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The effects of using cognitive discourse functions to instruct 4th-year children on report writing in a CLIL science class

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Abstract

The present study analyzed how a group of young Spanish-speaking English as a foreign language (EFL) learners in a content and language integrated learning (CLIL) science class responded to an instructional unit integrating attention to functional language and an inquiry-oriented approach to science. Working in cooperation with the researchers, a year 4 primary school teacher implemented a teaching sequence on levers with 48 9-10-year-olds over three weeks. The sequence, which was intended to raise the children's awareness of the demands involved in understanding (content goals) and expressing as written reports (rhetorical goals) how levers work, scaffolded their activity from item-based writing to the production of full texts. On completing the unit, each child independently wrote a report on levers, all of which were analyzed from the perspective of cognitive discourse functions and ideational

meaning. The results of these analyses are discussed in terms of their significance for CLIL writing with young learners.

Keywords: school genres; cognitive discourse functions; writing; CLIL; children

1. Introduction

In the last fifteen years, content and language integrated learning (CLIL), that is, the teaching in the foreign language (FL) of subjects other than the FL itself, has been introduced in different European countries, Spain among them, as an alternative or supplement to traditional FL programs (e.g., Coyle et al., 2010). Teaching science, mathematics or history in CLIL contexts is regarded as an educationally desirable goal on the grounds that the cognitive discourse functions (CDFs) involved in learning this type of content (e.g., define, classify, evaluate) offer students opportunities to access powerful knowledge (Morton, 2020). These functions, which lie at the interface between thinking and language, structure academic discourse and are thought to provide learners with lexical, grammatical and rhetorical resources for dealing with the construction and communication of subject knowledge (Dalton-Puffer, 2013). They are thus essential learning goals to be incorporated into the curriculum.

However, the way CLIL programs are currently implemented in some contexts represents a lack of commitment to these goals. CLIL has been found to result in "functional illiteracy" (Meyer et al., 2015, p. 41), with learners showing a poor command of basic discourse functions (Dalton-Puffer, 2004) or failing to articulate subject-specific concepts appropriately (Vollmer, 2008). These findings are an indication that many CLIL teachers still follow traditional, input-based, transmissional approaches in their instructional practices, conceptualize content and language as separate entities and, as a result, fail to understand that progress in the acquisition of knowledge cannot occur without the appropriate use of discipline-specific discourse (Meyer et al., 2015). The adoption of a different perspective on CLIL is therefore needed in which the links between content and language are strengthened through appropriate theoretical and pedagogical proposals.

A relevant approach in this direction is represented by systemic functional linguistics (SFL henceforth), a social semiotic theory of language where learning is understood as "learning to mean and to expand one's meaning potential" (Halliday, 1993, p. 113), and language as "the essential condition of knowing, the process by which experience becomes knowledge" (1993, p. 94). When applied to subject-specific writing at the elementary school level, SFL has proved useful in helping teachers in Australian and North American contexts make explicit

to students the relationship between the communicative purposes and discourse functions of texts (Santiago Schwarz & Hamman-Ortiz, 2020; Schleppegrell, 2004). Comparatively, the impact of CLIL on learners' production of cognitive discourse functions has hardly been analyzed, as CLIL research has largely been limited to contrastive studies with non-CLIL programs on the quality of texts produced by students (e.g., Artieda et al., 2017; Lahuerta, 2020). Two recent studies, however, have attempted to shed light on the academic language competence of grade 6 primary and grade 8 secondary school learners by analyzing their oral production of classification and comparison functions in L2 English and L1 Spanish in science and history (Evnitskaya & Dalton-Puffer, 2020) and their written definitions in history (Nashaat-Soby & Llinares, 2020). Both studies, informed by an SFL theory of learning, further our understanding of how CLIL learners express subject knowledge through their lexico-grammatical choices. However, neither of these studies was classroom-based and the corpus data they used was obtained by means of prompts designed specifically to elicit the targeted discourse functions.

As a result, the relationship between instruction, subject knowledge and L2 writing continues to be overlooked in CLIL primary school contexts. The present study attempts to fill this gap by focusing on the teaching and learning of primary-school CLIL science. Specifically, it is intended as an SFL-informed study of the impact of instructional scaffolding on children's L2 written production of reports, a school genre where defining and classifying are the main cognitive discourse functions.

2. Theoretical framework

The decision to look at children's L2 writing of reports on levers was motivated by the need to address CLIL science teaching from a literacy-oriented perspective. This decision was based on a theoretical assumption that conceptualizes school subjects as examples of social/community knowledge that can be more fully understood with the SFL-informed notions of genre and register. As discussed below, this interpretive framework can be complemented with the notion of cognitive discourse functions propounded by Dalton-Puffer (2013).

2.1. An SFL-informed view of school subjects

SFL provides a framework to understand the social view of subject-specific discourse through one of its basic tenets, which holds that the construction of meaning is facilitated when we flexibly adhere to the discursive conventions prevailing in the community (Coetzee-Lachmann, 2007). These conventions, related both to the content to be expressed and to the different ways of expressing content, are known as "genres," defined in SFL as "staged, goal-oriented social processes

which enact recurrent configurations of meaning and social practices in a given culture or community" (Martin & Rose, 2008, p. 6). As "goal-oriented" processes, genres point to the social functions of texts and, as "staged," they are taken to involve different steps that must be followed to achieve particular social purposes (Martin & Rose, 2008).

Genres are thought to materialize when people make choices from their lexico-grammatical and discursive repertoires, as well as from other semiotic resources (e.g., images, actions, gestures), to construct three types of functional meaning: ideational meaning, related to the representation of immediate or abstract experience; interpersonal meaning, oriented towards interaction with others; and textual meaning, focused on the potential of language for organizing meanings into texts (Schleppegrell, 2004). The specific realizations of these meta-functions, which occur simultaneously in any instance of language, are respectively affected by three situational variables, namely the field of the discourse (the topic), the tenor (the relations between participants) and the mode (the role played by language in the situation). Together, these variables constitute the "register" of texts, characterized as "a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings" (Halliday, 1978, p. 195).

When school subjects have been contemplated through the lens of these SFL core constructs, an increasing number of school genres have been identified (Martin & Rose, 2008; Rose & Martin, 2012), and their characteristic lexico-grammatical features highlighted (Christie & Derewianka, 2008; Moore, 2019). Two basic tenets of this approach are that (i) each subject seems to involve its own genres in which knowledge is "packed," such as, for example, reports and explanations in science or historical recounts in history (Morton, 2020); and (ii) the language used to construct knowledge and understanding in different subject areas, such as history, science, or mathematics, unfolds in different ways (Rose & Martin, 2012). Learning a subject from this perspective, therefore, means "being able to comprehend and produce the types of texts or genres (both oral and written) through which knowledge in the subject is communicated" (Morton, 2020, p. 9).

In consonance with these assumptions, learners' construction of scientific knowledge has been operationalized as consisting of several steps in an idealized knowledge path they are expected to traverse in their guided efforts to become familiar with the conventions of the school subject concerned (Veel, 1997). Each step in that path is taken to involve different genres that, in the case of science learning, have been conceptualized as four major activity domains, ranging from "doing things scientifically" and "organizing the world scientifically" to "explaining phenomena scientifically" and "arguing scientifically" (Polias, 2016).

Children's development in the first three domains has respectively been addressed in three emblematic studies where school teachers in the USA worked in collaboration with university researchers to guide and support English language learners' (ELLs) writing of procedural recounts (de Oliveira & Lan, 2014), reports (Brisk et al., 2011) and explanations (Accurso et al., 2016). De Oliveira and Lan (2014) analyzed the texts produced by a focal 4th-grade child after receiving staged instruction on writing procedural recounts. The child showed an increased ability to signal essential genre features and use more field-specific lexico-grammatical elements and temporal connectors to record events with more precision. In their evaluation of children's appropriation of the report genre after receiving SFL-informed instruction, Brisk et al. (2011) documented the performance of selected individual learners from pre-kindergarten to fifth grade and found that these learners generally understood that the main purpose of the report was to give information and organize the texts by topic rather than chronologically. Finally, Accurso et al. (2016) reported on a 4th-grade child who, at the end of the teaching unit, was able to use genre stages typical of school-based explanations, articulate specific lexical resources on the topic, construct herself as a knowledgeable student, and write more precisely and with greater cohesion.

2.2. CLIL science learning: The role of cognitive discourse functions

Taken as a whole, these studies have shown that ELLs, with the help of SFL-based pedagogies, were able to interpret the world in increasingly scientific ways by engaging in relevant school genres. Similarly, children's development of scientific knowledge in CLIL contexts can be interpreted as their ability to construct meaning in the specific genres and registers of school science, which they must gradually differentiate from everyday language use (Coetzee-Lachmann, 2007; Forey, 2020). However, the attested functional illiteracy of learners in CLIL contexts which, as suggested in the introduction, derives from instructional practices focused separately on content and language, demands that attention is paid not only to genre stages and associated linguistic features (as has been the case with the studies on ELLs discussed above) but also to the cognitive operations that, together with their corresponding linguistic realizations, students activate to remember, analyze, apply and communicate content knowledge. These operations, which have been regarded as organizing frames or building blocks for learners to develop subject literacy, are taken to give CLIL teachers the opportunity of clarifying learning and teaching goals and, therefore, provide a "focused and principled integration of content, literacy and language" (Morton, 2020, p. 11).

Although cognitive operations have been classified in many different ways in the world of education, Dalton-Puffer (2013) has reduced them to seven types

of cognitive discourse functions in the context of CLIL (i.e., classifying, defining, describing, evaluating, explaining, exploring and reporting). Situated at an intermediate level of granularity as compared to the higher levels of genres and registers, CDFs are taken to represent those classroom discourse patterns that "make (disciplinary) thought processes intersubjectively accessible and thus available for learning" (Dalton-Puffer, 2013, p. 230). They provide learners with schemata (discoursal, lexical and grammatical) for the task of "handling and acting upon curricular concepts, content and facts" (p. 231), although their generic and non-essentialist nature means that their meanings are not unitary and stable. Rather, they should be understood as networks that show wide variability in the ways they are realized and/or specified in local contexts.

Bearing these considerations in mind, we have focused our study on the design, implementation and analysis of a teaching unit on the report genre in a specific CLIL context by drawing on SFL-informed approaches to literacy and turning to CDFs as another conceptual framework. An immediate consequence of this approach is that, in order to instruct learners to engage in CDFs and ameliorate functional illiteracy in CLIL contexts as a result, teachers must be helped to move from transmission modes of teaching content to other modes progressively oriented to students' guided and autonomous production of integrated content and language (Meyer et al., 2015). One important means to this end is the teaching-learning cycle (TLC), a recursive pedagogical process consisting of a series of stages that provide a model for teachers to implement literacy instruction (Accurso et al., 2016). Through these stages, students are gradually guided from initial teacher-led analyses of mentor texts in the target genre (deconstruction) and collaboration with the teacher in the production of joint texts (joint construction) to their autonomous control of text writing (independent construction). Students are expected to build their content knowledge through each of these stages with the guidance and feedback received from the teacher (Humphrey & McNaught, 2015). The efficacy of the TLC as an instructional approach in primary school contexts has been shown in both qualitative (e.g., de Oliveira & Lan, 2014, de Oliveira et al., 2020) and interventionist (e.g., Parkin, 2014) research. In the present study, an adaptation of the TLC is employed as an essential methodological procedure.

2.3. The present study

The present study builds on the above suggestions in a project where university researchers and a CLIL primary school teacher collaborated in the planning and implementation of literacy activities informed by SFL and CDFs, which were intended to support EFL children's learning of science language and content. We

designed a unit of instruction in which the lessons provided the children with opportunities and support for writing reports on levers, a central topic within the Spanish science curriculum in primary education. The main aim of the study was, therefore, to determine the usefulness of this instructional approach by describing the functional and linguistic features of the reports written by the children after instruction.

2.4. The report genre

The main purpose of the report genre is to present meanings constructed by others (usually experts) who have done some kind of research on a topic (Polias, 2010). Reports are expected to provide information by describing attributes, properties or behaviors of an entity or class (Fang & Wang, 2011), and organizing data clearly and succinctly (Schleppegrell, 2004). In consonance, reports usually present a relatively static organization which is considered essential to help learners describe and classify the phenomena studied.

As a school genre, reports consist of three main stages: a general opening statement, followed by modules of factual information grouped by topic, and concluded with an optional general statement (Brisk et al., 2011; Christie & Derewianka, 2008). Defined in this way, reports may be thought of as having classifying and defining as their main CDFs (Dalton-Puffer, 2013). According to Evnitskaya and Dalton-Puffer (2020), classifications may vary around three basic parameters which include direction (whether the member to be classified is introduced before the class it belongs to or vice versa), basis (the criteria on which the similarities and differences between members constituting the classification are established), and completeness (whether all three previous elements, that is, member, class and basis of classification, are present or one of them is absent). Definitions, in turn, are usually realized by including class membership and specifying those features (qualities, circumstances, etc.) that distinguish the target term from other terms (Nashaat-Sobhy & Llinares, 2020), although the writer may also provide additional information by means of expansions, which include examples, clarifications, extensions or explanations (Nashaat-Sobhy & Llinares, 2020). As shown below, we have used this description of classifications and definitions to characterize children's reports on levers from a functional perspective.

When viewed from a register perspective, reports are seen to involve four types of meaning (Fang & Wang, 2011) which are presented in Table 1 (adapted to fit the topic of levers).

Table 1 Functional features of reports (adapted from Fang & Wang, 2011)

Types of meaning	Definition	Lexico-grammatical choices to express meaning
Experiential meaning	The content being defined and classified. It consists of processes (what is going on), participants (who or what is involved), and circumstances (where, when, how, with whom, etc.).	- Processes: mainly relational verbs (to be, to have, there is, etc.), and occasional action verbs (push, etc.). - Participants: mainly technical vocabulary (fulcrum, effort, etc.) and complex noun phrases (three types of levers, a type of simple machine, etc.). - Circumstances: adverbials and prepositional phrases (in the middle, on a fixed point, etc.).
Logical meaning	The logical and dependency relations between clauses.	- Simple clauses (the load is the heavy part of the lever, etc.). - Complex clauses (e.g., we need to look at what is in the middle, the effort is where a thing or a man put the effort, etc.). - Non-finite clauses (to identify levers, etc.). - Logical connectors (because, but, etc.).
The combination of experiential and logical meaning forms the ideational meta-function of the report which, in turn, determines the scientific value of clauses, that is, whether or not the student displays knowledge of levers that is acceptable to the scientific community.		
Interpersonal meaning	The way the relationship between the writer and the reader is established.	- Predominance of the declarative mood, with low modality and absence of appraisal features, which means: (i) use of objective, formal language, (ii) consideration of the writer as somebody who "knows" about the topic reported.
Textual meaning	How textual coherence is achieved.	- Mechanisms of thematic progression and referential ties (pronouns, lexical cohesion, etc.).

Given that the weight of what gets defined, classified or compared in reports lies in the ideational meta-function in its double consideration of experiential and logical meaning-making, we focused on children's knowledge construction of levers by looking at how they functionally developed that knowledge through the clauses they produced in their written texts. Accordingly, the following research questions were formulated:

RQ1: How do 4th-year children engage in defining and classifying when writing reports on levers in a CLIL science class after receiving instruction on the development of these CDFs?
RQ2: What ideational meaning-making resources are used by these children to express those functions?

3. Method

3.1. Context and participants

The study was conducted in a state primary school in a middle-class area located in southeast Spain. The participants were 48 4th-year children, aged from nine to ten, divided into two mixed-ability classes taught by the same teacher. As participants

in a CLIL program, the children had been receiving five English sessions and two CLIL Science sessions every week from their 1st year of primary education.

The teacher had been teaching English and CLIL at a primary-school level for more than ten years, held an MA in bilingual education and had taken in-service courses on teaching CLIL. In one of these courses, promoted by the local education authority, she was introduced to SFL principles and related empirical research and became highly interested in the application of this methodology to her own teaching. To that end, she contacted two researchers, former professors of hers (the first two authors of the paper), with the purpose of collaborating in the design and implementation of a project on CLIL science teaching. After deliberating on the chronology, methodology and content to be taught, a series of decisions was jointly taken (see below).

3.2. Instructional sequence

In line with the science curriculum, the decision to focus on levers was based on the content the teacher was expected to cover at the time of the study. This content included the characterization of levers as simple machines, the description of their parts, and their classification into different types. The teacher, in collaboration with the researchers, divided the instructional intervention into two main parts. The first part was intended to build the field by drawing on children's knowledge of levers and gradually familiarizing them with their characteristics and types (four one-hour sessions), while the second part was focused on teaching the writing of reports (another four one-hour sessions). Throughout this two-stage process, the children's written production was scaffolded from initial item-based writing to the autonomous production of texts. Along the way, the teacher made use of talk as a propaedeutic for writing (e.g., Christie & Derewianka, 2008) through "dialogic inquiry," which involved the use of appropriate questions (Valverde Caravaca, 2019), and "class discussions," that is, exchanges of meanings and ideas with the children (Dawes et al., 2010).

3.2.1. Building the field

Initially, the children were given several sets of pictures representing different objects (levers) and were asked to identify their similarities. The aim of this initial activity was to encourage them to use criteria to classify the objects and allow the teacher to elicit their scientific knowledge of levers, which turned out to be inexistent. In fact, the children did not use the term *lever* in any case but relied mostly on their L2 and L1 to describe the objects presented (e.g., crowbars, oars and scissors), suggest what they were used for, or claim that they did not resemble one another (see the example in Figure 1).

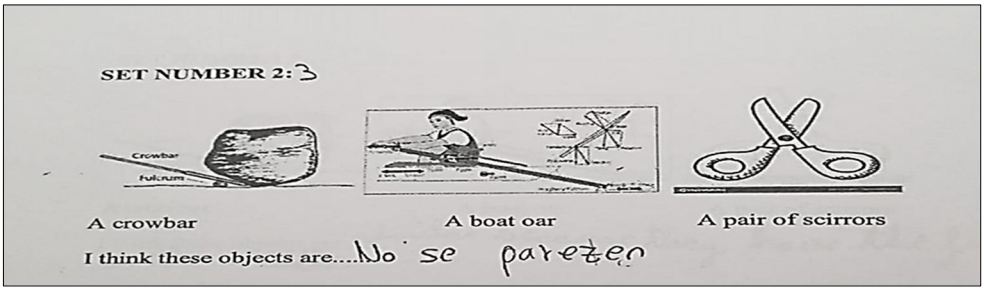

Figure 1 Identification of similarities between different objects

Having collected this information, the teacher's aim was to help the children understand the characteristics and types of levers through activities that included (i) analyzing video presentations and texts; (ii) building bridges between familiar everyday knowledge and unfamiliar scientific content by asking children to identify levers in their nearby environment; (iii) encouraging children to produce appropriate scientific terms to identify parts and types of levers, such as the position of effort, fulcrum or load; and (iv) making sure children were not distracted by the size and appearance of levers in their attempts to classify them.

To check their knowledge after completing these activities in the four one-hour sessions (see above), the children were given (one one-hour session) the initial set of pictures again, as well as a problem-solving activity in which they were asked to classify pictures of levers and give reasons for their choices (see Figure 2). While the outcomes of these activities were checked in class, the teacher elicited examples of levers that, despite differences in size and appearance, belonged to the same group.

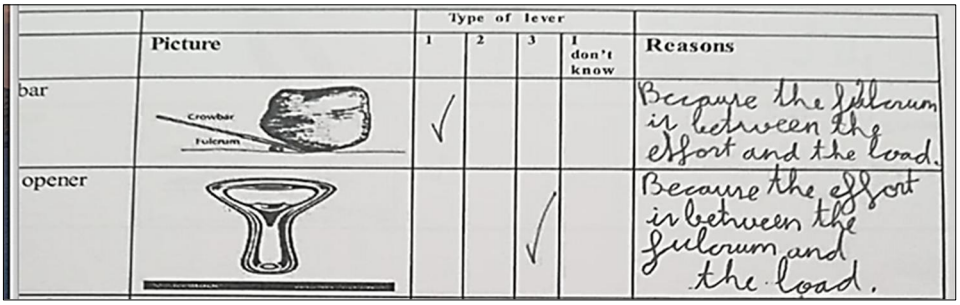

Figure 2 Classification of levers and reasons for the choice

Although specific SFL terminology was not explicitly introduced, its implicit use in the abovementioned activities (e.g., "fulcrum," "effort," "load," as instances of participants; "is," "have," as instances of processes; or "in the middle,"

"on one end," "between . . . and . . ." as instances of circumstances) allowed the teacher to make sure that the children were reasonably familiar with the concepts and terms involved in the definition and classification of levers.

3.2.2. Focusing on reports

Once the field had been built to a reasonable extent, writing instruction began. The teaching sequence employed was largely inspired by the teaching-learning cycle (Martin & Rose, 2008), although an initial model text was not used in this case (see de Oliveira & Lan, 2014 for alternative procedures to initiate the TLC). The children had analyzed two model reports and used a graphic organizer for guided writing in a previous unit on states of matter, and the teacher expected them to have some prior knowledge of the way descriptions and classifications are expressed in this genre.

With those assumptions in mind, the children's transition from supported to autonomous writing was scaffolded with a series of activities that included the use of graphic organizers, guided writing, teacher feedback and autonomous writing (see Figure 3).

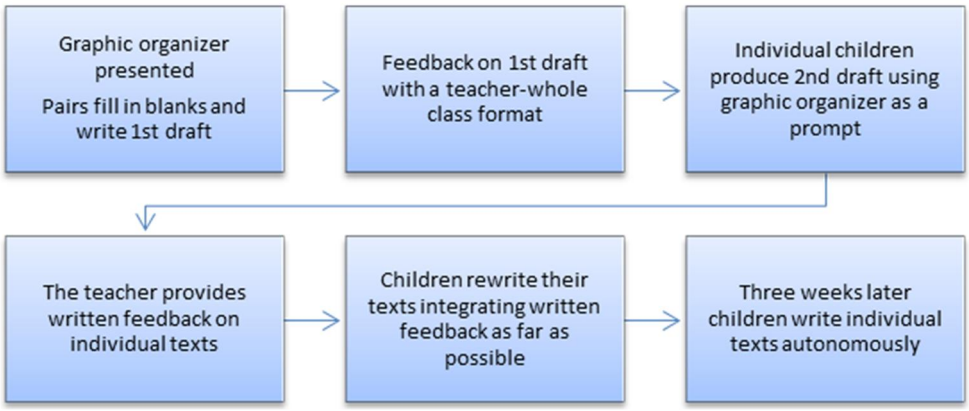

Figure 3 Scaffolding stages in teaching report writing

In the first session of writing instruction (see Figure 3), the teacher presented a graphic organizer intended to adapt the defining and classifying CDFs involved in the report genre (see above) to the specifics of the field previously built (levers) and the children's levels of knowledge and L2 proficiency. The organizer, therefore, consisted of a series of prompts and blanks related to a number of functional subcategories which included the definition of levers and their parts as the basis for their classification in types, the definition of each type, and the comparison of levers in terms of size and appearance by way of conclusion. Expansions in the form of examples were also

included in various sections (see Figure 4). After explaining the meaning and functions of the prompts and suggesting alternatives through sentence modeling on how the blanks might be filled in, the children were asked to complete a draft in pairs using the organizer as a resource. The texts produced were collected by the teacher to identify those aspects in need of feedback.

<table>
<tr><td colspan="3">Definition: Levers are .....</td></tr>
<tr><td colspan="3">Main parts or levers. There are three parts in .....
Definition of each part. The fulcrum is .....</td></tr>
<tr><td colspan="3">Announcing types of levers. There are .....
Criteria to classify levers. The identification of each type depends on .....</td></tr>
<tr><td>Characteristics of 1st type levers .....
Examples .....</td><td>Characteristics of 2nd type levers .....
Examples .....</td><td>Characteristics of 3rd type levers .....
Examples .....</td></tr>
<tr><td colspan="3">Conclusion. Many levers are different in size and appearance, but they belong to the same group.
For example, the ....., the ....., and the ..... different, but they ..... group, because .....
The ....., the ....., and the ..... also look different, but ....., because .....</td></tr>
</table>

Figure 4 Textual graphic organizer for writing a report on levers

In the following session, each pair was given back their text so that they could compare it with the feedback now provided by the teacher to the whole class. The teacher alternatively showed on the whiteboard three of the 24 texts produced by the pairs and used them as input sources to elicit information from the children on:

1) the different functional subcategories covered, as in:

T: In this text, have levers been classified in three classes?
S: Yes, class 1, class 2 and class 3
T: and the last paragraph comparing levers on their size and appearance, has it been included?
SS: No, no
T: Remember that you have to include all the information on the different parts of the diagram (graphic organizer)

2) the scientific validity of certain clauses regardless of the linguistic problems they might involve, as in:

T: And this text says that “in class two, the load is in the middle.” Is it correct?
S: No, because “middle” has only one “d”
T: Right, but one thing is the definition, which is correct, is true, isn’t it?
S: Yes

T: Why is it true?
S: Because the load is in the middle
T: And another thing is that there is a spelling mistake here (points to the word *midle on the WB). Do you understand?
S: Yes

3) the separation of ideas with appropriate paragraphing and/or punctuation, as in:

T. Have these children written a full stop after the definition of levers?
SS: No, no
T: and do you think that they have to write one?
S: Yes, because the definition is different, different that the types of levers, is different
T: Yes, it is a different idea. So, first "a lever is a type of simple machine," then a full stop, and then, starting with a capital letter, "There are different types of levers"

When needed, the teacher also suggested occasional lexico-grammatical alternatives to be used in the appropriate places.

In the next session, each child was given the same graphic organizer and asked to individually write a draft based on it. Once completed, the teacher provided written feedback in the form of comments on each individual text. The feedback provided mostly consisted of (i) focusing children's attention on the functional categories they had not addressed in their texts (e.g., "you have not included the criteria used to classify levers") and (ii) showing them how to formulate full clauses as an alternative to writing in note form (e.g., "Some examples of first type levers are the seesaw . . ." rather than "Examples 1st type: seesaw . . ."). Less frequently, the teacher evaluated the scientific validity of some examples (e.g., "a wheelbarrow is not an example of a first-class lever"), corrected spelling mistakes ("which" rather than "with;" "between" rather than "behind;" "stick" rather than "stich") and reminded a few children to follow the textual structure in the graphic organizer rather than writing in bulleted points (e.g., "you have to follow the diagram"). In the fourth and final session, the annotated texts were returned to the children, who individually rewrote their reports incorporating the feedback provided by the teacher as far as possible.

Three weeks after rewriting their guided texts, the teacher spent one session refreshing the children's knowledge of levers and the textual structure of reports. In the next session, each child was asked to independently write a report, following this prompt:

Write a composition on levers in which you have to:
- Give a definition of levers (and their parts).
- Describe the different types of levers and give examples of each type.
- Say that levers with different size and appearance may be of the same type, and give examples.

The prompt was based on the belief that the three content goals it included might facilitate the children's retrieval of information from their long-term memory (Klein et al., 2017).

3.3. Data analysis

The texts produced by the children in this final session (*N* = 48) were collected for the analysis of their functional structure and ideational meaning. In consonance with the way report writing had been scaffolded by the teacher, the following functional subcategories of defining and classifying CDFs were analyzed:

- Definition of levers: 1) defining.
- Parts of levers: 2) naming parts; 3) defining parts.
- Types of levers: 4) announcing types; 5) giving classification criteria; 6) defining each type; 7) giving examples of each type.
- Conclusion: 8) providing a claim; 9) giving contrasting examples.

The clause was used as the basic unit in which (i) these functional subcategories were embodied, and (ii) the different lexico-grammatical resources used by the children to express ideational meaning became apparent (see Table 1). We did not take into account accuracy, punctuation or spelling mistakes in the analyses of clauses because, together with Brisk et al. (2011), we considered these dimensions to be part of learners' general writing development rather than specific to the report genre.

On the basis of these decisions, we identified a number of variations in the clauses produced by the children which ranged from simple and complex clauses (including coordinate and subordinate clauses) to a few cases in which translanguaging was used. These variations, together with the lexico-grammatical resources used in each case, their scientific value and the functional subcategories concerned, are illustrated in the examples below.

> Example 1: A lever is a type of simple machine.
>
> Logical meaning: simple clause. Experiential meaning: (i) process expressed with a relational verb ("is"); (ii) participants expressed with an expanded noun including a prepositional group ("type of simple machine") plus technical vocabulary ("lever," "simple machine"). Correct scientific value. One functional subcategory involved: defining levers.
>
> Example 2: Levers are simple machines and have three elements: fulcrum, load and effort.
>
> Logical meaning: coordinate complex clause, consisting of two main clauses ("Levers are simple machines," "have three elements: fulcrum, load and effort") and a connector ("and"). Experiential meaning: (ii) processes expressed with relational verbs ("are,"

"have"); (iii) participants expressed with technical vocabulary ("levers," "simple machines," "fulcrum," "load," effort") and an expanded nominal group in which fulcrum, load and effort are the specifications of elements ("elements: fulcrum, load and effort"). Correct scientific value. Two functional subcategories involved: defining levers and naming their parts.

Example 3: A scissors is class 1 because the fulcrum is in the middle.

Logical meaning: subordinate complex clause including a main clause ("a scissors is Class1"), a subordinate clause of reason ("because the fulcrum is in the middle") and a connector ("because"). Experiential meaning: (ii) processes expressed with relational verbs ("is," "is"); (iii) participants expressed with technical vocabulary ("scissors," "class 1," "fulcrum;" and (iii) circumstances expressed with a prepositional phrase ("in the middle"). Correct scientific value. Functional subcategory involved: giving examples of each type of levers.

Example 4: A low (load) is the part you are empujar (push) this cosa (thing).

Logical meaning: subordinate complex clause including a main clause ("a low is the part") and a subordinate defining clause with an elliptical relative pronoun ("(that) you are empujar this cosa"). Experiential meaning: (ii) processes expressed with a relational ("is") and an action verb ("empujar"); (iii) participants expressed with everyday terms in L2 ("low") and L1 ("empujar," "cosa"). Incorrect scientific value. Functional subcategory involved: defining parts of levers.

With these variations in mind, the analysis of all the texts produced by the children was conducted by the two researchers under the principles of collaborative coding (Smagorinsky, 2008). This involved the use of a systematic comparison and contrast approach intended to refine, if needed, the categories previously established with the aim of capturing the nature of the individually produced texts. Discrepancies between the two coders were resolved through discussion until complete agreement was achieved. Eventually, 449 clauses were identified in the aggregate of all texts. The specifics of this global figure are reported in the next section.

4. Results

In response to the first research question, the analysis of the functional subcategories covered by the children showed that four main learner profiles could be distinguished. As shown in Table 2, individual learners within each profile included different information in their texts: from up to three subcategories by each child in profile one (P1, henceforth) and five in P2, to up to seven subcategories in P3 and nine (the maximum) in P 4. In line with these individual results, the number of functional subcategories covered by each profile as a group also increased gradually from four by P1 as a group, and seven by P2, to eight by P3, and nine subcategories by P9.

Table 2 Children's profiles in coverage of subcategories

Profiles (*N* = number of children)	Subcategories covered by each child	Subcategories covered by each profile as a group
Profile 1 (*N* = 11)	Up to 3 subcategories	Defining levers, announcing types of levers, defining types and giving examples of types (4 subcategories)
Profile 2 (*N* = 15)	Up to 5 subcategories	All of the above plus naming parts of levers, criteria for classification in types and claim in conclusion (7 subcategories)
Profile 3 (*N* = 15)	Up to 7 subcategories	All of the above plus giving examples in the conclusion (8 subcategories)
Profile 4 (*N* = 7)	Up to 9 subcategories	All the above plus defining parts of levers (9 subcategories)

Two examples are provided below as an illustration of the different subcategories (in brackets) covered by children in Profiles 1 and 4.

Example 5: Profile 1

a lever is a type of machine examples: sisors, hammer and sisaw.
(Defining with examples)
has three types: class 1, class 2 and class 3. (Announcing types of levers)
class 1: is the fulcrum is between the effort and the load.
class 2: is the load between the effort and the fulcrum.
class 3: is the effort in the middle. (Defining each type)

Example 6: Profile 4

Levers are simple machines (Defining) and they have three parts: the fulcrum, the load and the efford. (Naming parts of levers)
The fulcrum is the part that is stil, the part that doesn't move. The efford is where a person do things with an object. The load is the wight of an object. (Defining each part)
There are three tipes of levers. (Announcing types of levers) To identify the class we need to look what is in the middle. (Providing a criterium to classify levers)
Class 1: in class one the fulcrum is in the middle and the load and efford are in the sizes. Some examples are: the seesaaw, a botele oupener, some scissors...
Class 2: in class tow the load is in the middle and the efford and the fulcrum are in thye sizes. Some examples are: a schoolbag, a weel barrow...
Class 3; in class three the efford is in the middle and tye fulcrum and the load are in the sizes. Some examples are: a broom, a hockey stick... (Describing and giving examples of each type)
Simple machines can be very different but some of them are levers and they can be of the same class. (Providing a conclusion claim) Some examples are: a seesaw and a botele opener of class 1, a schoolbag and a weel barrow of class 2, a broom and a hockey stick of class 3. (Giving examples of the claim)

The answer to the second research question, which inquired about the ideational meaning-making resources used by the children to write their reports, was addressed by taking the clause as the unit of analysis. On this premise, we sought to identify if there were quantitative differences between the profiles identified above in the (i) scientific value of their clauses, the number of (ii) simple and (iii) complex clauses produced, and (iv) the use of complex clauses. For the analyses of (i), (ii) and (iii), Kruskall-Wallis and Mann-Whitney non-parametric tests were used.

As shown in Figure 5, the percentage of scientifically correct clauses produced by Profile 1 (M = 79.73, SD = 3.22) was noticeably inferior to the percentages of the other groups (Profile 2: M = 92.07, SD = 2.46; Profile 3: M = 92.47, SD = 2.03; Profile 4: M = 93.29, SD = 2.28). These differences were confirmed by a Kruskall-Wallis test showing overall significant differences among the groups (χ^2 = 25.82, p = .00). A subsequent Mann-Whitney test identified this significance in the differences between Profiles 1 and 2 (U = .00, Z = -4.28, p = .00), 1 and 3 (U = .00, Z = -4.29, p = .00), and 1 and 4 (U = .00, Z = -3.49; p = .01). No significant differences between other profiles were found.

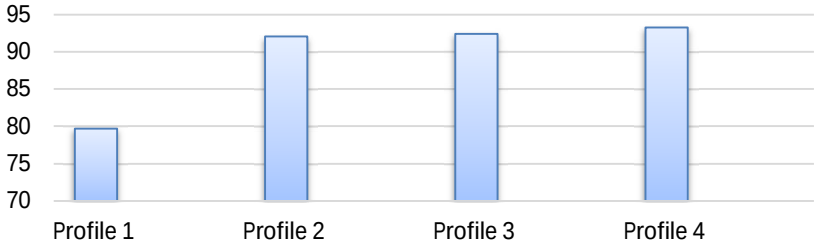

Figure 5 Percentages of conceptually correct clauses by profile

As shown in Figure 6, the average number of *simple clauses* produced by Profile 1 (M = 4.27, SD = 1.61) was almost doubled by the other three profiles, in which the children produced around eight simple clauses each (Profile 2: M = 7.73, SD = 1.71; Profile 3: M = 8.27, SD = 3.01; Profile 4: M = 8.29, SD = 3.03). These differences were confirmed by a Kruskall-Wallis test which showed overall significant differences among the groups (χ^2 = 15.86, p = .00). A subsequent Mann-Whitney test identified this significance in the differences between Profiles 1 and 2 (U = 12.00, Z = -3.71, p = .00), 1 and 3 (U = 23.50, Z = -3.09, p = .01), and 1 and 4 (U = 11, Z = -2.54; p = .01). No other significant differences between other profiles were found.

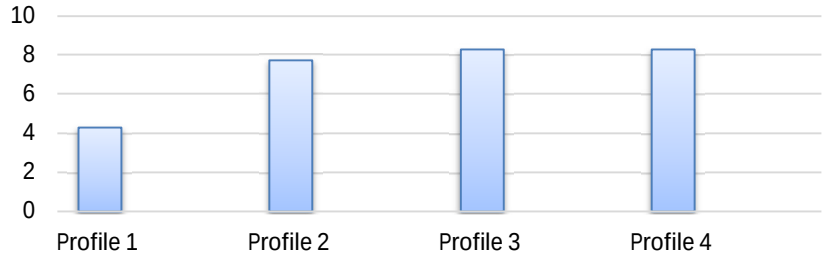

Figure 6 Average number of simple clauses across profiles

A gradual and significant increase in children's performance was apparent when their *complex clauses* were analyzed. As shown in Figure 7, the average production of these clauses steadily increased from $M = 0.27$ ($SD = 0.64$) and $M = 1.40$ ($SD = 1.24$) by children in P1 and P2, respectively, to $M = 2.60$ ($SD = 1.64$) by P3, and was almost doubled ($M = 5.14$, $SD = 2.19$) by the children in P4. These descriptive patterns were globally confirmed by a Kruskall-Wallis test indicating overall significant differences among groups ($\chi^2 = 27.98$; $p = .00$), and subsequently corroborated by a Mann-Whitney test which found significant differences between P1 and P2 ($U = 31.50$, $Z = -2.83$; $p = .01$), P1 and P3 ($U = 8.500$, $Z = -3.96$, $p = .00$), P1 and P4 ($U = .00$, $Z = -3.72$, $p = .00$), P2 and P4 ($U = 5.00$, $Z = -3.41$, $p = .00$), and between P3 and P4 ($U = 15.50$, $Z = -2.67$, $p = .01$). Therefore, the only groups that did not show significant differences in the production of complex sentences were P2 and P3 when they were compared to each other.

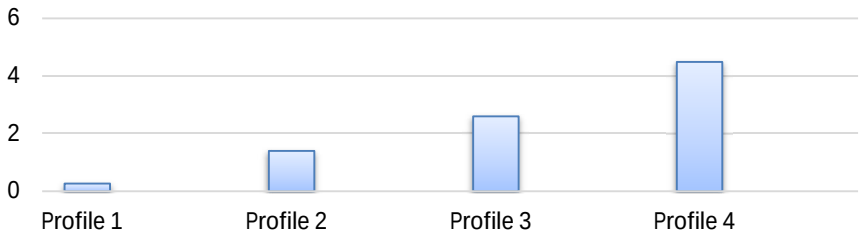

Figure 7 Average number of complex clauses across profiles

Given these differences, we wondered *how these complex clauses were used* by the children across the different functional subcategories covered in their texts. Table 3 shows the five subcategories in which complex clauses (together with unreported simple clauses) were differentially used by the groups. Table 3 also shows the remaining four categories, which were only addressed by means of simple clauses.

Table 3 Use of complex clause by functional subcategory

Functional subcategories	Use of complex clauses (together with unreported simple clauses)	Profiles
Defining levers Naming parts	Yes	All profiles
Defining parts Announcing types	Yes	Profile 4
Giving a criterium Defining types Giving examples of types	Yes	Profiles 2, 3 & 4
Giving a conclusion claim	Yes	Profiles 2, 3 & 4
Giving examples	Yes	Profiles 3 & 4

5. Discussion

The present study analyzed the effects of a teaching unit intended to raise 4th-year primary-school CLIL learners' awareness of the demands involved in understanding and expressing in writing the main characteristics of levers. The data showed that around 75% of the children (Profiles 2, 3 and 4 together) managed to develop their knowledge of the subject matter and to communicate that knowledge following the conventions of the report genre. These results were greatly dependent on the SFL-informed nature of the unit and the fact that children's attention was drawn to the CDFs of defining and classifying as building blocks they could use to develop their subject literacy skills (see Morton, 2020). Crucial pedagogical strategies in this development were the transition from graphic organizers to guided writing and the provision of feedback by the teacher on the texts produced by the children. As shown in the examples above, this feedback revolved around the integration of content and language, since it was mostly focused on the functional subcategories to be covered, the distinction between scientific validity and the formal characteristics of clauses, the textual value of paragraphing and punctuation, and the need to write full clauses rather than notes. The convergence of all these instructional elements eventually allowed the children to express, with varying degrees of success, their knowledge of the topic through subject-specific language, that is, define, classify and exemplify different parts and types of levers by means of simple and complex clauses. These findings indicate that a focus on the ideational function of language to make meaning may enable young learners to express their science knowledge in writing (Hodgson-Drysdale, 2014; Schleppegrell, 2004).

More generally, the study provides novel evidence to suggest that writing instruction combining attention to genre and disciplinary language by means of cognitive discourse functions can scaffold children's integration of language, content and literacy knowledge in a CLIL context. This integration was achieved

through the implementation of adequate pedagogical procedures, and may be interpreted as an alternative to the "functional illiteracy" issue (Meyer et al., 2015). As suggested in the introduction, functional illiteracy has been associated with the prioritization of content over language in CLIL contexts on the assumption that learning general lexico-grammatical features and discipline-related language occurs naturally when content is taught through the target language (Hu & Gao, 2021). These findings also complement research in elementary-school contexts in the US, where a growing number of studies have shown that raising children's awareness of the linguistic and structural features of school genres can help them express their disciplinary content knowledge by producing increasingly complex genre-specific texts (see Santiago Schwarz & Hamman-Ortiz, 2020).

However, as a counterpoint to this positive effect of instruction, the data also showed that Profile 1 children, as compared to the other groups, addressed fewer functional subcategories (not more than four as a group), produced significantly fewer simple and complex clauses, and displayed less content knowledge. As a possible explanation for these findings, the teacher suggested that these children generally showed low levels of L2 oral comprehension in class and that some had important reasoning and memorization problems. They appeared to have little interest in any stimulus that required cognitive effort and had to be assiduously required to pay attention. Similar negative findings have also been reported by Hermansson et al. (2019) in an SFL-informed study intended to assess the effects of the joint construction stage of the TLC on the quality of L1 narrative texts produced by Swedish primary-school children. The low achievers in this study showed very little improvement in the quality of their texts, and the authors speculated that this might have been due to their limited working memory capacity, which did not allow them to process and update the information continuously delivered by the teacher and other class members while engaged in interactive metacognitive talk. A similar difficulty in processing information might have been experienced by Profile 1 children in our study in the different episodes of dialogic inquiry and discussion occurring in the teaching sequence (see the method section). As a result, they benefitted very little from the scaffolding provided in class when faced with writing their reports independently.

These variable effects of CLIL instruction should be viewed in connection with the need to ensure that over- and under-achievers alike may benefit from CLIL programs, especially after claims about their lack of equity have been voiced (e.g., Bruton, 2013). Different European studies on stakeholders' perceptions of CLIL programs have stressed that attention to diversity is a key challenge for practitioners and administrators to address (e.g., Pérez Cañado, 2016). Despite the infancy of the field, both general and specific lines of action have been suggested for this purpose, such as the provision of instruction through flexible

groupings, the negotiation of joint intervention strategies with parents as a function of students' attitudes and capabilities, or the use of continuous feedback (Madrid & Pérez Cañado, 2018). Other proposals include the implementation of specific teacher education programs that incorporate theoretical frameworks and evidence-based practice especially geared to cope with student diversity (More et al., 2016).

6. Concluding remarks

Given the promising results of our exploratory study with young EFL learners, we suggest that a similar approach to writing instruction might be usefully adopted in CLIL primary school science classes to strengthen children's knowledge of the associations between content and language. This seems important, given the mixed findings so far reported about the impact of CLIL science programs on learning outcomes in comparison to L1 programs (Fernández-Sanjurjo et al., 2017), the limited attention paid to language in CLIL classes as opposed to the concerns shown by teachers to ensure that children cover the vast amount of content included in science curricula (López-Ramón, 2015), and the fact that children's writing is undervalued as a site for language learning (Coyle & Cánovas Guirao, 2019). Yet, available scholarship on CLIL writing in secondary-school contexts has afforded detailed longitudinal data documenting the gradual emergence of ideational, interpersonal and textual features in high-school learners' history essays (McCabe & Whittaker, 2016; Whittaker & McCabe, 2020). Although these studies, as noted above, did not include an instructional intervention explicitly aimed at teaching disciplinary language or genre-specific writing, the authors have acknowledged the importance of "making explicit the language for subject literacy" (Whittaker & McCabe, 2020, p. 327). In this sense, the present study offers encouraging results for the application of such an instructional approach in CLIL education with younger learners.

In this application, different avenues for further research might be contemplated. The effects of the present intervention have only been explored in terms of outcome, that is, the final texts produced by the children. A more process-oriented approach might analyze how children transition between each stage of the TLC cycle not only in terms of experiential and logical meanings but also of interpersonal and textual features. This set of functional categories, in their double dimension of teaching and analytical tools, could be shared with teachers and spark further studies on other genres, for more extended periods of time and bearing in mind children's cognitive processes and individual characteristics. The categories could also be used to understand how multimodal resources are used in CLIL classes to achieve the highest degree of "pedagogical

resonance" (Polias, 2010). Finally, SFL-informed professional development programs aimed to integrate the implementation of curricular genres with attention to student diversity might be enacted and explored through university-school partnerships involving iterative cycles of exploration, research design and reflection (Santiago Schwarz & Hamman-Ortiz, 2020).

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