation. As more and more droplets come together, clouds are formed. (...)*	(Natural Sciences, 8th grade, 3rd cycle of PE, *Portugal*) [...] **collect** data on relevant variables of different phenomena, **find** quantitative **relationships** and **express** them with formal **representations** of different types [...] (learning objectives for the 8th grade Science-CF curriculum, SS of I level, *Italy*) Being able to make scientific **observations** about the properties of gases. a) **Demonstrate** the differences in the properties of gases (e.g., volume, pressure, expansion, compressibility, miscibility, density). b) **Collect** and **record data** on the properties of gases.	*then…*) and temporal subordinate sentences (*when/after something happens…*) - Nominalisations: verbs/adjectives that become nouns (*evaporation, condensation…*)

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
						c) **Describe** the patterns about the properties of gases (e.g., pressure, volume, temperature and amount of matter) utilizing **different levels of representations**. (Chemistry, Grade 10, *Turkey*). **Describe** the life cycles of organisms (Biology 8th grade lower secondary *Croatia*).	
EVALUATE	Students can make coherent scientific claims based on data/evidence, without necessarily providing justification for the claim. Students include personal opinions mainly through the use of qualifying adjectives.	Students can make coherent scientific claims based on data/evidence, and provide supporting justifications. They acknowledge/refute potential counterarguments. Students can make decisions based on findings, interpreting, discussing (bringing other viewpoints) and	**B1**. In your opinion, why do we need renewable energies? Among renewable energies, which one is the most suitable? **B2.** Can nuclear power help answer our energy needs?	*We need renewable energies to pollute less. If we continue consuming what we currently consume, the resources of the earth will be reduced and will end. With renewable energies, however, there is no pollution and can be achieved with the movement of the wind, the light of the*	*Nuclear power attracts diametrically opposed viewpoints: its advocates see it as relatively inexpensive and sustainable and a way to combat global warming, while its opponents see its waste as so toxic and long-lasting that it is a*	**Critically assess** the conditions of livestock farming and their impact on food quality; **Take a stance on** various forms of alternative diets; **Evaluate** the limiting criteria for blood donation (from 2nd to 4th year of high/ secondary grammar schools, *Slovakia*)	-Expressions to give opinion (*in my opinion, I think…*). These are more subjective [B1] - Expressions to give evidence and justification (*because, on the one hand, so…*) - Exemplification expressions (*for instance, for example…*)

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
		critically evaluating them.		*sun, or the movement of the sea: it will never end. It is true that when choosing the best option, we must look at the environment.*	*threat to the planet. With respect to the emissions of greenhouse gases, nuclear power is a clean way of producing electricity when compared with coal-fired power stations, which currently meet most of the world's electricity demands. (...). Nevertheless, even though nuclear power stations produce fewer greenhouse gases than fossil-fuel power stations, they do present contamination risks to the planet with emissions of radioactivity and, more significantly, with the disposal of waste and accidents at the power plants. (...). However, despite all the planned*	**Interpret** information on population dynamics resulting from biotic relationships, **evaluating** their consequences for ecosystems (Natural Sciences, 8th grade, 3rd cycle of PE, *Portugal*) **Discuss** the causes and consequences of changes in ecosystems, **justifying** the importance of the dynamic balance of ecosystems and how their management can contribute to achieving the goals of sustainable development (Natural Sciences, 8th grade, 3rd cycle of PE, *Portugal*) **Relate** the influence of living beings to the evolution of the Earth's atmosphere	- Expressions to bring others' voices (*according to X study…*) - Expressions to refute/acknowledge potential counterarguments (*it is true that… however, on the other hand…*) - First conditional (*if we continue consuming X, resources will end*)

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
					precautions, human carelessness and natural disasters have caused very serious accidents at nuclear plants.	and to the greenhouse effect on the Earth (Natural Sciences, 8th grade, 3rd cycle of PE, *Portugal*) **Decide** on the most suitable acidic or basic products. a) **Determine** the purpose for the selection of acidic or basic products used for stomach, mouth, teeth and skin health. b) **Obtain** information by carrying out experiments for the purpose. c) **Formulate** propositions about the result of acid-base reactions based on observations from the experiment. d) **Make** a reasoning check on the propositions. e) **Select** appropriate	

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
						products with acidic or basic properties in terms of stomach, mouth, teeth and skin health. f) **Reflect** on the health effects of the products chosen for stomach, mouth, teeth and skin health. (Chemistry, Grade 11, *Turkey*)	
EXPLAIN	Students can give sequential, factorial and consequential monocausal scientific explanations by using simple causal connectives and adverbial clauses.	Students can give scientific theoretical explanations, bringing theory to support cause-effect relations, as well as factorial and multicausal explanations. In multicausal explanations, they can isolate the effect of single causes and variables, and describe how they interact and affect each other. They use a wide range of lexical resources to express cause-effect	B1. If we drop an apple and a metal object from the roof, which will reach the ground first? Why does that happen? B2. What are the consequences of air pollution in Hong Kong?	*Depending on the weight of the metal object and the apple. If they have the same weight, they will reach the ground at the same time, and if they have different weights, the heaviest will reach first.*	*Visibility degradation is caused by airborne particles which scatter light and serve as condensation nuclei for clouds and fog. The particulates can come from natural phenomena such as volcanic eruptions, dust storms and sea spray, or from human activities such as combustion. In Hong Kong, the combustion of fossil fuels in cars is the*	**Explain** the main conditions on Earth that have allowed life to develop and be maintained, linking this to knowledge from other disciplines (e.g. Physical and Chemical Sciences) (Natural Sciences, 8th grade, 3rd cycle of PE, *Portugal*) **Explain** the importance of the different phases of the cell cycle; **Explain** the mechanism that	-Chronological, sequential and order connectives (*then, after…*) - Cause-effect connectives (*because of that, since, so…*) - Cause-effect nouns (*cause, reason, consequence…*) - Dynamic and cause-effect verbs (*affect, impact, produce…*) - Zero and first conditionals (*if X happens, then X*

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
		relationships, with increasingly abstract (and microscopic) language.			*main contributor and the situation is worsened by the occurrence of photochemical smog, which is formed when smoke and exhaust fumes are trapped in a fog and undergo photochemical reactions.*	ensures the genetic information of the daughter cell matches that of the parent cell (1st year of high/ secondary grammar schools, *Slovakia*) **Interpret** graphs of the evolution of temperature and atmospheric carbon dioxide over geological time (Natural Sciences, 8th grade, 3rd cycle of PE, *Portugal*)	*happens/will happen*) - Present simple tenses in causal explanations (*mass impacts weight*) - Past tenses for chronological / sequential explanations (*plants produced starch during the photosynthesis)*
EXPLORE	Students can formulate hypotheses and think about potential scenarios, without necessarily sustaining these with evidence or applying previously learnt concepts. Students' use of explorative language shows a certain degree of	Students can make plausible predictions based on an advanced conceptual understanding of scientific concepts and phenomena, relating variables with each other and isolating their effects. Students can formulate research questions and hypotheses with a	**B1.** What do you hypothesise? Assess possible outcomes. What would happen if everybody started using electric cars? **B2.** What might affect the growth of a plant?	*a) Pollution would decrease, but electricity consumption would increase significantly.* *b) Many current societal problems would be avoided. For example, air quality would be much better.*	*In this experiment, we were asked to identify what might affect the growth of a plant. I chose to grow broccoli. We were to apply a variable to one of the plants and the other we were to use as a control. My variable was that the plant would grow better if I*	**Predict** answers that can be verified with the tools and knowledge acquired, experimentally and deductively (Year 10, *Basque Country*) Formulate hypotheses; Design an experiment to confirm the hypothesis; Conduct observations and	- Second and third conditionals (*if X happened, Y would happen*) - Future tenses for predictions (*We assume that X will affect Y*) -Purpose clauses (*in order to, so that…*) for formulation of hypotheses and designing experiments

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
	uncertainty.	certain degree of certainty, and can accordingly plan experiments.			*spoke Swedish to it. My prediction was that if I spoke Swedish for 30 seconds to one plant (Veg 1) every time I went up to the plants, then it would grow better than the other. I used two small seedlings planted in two separate plastic pots filled with potting soil, and these were placed in the direct sunlight of the greenhouse. I put labelled sticks into the soil to identify the two plants: Veg 1 was the plant to be spoken to in Swedish, Veg 2 was the control. The measuring of the plants and the recording of the data were pivotal to the experiment. I measured the weight (g) using spring scales, and*	experiments; (1st - 4th year of high/ secondary grammar schools, Slovakia) **Verify** the existence of reflexes and the function of sensory receptors (3rd year of high/ secondary grammar schools, *Slovakia*) [...] **experiment** through (non-hazardous) reactions even with household chemicals and **interpret** them on the basis of simple models of the structure of the matter (learning objectives for the 8th grade Science-CF curriculum, SS of I level, *Italy*) **Interpret** the influence of certain abiotic factors on ecosystems in general and **apply** it to examples in the region where the	- Adverbs to express certainty (*probably, likely, for sure, perhaps, definitely, indeed…*) -Modal verbs (*could, might, may…*)

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
					the height and width (cm) using a ruler.	school is located (Natural Sciences, 8th grade, 3rd cycle of PE, *Portugal*)	
REPORT - *RECOUNT***	Students can inform and narrate experiments and processes in a very straightforward way. The phases and/or ideas and the connection between these are not necessarily well-established.	Students can inform and narrate experiments, processes and findings by making connections with previous experiments and/or studies. The connections between phases and/or ideas are smooth and clear.	**B1.** What did Rutherford find when he conducted the alpha-scattering experiment? **B2.** What is the effect of different respiratory substrates (e.g. glucose, sucrose, starch) on the rate of respiration of yeast cells? Carry out an experiment and report the main results.	*In his experiment, Rutherford shot alpha particles through a very thin gold foil, and he made three observations:* *- Most of the alpha particles passed through the gold foil and continued traveling on a straight line.* *-Some alpha particles passed through, but did not go straight. They traveled in a slightly different direction when they passed through the gold foil.* *- A few of the alpha particles bounced back and did not pass through the gold foil. He concluded that there is a big empty space in the atomic*	*Since carbon dioxide is released as a by-product of anaerobic respiration, the volume of carbon dioxide gas inside the tube will increase, thus increasing the gas pressure inside the tube. The greater the increase in gas pressure, the faster the rate of respiration of yeast cells. The results show that tube D (with 1 % sucrose solution as substrate) has the fastest rate of respiration. It is because, with the aid of an enzyme, one sucrose molecule will be*	Prepare a **report** on the practical activity (1st - 4th year of high/ secondary grammar schools, *Slovakia*) **Inform** about the procedures, results and ideas related to research projects in analogical or digital formats (presentations, graphs, posters, reports…) (Year 10, *Basque Country*) **Apply** basic principles and methodology of scientific research while **reporting** the obtained results (Biology each grade secondary school *Croatia*).	-Past tense for methods and procedures (*the alpha particles bounced back*) - Present tense for findings, results (facts) and implications (*magnesium reacts rapidly with hydrochloric acid to form magnesium chloride*) - Action or dynamic verbs (*changed, passed, happened, reacted…*) - Reporting verbs (*discovered, observed…*) - Objective language – use of passive voice (*the experiment was conducted…*) [B2]

CDF	B1 - low-level	B2 - high-level	Learning situation	B1 - example	B2 - example	Link to curriculum	Key language
				structure.	*broken down into one fructose and one glucose molecule. As a result, tube D provides more respiratory substrates for yeast cells. The more respiratory substrates there are, the greater the rate of respiration. So tube D gives the highest respiratory rate. (Polias, 2005, 2016)*		- To make connections, contrast and similarity clauses (*in line with the study by X, in contrast to X*), - Reported speech to bring previous studies and theories (*Rutherford concluded that X…*) - Temporal clauses and temporal connectives for sequencing (*after, then, when X happens…*)

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