Full Title: What is an Ecosystem? Defining science in primary school CLIL contexts
Short Title: Defining in CLIL

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Abstract

In Content and Language Integrated Learning (CLIL) contexts, students are expected to express disciplinary knowledge in a second/foreign language. One construct that has proven useful for the identification and realization of language functions in disciplinary knowledge is Dalton-Puffer's (2013) model of cognitive discourse functions (CDFs). Additionally, Systemic Functional Linguistics (SFL) has already been proven useful for distinguishing lexico-grammatical features that characterise different CDFs in CLIL students' productions (e.g., Author 2 & Author 1, 2020; Evnitskaya & Dalton—Puffer, 2020). In this article, we use SFL to analyse the oral and written realisations of the CDF Define by 6 th grade students participating in a CLIL program in Madrid, Spain. A total of 83 students responded to the same prompt (on science) in writing (in the form of a blog) as well as orally (in the form of an interview). In the oral interviews the co-construction of definitions by the students with the interviewer (researcher) and another peer are explored using the notion of Legitimation Code Theory and the concept of semantic waves (Maton, 2013). The analysis of students' definitions is also related to primary CLIL teachers' evaluations using comparative judgement.

Keywords: CLIL; systemic functional linguistics; semantic waves; oral and written definitions; comparative judgement

1. Introduction

In many European countries, two major actions have been implemented to enhance bi/multilingualism: lowering the starting age for teaching foreign languages and the implementation of Content and Language Integrated Learning (CLIL) programs, where languages are taught through other school disciplines. These two trends have recently been implemented together in countries like Spain, where CLIL programs in primary schools have grown, particularly in monolingual communities like Madrid and Andalucía. Research on CLIL at the primary school level has been particularly prolific in Spain in the last few years, mainly focusing on the effect of CLIL on students' competence in the L2 (e.g. Pladevall-Ballester & Vallbona, 2016) or on CLIL teachers' and students' attitudes and motivation towards English, often comparing CLIL and non-CLIL contexts (e.g. Campillo, Sánchez & Millares, 2019). However, few studies have explored the double challenge that young learners face in understanding and expressing content in a second language (L2), in other words, the added difficulty of learning academic language in the L2 at such a young age. Almost a decade ago, studies like Madrid (2011) reported on the linguistic difficulties of CLIL students in science in contrast with students studying the same subject in Spanish. If we assume that our understanding of language can be used to model the process of learning (Halliday, 2007), it is key to investigate the specific academic linguistic challenges that primary CLIL students face to access and express knowledge in different subjects. This requires the identification of the linguistic resources that are necessary for students to understand and express content in the L2 in both their oral and written performance, as well as to discern issues that are equally challenging for them when learning the same academic content in the first language (L1). Hughes and Madrid (2020), for example, reported higher scores in science content knowledge by non-CLIL students than by CLIL students, but studies are also needed that look at the same students' abilities to express content in the L2 and L1 (e.g., Author 2 & Author 1, 2020; Whittaker & McCabe, 2020).

A framework that was born with the intention of bridging the gap between disciplinary knowledge and the language used in textbooks and in the classroom, and with the purpose of helping CLIL teachers and their students, is Dalton-Puffer's (2013) model of "Cognitive Discourse Functions" (or CDFs). Previous studies using CDFs have shown that their realization requires different linguistic resources across fields, i.e., across school subjects (e.g., Evnitskaya & Dalton-Puffer, 2020) and topics within the same subject (e.g., Author 2 & Author 1, 2020), which not only adds to the complexity of learning these language functions but also of teaching and evaluating them.

In addition to the many available realizations for a single CDF, expressing content requires the unpacking and repacking of complex concepts by the teachers for students' academic knowledge building (Maton & Doran, 2017). Teachers, in turn, require students to also unpack these concepts to show the extent of their knowledge for learning and evaluation purposes. One way of tracing this process is by applying the concept of Legitimation Code Theory (LCT) and semantic waves (Maton, 2013) in tandem with SFL (Halliday & Matthiessen, 2014). LCT is a sociological model which proposes that different practices and contexts legitimate different forms and codes of knowledge (Maton, 2020). Within this theory, the concept of semantic waves involves the notions of semantic gravity and semantic density. Semantic gravity (SG) refers to the extent to which meaning is context dependent (SG+) or independent (SG-).

Semantic density (SD) refers to the degree of condensation of meaning; the more meanings are related to a term, the more condensed the meaning and the stronger the semantic density (SD+). When introducing technical terms (SG-/SD+), different strategies and communicative resources, including everyday registers and familiar examples (SG+/SD-), are used to unpack the meaning of these terms, which can be repacked, resulting in semantic waves. As the language choices used for realizing these shifts show the range of relations associated with a given term (Maton & Doran, 2017), SFL is the perfect companion for LCT, with its view of language as a system of linguistic choices that is used for communication purposes. To gain insight into the semantic shifts and the linguistic choices in CLIL students' realization of CDFs, it is interesting, then, to explore students' definitions in different modes (written or oral), individually or in co-construction with others.

Finally, several studies have claimed the need for a greater collaboration between teachers and researchers. As argued by Sato and Loewen (2019: 1): "both researchers and teachers need to be willing and open for there to be an effective research–pedagogy dialogue". In their study, teachers pointed out the need for participating in workshops and activities where they could form part of a *community of practice*[1]. In the case of CLIL, the community of practice would need to incorporate content teachers, L2 teachers, L1 teachers and researchers. In other words, dialogue would be necessary between teachers and researchers, but also among teachers with different profiles and backgrounds.

In this study, we investigate primary CLIL students' production of definitions in science, comparing the students' definitions in the language of instruction (English) and their L1 (Spanish). We also compare the same students' definitions in writing and in interaction/co-construction with a teacher/researcher and with their peers. The study also compares the researchers' evaluation of the students' definitions with CLIL primary school teachers' judgments of definitions in a shared CLIL teachers/researchers' seminar.

2. The language of science in CLIL

In the last couple of decades, the field of science education has benefitted from research aimed at innovation in teaching and learning. Some of these studies have emphasized the role of interaction and student-centred approaches in the learning of science (e.g. Lemke, 2003; Mortimer and Scott, 2003). Within CLIL, studies focusing on science classrooms have analysed the use of multimodal resources to "do" science (e.g. Escobar Urmeneta & Evnitskaya, 2014), as well as the role of interaction in students' understanding of technical terms (e.g. Lin, Lo & Liu, 2020; Nikula, 2017), highlighting the effect of scaffolding and unpacking/repacking on students' expression and understanding of scientific concepts.

As any other discipline, physical/natural science has its own genres and discipline-based conventions. In Author 1 et al.'s (2012) application of genre theory to the analysis of

[1] It is necessary to clarify that the term *community of practice* used in Sato and Loewen (2019) is not exactly equivalent to the more complex conceptualization of *Communities of Practice* developed by Lave and Wenger (1991).

CLIL classroom interaction, students are said to encounter three main text types in science: procedures, reports and explanations. As argued in Author 1 et al. (2012), one key feature of the report is the definition of a phenomenon, and because natural sciences, more than in the case of social sciences, often organize knowledge vertically in hierarchical taxonomies, with concepts and constructs building on one another in superordinate structures (Bernstein,1999), defining and definitions are important for the understanding and construction of scientific concepts. While definition is part of a genre, it is considered an independent CDF in Dalton-Puffer's (2013) model, and in the present study.

3. Defining as a cognitive linguistic operation

Defining, like other recurring language functions (classifying, describing, evaluating, explaining, exploring and reporting), is a cognitive process that is represented linguistically when telling others about the extension of an object of specialist knowledge (Dalton-Puffer, 2013). For students to develop scientific literacy, they first need to become familiar with basic concepts, elements and principles in science topics, which starts with knowing specialized terms, paving the way for more complex higher order thinking skills. Knowledge of specialized terms ranges from naming objects or labelling parts of wholes and processes (the lower end), to drawing on earlier studied definitions, and finally to improvising or proposing new ones (the higher end). In order to define, students need to: 1) disconnect the meaning of specialised concepts from their common everyday connotations (Vollmer, 2010, pp. 10-11)—e.g., 'a flask' is a container for liquid, but in science it is part of the laboratory glassware equipment—, and 2) search their linguistic repertoire for a coherent set of descriptions or *specifying features* that would enable others to distinguish the defined term from other similar ones (Benelli, Belacchi, Gini & Lucangeli, 2016). Specifying features may include *class* membership, if students decide to refer to which specific class the target term belongs—e.g., 'a mammal' is 'an animal', or 'a spider' is 'an insect' (vs. 'a living thing' which is broader). Class membership clearly results in more specificity, typical of scientific and academic discourse (Trimble, 1985), and, therefore, definitions which include class are considered canonical (complete). When the class membership forms part of the target term, its mention could be seen as redundant—e.g., 'the periodic *table*' is '*a tabular display* of chemical elements'—, so the term may be defined by its functional description or by its composition (Trimble, 1985, p. 76)—e.g., respectively, 'the periodic table *shows the properties of* individual chemical elements' or 'it *has seven rows and eighteen columns* of metals, halogens and gases, organized by their chemical properties'. This latter definition, though equally meaningful without the class word (*tabular display*), is not considered a canonical definition, but a semi-formal one, as the class membership is not mentioned. Beyond class membership, and drawing on SFL, specifying features may include:

a. *qualities* (e.g. 'interconnected elements').
b. *possessions* (e.g. 'formed of habitat and living things').
c. *circumstances* of place and time (e.g. 'in the same area').
d. *reports* (e.g. 'animals that live, feed and reproduce…')
e. *entities*—an attribute like class membership that does not fulfil an identifying role on its own (Halliday & Matthiessen, 2014, p. 286) — (e.g. 'a combination of living things').

Non-formal definitions may also be realized through examples, translations, comparisons and/or synonyms (see Trimble, 1985, p. 79; Vollmer, 2010, p. 24.). Though all types of definitions (formal with class word, semi-formal without a class word, or non-formal using single words as an equivalent—e.g., synonyms or translations, and any type with or without expansions) are meaningful, formal definitions reflect the type of language gained from school-based tasks, and is considered to require more analysis of knowledge (Snow, Cancino, Temple & Schley, 1990, p. 104).

Irrespective of their formality, definitions may include expansions, which add further information to the definition (Trimble, 1985; Halliday & Matthiessen, 2014):

a. *classifications* (e.g. '…these have three types…').
b. *exemplifications* (e.g. '…for example…').
c. *circumstances* (adding information about time, space, manner, extent, cause, contingency or accompaniment often in the form of prepositional phrases; e.g., 'in…, with …, because of…');
d. *clarification*s (e.g. 'this means that…');
e. *extensions* (additional clauses that are not explicitly marked for any logical-semantic relation with the primary identifying clause);
f. *explications* (explaining new terms that come up when defining).

In LCT terms, defining in any mode requires unpacking the main concept by moving from SG-/SD+ to SG+/SD-, and the more specifying features and expansions there are, the more unpacking there is likely to be.

Naturally, the linguistic choices students make when defining will depend on whether the target term is a tangible object or an abstract concept (Author 2 & Author 1, 2020), but more importantly for the purpose of this study, it will also depend on factors related to the learning situation (Martin & Veel, 1998), whether the situation is one in which students interact and definitions are jointly constructed or students are prompted to produce definitions in writing as a task after an instructional period, also whether students are studying in a bilingual context, using their L1 or L2 to define, and whether the language in which they define in is their curricular language (Snow et al., 1990).

3.1. Definitions across languages

Malakoff (1988) found a strong interaction between the language of instruction and the language of information presentation in primary French-English bilinguals who were receiving primary instruction in either French or English. That is, students were found to perform well on school tasks in the language they were instructed in. This would imply that CLIL students studying through English should be able to perform well (e.g., provide meaningful complete information and conventional definitional structures) on definition tasks in English, provided they had chances to practice with definitions in that language.

Language interdependence was already established by Cummins (1981) and tested in Cummins et al. (1984), showing that the instruction through one language can promote proficiency in another language provided the student has enough exposure and

motivation to transfer the conceptual content accessed in one language to the other language. Again, this would imply that CLIL students instructed in L2 English can be expected to transfer metalinguistic knowledge (semantic and syntactic knowledge) from their instructional settings to productions in their L1 as long as the conditions of exposure and motivation are fulfilled. To see to what extent these premises hold, we refer here to two studies from different contexts that compared primary school students' definitions in two languages.

Snow et al. (1990) elicited oral definitions from 135 primary students in a school in New York in both English (the L1 for most students and the language of instruction in non-language school subjects) and French (the foreign language (L2) in which the students received language classes). The results revealed that students produced overall better definitions in their L1 (also the curricular language) but noted that 9 of the 71 students who provided well-structured definitions in French were considered excellent L2 learners by their teachers and received almost the same score on their definitions in French as in their English definitions. The authors concluded on the positive role of language interdependence.

In the second study, Author 2 & Author 1 (2020) compared the written English and Spanish definitions of 6th grade CLIL students, whose L1 was Spanish and who studied History and Science through English. The prompt invited the students to define a historical period which they had studied in their History class for a blog entry. The students participating in the study were divided into two groups, where one group was given the prompt in English and the other in Spanish. The study yielded two main findings. The first one was that the number of students who chose to define in the group assigned the Spanish prompt was more statistically detectable (79.1%) than in the group assigned the English prompt (33.33%), in other words, two thirds of the students who received the English prompt did not respond to the part eliciting a definition. This indicates that the interface between students' productions and the language of instruction (English) was not visible, but they could transfer knowledge from the latter into their L1. The second finding was that they did not produce canonical structures, irrespective of the language in which they defined (88.89% in English and 70.27% in Spanish out of the total number of definitions). All in all, then, the results from this study did not reveal any noticeable effect for language on defining in this context.

3.2. Definitions across modes

Many studies have compared students' oral and written language production in a variety of contexts, but few have compared students' definitions across modes. Marinellie's (2009) study of primary school students' definitions in their L1 (English) showed that class words (a constituent of formal definitions as mentioned earlier) were produced more in the written mode, and 'time for thinking and planning' was speculated to be the reason for this difference. Interestingly, this may also play a role in oral production, as Snow et al. (1990) noticed that oral definitions characterised by "many false starts, hesitations and restructurings" (p. 96) were also generally better structured.

Hoffman and Hopf (2015), who analysed teacher-student interactions in CLIL Biology lessons in Austria, found that teachers uttered formal definitions when dictating students how to recall definitions for testing purposes (p. 127), thus communicating the

value of showing the full extent of the knowledge available to them in the form of canonical structures. However, the same teachers used non-canonical definitions to introduce new terms and to overcome comprehension problems. These studies, then, indicate differences in the way definitions are taught and required by teachers in oral and written modes.

3.3. Students' definitions and pedagogy

Although teachers often have linguistic and structural/rhetorical expectations of students' productions at different learning stages, these expectations and the purposes of CDFs like definitions are not always communicated to the students. According to a summary of studies on the emergence of CDFs in the classroom, including 'defining' (see Dalton-Puffer et al., 2018), most of the definitions are presented by the teacher, while students minimally engage to make sense of the new information. More importantly, almost never is the object of the definition given conscious attention, i.e., many of the teachers' definitions are not labelled as such and can be seen by the students as clarifications for comprehension, or even as part of the teacher's plenary opening. Also, there are no instances in which teachers pause to discuss definition construction, but rather recite model definitions for students to take note of. This, according to Schleppegrell (2004, p. 36), makes it difficult for the students to play their part well.

Any speech event requires understanding the purpose of the event and making conscious linguistic choices for the task at hand. This, however, is more often than not done implicitly by the teachers as part of their scaffolding routine; for example, in the extracts from a science lesson provided by He and Forey (2018), the teacher uses informal language and gestures to communicate the meaning of new terms, with more demand for the use of specific expressions and academic language as the lesson progresses. Because students are exposed to oral and written language as interdependent communication mediums, it is important that teachers take the time to reflect on what expectations (e.g., completeness and technicality, abstraction, expansions) they have of students for different task types (learning situations). In the case of defining, there are criteria for what makes a "good definition" from an applied linguistics perspective (see Author 2 & Author 1, 2020) but content (and language) teachers' criteria are key, as their expectations from the learning process shape both pedagogy and assessment of their students' expression of content, including definitions of relevant concepts in their field.

4. The present study

The present study draws on an earlier one which investigated the types and composition of the written definitions by CLIL students in History at primary and secondary school levels (Author 2 & Author 1, 2020). This study revealed that there was little difference in students' definitions in their L2 and L1 in spite of the fact that these students had studied History only in English. In contrast, differences were found in relation to the field (topic), even within the same subject (History). Given the relevance of the field in the type and structure of definitions, in this study we focus on primary school CLIL students' definitions in another subject (Biology) and compare not only their definitions in their L2 (English) and L1 (Spanish) but also across modes (in

writing and orally). We also relate our analysis of definitions with primary CLIL teachers' assessments using comparative judgement (Jones & Wheadon, 2015), an assessment method that allows experts (teachers, in this case) to create a reliable scale of quality performance by making holistic comparative judgements of pairs of texts or other types of students' work.

The specific research questions are the following:

1. Are there differences in CLIL primary school students' definitions in science across languages (L2 English and L1 Spanish)?
2. Are there differences in CLIL primary school students' definitions in science across modes, written and spoken?
3. What definitions are considered better by CLIL teachers in science as shown in comparative judgements?

5. Context, data and procedures

The study forms part of two larger research projects[2] one of whose aims is to examine the development of students' academic language resources for the expression of content in the transition from primary to secondary education in the Comunidad de Madrid bilingual program (Spain). The data was collected using specific prompts to elicit the seven CDFs (Dalton-Puffer, 2013) in learners' written and oral productions (in the form of a blog entry and an interview on a radio show, respectively), both in L2 English and L1 Spanish. Oral prompts followed the structure of the written prompts, both in terms of the topic and the types and the sequencing of the elicited CDFs. The participants in the oral task were a researcher/interviewer and two students. Thus, the CDFs were often co-constructed between the researcher and a student, or between students. The analysis of students' academic language production was done using Trimble's (1985) structural approach for the analysis of definitions, SFL for examining specifying features and expansions, and LCT for exploring semantic waves in co-constructed oral definitions. The project also involved content and language teachers participating with researchers in the assessment of students' expression of content (thus, using a content and language integration perspective).

5.1. Data

The participants in the present study are students in their last year of primary education (grade 6, ages 10-12). These students have studied 1/3 of the curriculum in English since grade 1, including the discipline of Natural Science. As shown in Table 1, all the grade 6 students from one school (a total of three groups) participated in the study. Two groups, a total number of 55 students, were prompted to define *Ecosystems* in English in the written task, and almost the same students subsequently defined the same term in the oral task on the same day[3]. The written prompt began as follows: *You are a teenage adviser for Greenpeace. Today you are writing an Internet blog about ecosystems. Please define for your readers what an ecosystem is…*The oral prompt was presented in the form of a radio program, as follows: *Remember you are a teenage adviser for Greenpeace. You have written your blog on Ecosystems. Today you are on a*

[2] These projects have received support from the Spanish Ministry of Economy and Competitiveness (FFI2014-55590-R) and the Spanish Ministry of Science and Innovation (RTI2018-094961-B-I00).

[3] As shown in table 1, 3 students in group C did not perform the oral task

radio program. We are going to be talking about Ecosystems. Can you tell us/the audience what an ecosystem is? Both the written and oral prompts continued eliciting other CDFs.

A third group of 28 students (Group B) responded to the same prompt in Spanish. The groups that responded to the prompt on Biology in English (A and C), responded to the prompt on History in Spanish and viceversa (see Author 2 & Author 1, 2020, on the History prompt).

Table 1. Number of participating students

	Science in English		Science in Spanish
	Group A	Group C	Group B
Oral – in pairs	26 (13 pairs)	26 (13 pairs)	28 (14 pairs)
Written – individually	26	29	28

5.2. Procedure

We used Trimble's (1985) types of definitions to code our data; however, in line with a previous study on CLIL students' definitions in History (Author 2 & Author 1, 2020), both semi-formal and non-formal definitions were coded as semi-formal. To code specifying features and expansions, we resorted to SFL (Halliday & Matthiessen, 2014) and created a scheme in the UAM-Corpus Tool (see O'Donnell, 2008) with definition types, specifying features and expansions (see Table 2). SFL allowed us to identify the linguistic components of students' definitions following a meaning-oriented perspective, which was considered necessary for an integrated approach to content and language learning. For the analysis of the oral data, SFL was complemented with LCT, and more specifically with the concept of "semantic waves", as has been done in recent studies on CLIL (Lo et al., 2020). Coding decisions were taken after thorough discussions and full consensus of both co-authors.

Table 2. Definitions: types, components, and examples[4]

Following Trimble (1985)		Examples	Description
Definition Types	Formal (canonical)	An ecosystem is ***some space*** that have water, forest, plants, air, living things and rocks.	*Canonical form with definiens and differentia*
	Semi-formal (non-canonical)	The ecosystem is ***like a food chain***.	*Definition without an explicit class word (with or without specifying features)*

[4] All the examples from students' language in the manuscript are verbatim from the children's output

Following Halliday and Matthiessen (2014)

Specifying features	Class	An ecosystem is ***a habitat*** formed of living things	*A feature that functions as a categorical word.*
	Quality	An ecosystem is a ***natural*** system…	*Assigning a quality to the term (or subject of the definition).*
	Possession	An ecosystem is some space that ***have*** water, forest, plants, air, living things and rocks.	*Assigning possession to the term*
	Circumstance	An ecosystem is all living things ***in the world***.	*Assigning a circumstance to the term (time, space, manner, extent, cause, contingency, accompaniment)*
	Report	An ecosystem is a community of animals and smaller organisms ***that live, feed, and reproduce.***	*The specifying features take the form of 'reporting' actions or events.*
	Entity	Un ecosistema es ***todo lo relacionado con la naturaleza*** (An ecosystem is ***all that is related to nature***) [5]	*Assigning the term membership specification*
Expansions	Classification	Un ecosistema es … […]. Los animales viven en diferentes sitios ***unos son aquaticos, otros son terrestres y otros son de los dos tipos***. (An ecosystem is…[…]. The animals live in different places ***some are aquatic, others are terrestrial, and others are of both types***).	*Elaboration: Taxonomizing and categorizing*
	Explication	None found	*Elaboration: Using synonyms to explain terms that need explanation within the definition*, found in natural sciences and technology, according to Trimble (1985)
	Exemplification	… it also includes non-living environments …: ***the weather, the climate***	*Elaboration: Giving examples*
	Circumstance	None found	*Enhancement: Expanding through circumstance (time, space, manner, extent, cause, contingency, accompaniment)*

[5] Examples from students' definitions in Spanish are provided in the table where the exemplified features were not used in English.

	Clarification	None found	*Elaboration: to be more precise or to back up the primary clause with an explanatory comment*
	Extension	Un ecosistema es una comunidad de hábitats y animales o insectos, etc. ***Los animales/insectos están integrados entre ellos mismos y los hábitats.*** (…etc. ***The animals/insects are integrated among themselves and with the habitat***)	*Expansion clauses that are not explicitly marked for any logical-semantic relation.*

In addition, two primary CLIL science and English teachers assessed the definitions written by the students in English using comparative judgement. This was done as part of a seminar where 7 primary and secondary school teachers of English, Spanish, Science, History and Art judged CLIL students' production of different CDFs in different subjects and the results of their judgments were subsequently discussed with the research team. The teachers were asked to use their own criteria in their judgements of the students' definitions, using the program "No More Marking" (https://www.nomoremarking.com). In this paper, we present the ranking of the students' definitions of "Ecosystem", resulting from the two primary school teachers' judgements as well as the discussion that followed in one of the sessions of the seminar.

6. Findings

We present results comparing students' written definitions across languages, students' definitions in English across modes (written and oral) and teachers' judgements of students' written definitions in English.

6.1. Students' written definitions across languages

With regards to the types of definitions used across languages, Table 3 shows no statistical differences between students' definitions in English and Spanish, it shows that the majority of the definitions in both languages are formal (see examples 1 and 2) and that the only difference is that the formal definitions in English are somewhat higher in number. What is also evident in both languages is the small number of *expansions*, although the expansions in Spanish were more (5 expansions as opposed to 2 expansions in English), which were mostly *exemplifications*.

Example 1: *An ecosystem is a community formed of a habitat, living things and the interaction between the different living things*.

Example 2: *Un ecosistema es una comunidad formada por seres vivos, habitantes y la diferencia entre los seres vivos y sus habitats*.

Table 3. Instances, types and components of definitions across languages at Primary school level (Ecosystems)

		English		Spanish		T-STAT	Significance
		N of Ss = 55	Per 1000 tokens	*N* of Ss = 28	Per 1000 tokens		
N of Definitions		55		27			
	Formal	41	4.81	22	4.56	0.29	
	Semi-formal	14	1.64	5	1.04	0.67	
Specifying features and Expansions		*N*= 130		*N*= 63			
	Specifying features	128	15.03	58	12.03	0.89	
	Expansions	2	0.23	5	1.04	2.17	++
Breakdown of Specifying features		*N*=128		*N*= 58			
	Class	40	4.70	22	4.56	0.39	
	Quality	8	0.94	5	1.04	0.40	
	Possession	53	6.22	22	4.56	0.82	
	Circumstance	18	2.11	6	1.24	0.89	
	Report	9	1.06	1	0.21	1.59	
	Entity	0	0.00	2	0.41	0.00	
Breakdown of Expansions		*N*= 2		*N*= 5			
	Classification	0	0.00	1	0.21	0.00	
	Explication	0	0.00	0	0.00	0.00	
	Exemplification	2	0.23	3	0.62	1.27	
	Circumstance	0	0.00	0	0.00	0.00	
	Clarification	0	0.00	0	0.00	0.00	
	Extension	0	0.00	1	0.21	0.00	

* +++ indicates significance at 98% level, ++ at the 95% level and + at the 90% level

Though the language in which students studied Biology and ecosystems was English, they employ similar definitional structures in terms of type and functional components in Spanish. This shows that these students were able to transfer semantic and syntactic knowledge learned in English to their L1, as in previous studies (Cummins, 1981; Snow et al. 1990). These results are in line with those reported by Author 2 & Author 1 (2020) where these very same students produced the same type of definitions (in this case semi-formal) in History.

6.2. Students' definitions across modes

When comparing the students' performance on definitions across modes in English, a higher percentage of formal definitions can be observed in the written mode, as seen in Table 4 below, though these were not statistically detectable. The main differences observed across modes are the statistically higher occurrence of *specifying features* in the written data, especially *possessions* (An ecosystem *has*; is *formed of*/*by*…), and the statistically higher occurrence of *expansions* in the spoken data. Regarding the use of expansions, in the spoken definitions there is more variation in the type of expansion as well as a higher statistically detectable number of *exemplifications* than in the written data. These, however, could be the result of students' commentary on each other's definitions in the oral task.

Table 4. Instances, types and components of definitions across modes at Primary school level (Ecology)

		Spoken		Written		T-STAT	Significance*
		N of Ss = 52 (26 pairs)	Per 1000 tokens	*N* of Ss = 55	Per 1000 tokens		
N of Definitions		*N*= 30		*N*= 55			
	Formal	18	0.41	41	4.81	1.04	
	Semi-formal	12	0.27	14	1.64	1.06	
Specifying features and Expansions		*N*= 77		*N*= 130			
	Specifying features	53	1.20	128	15.03	2.82	+++
	Expansions	24	0.54	2	0.23	6.44	+++
Breakdown of Specifying features		*N*= 53		*N*= 128			
	Class	18	0.41	40	4.70	0.94	
	Quality	0	0.00	8	0.94	0.00	
	Possession	16	0.36	53	6.22	2.56	+++
	Circumstance	9	0.20	18	2.11	0.35	
	Report	1	0.02	9	1.06	1.77	+
	Entity	9	0.20	0	0.00	0.00	
Breakdown of Expansions		*N*= 23		*N*= 2			
	Classification	0	0.00	0	0.00	0.00	
	Explication	2	0.05	0	0.00	0.00	
	Exemplification	9	0.20	2	0.23	3.20	+++
	Circumstance	1	0.02	0	0.00	0.00	
	Clarification	4	0.09	0	0.00	0.00	
	Extension	7	0.16	0	0.00	0.00	

* +++ indicates significance at 98% level, ++ at the 95% level and + at the 90% level

In line with other studies, the fact that more formal definitions were found in writing could be explained as follows: 1) the students probably perceived the written prompt as a school task, or situated them in that set of mind, whereas the oral interview was perceived as a more conversational activity (see Snow et al., 1990); 2) the teachers' definitional style during classroom interaction could have led the students to reserve the more formal definitions for written production (see Hoffman & Hopf, 2015); and finally 3) in the writing task the students had more time for thinking about which class words to use and for planning/recalling the canonical structure (Marinellie, 2009), which could also explain the higher number of *specifying features* (*possessions* mostly and some *reporting*) in this mode.

The analysis of the oral interactions between the students and the interviewer showed that the majority of the cases of expansions (18 of 24 cases) were prompted either through an explicit request to add more information (example 3) or as a response to backchanneling (example 4) by the interviewer. On fewer occasions we see students volunteering expansions in the spoken definitions (example 5)

Student	Interviewer	*Expansion*
Example 3: *Are some animals and some plants that are together in the same place*	*Can you add anything?*	*They are in the same place environment or area* (explication)
Example 4: *All the living things that help live better*	*Hmm*	*And also there are also non-living things that also help us live* (expansion)
Example 5: *An ecosystem is a place in where living things and habitat-non-living things living things and the habitat live together*	_____	*and is also composed from the interactions between the living things, themselves and the habitat* (clarification)

To understand the phenomenon of unpacking information in oral definitions, we showcase the application of LCT and the concept of semantic waves in Extracts 1 and 2 below, which allowed us to investigate how oral definitions were co-constructed with the interviewer/researcher. Although the extracts do not reflect stringently the complete wave-part of the theory, we believe they illustrate the shift movement from the technicalized and condensed meaning of 'ecosystem' or 'living things' (SG-/SD+) to the simpler more concrete examples (SG+/SD-) and viceversa, as well as its role in the co-construction of spoken definitions.

Extract 1

S1 ah is **all the living °things that the planet has.**°

INT can you add anything?

S2 e:h (.) e:h there are other °living things.°

INT hm hm so, **for example**?

S2 **e:h for example: plants, animals and us ((she points at MC and herself)).**

INT that's it, right. It's good to do both, to do a scientific definition and then to help people understand (.) you know, what this means, because it is very abstract. °I think that's very nice.°

In this extract, the interviewer/researcher prompts S2 to unpack the concept of 'living things' (SD+/SG-), introduced by S1, with an example. S2 responds with "plants, animals, and us", showing actual understanding of the term 'living things' as part of the definition of *Ecosystems*. Interestingly, the interviewer comments afterwards on the need to both use and explain abstract terms. Another example of students' co-constructed definitions (scaffolded by the interviewer) is shown in Extract 2 below.

Extract 2

INT **…**So the first thing is to define (.) an ecosystem ((LS nods)). Which of you would like to do that?

S1 eh ok- **an ecosystem**,

INT hm hm

S1 **i- are some animals and some plants that are are together, a eh are i- in the same place.**

INT hm hm. Can you add anything?

S2 e:h yes. **Tha:t they are e:h** ((looks at HV)) **in the same place like he: like she said, and and he is in an environment or an area.**

INT hm hm. That's nice, okay.

In contrast with the previous extract, here S2 provides a more abstract/academic term for "animals and some plants together in same place", repacking S1's concrete specific terms (SG+ and SD-) into the term 'environment' (SG-/SD+) within the context of Ecosystems.

6.3. CLIL teachers' judgements of students' definitions

After selecting 7 of the students' definitions illustrating the different types and structures identified in our analysis (including formal, semi-formal, with and without expansions), we asked two primary school CLIL teachers to assess them using comparative judgment (through "No More Marking"). The ranking obtained from the judgements is presented in Figure 1 below:

Figure 1. Results of teachers' assessment of students' definitions using *comparative judgement*

A) An ecosistem is like a foodchange, in an ecosistem we have producers, consumers and decomposers.	0
B) An ecosystem is all the living thing (plant, animals) in a give area.	1,1
C) An ecosystem is a complex set of relationships among the living resources, habitats and residents.	2,2
D) And ecosystem is a comunity formed of a habitat, living things and the interactions between the different living things themselves and the habitat	3,8
E) An ecosystem is some space that have some water, forest, plants, air, living things and rocks.	5,6
F) Ecosistem includes all of the living things in a given area, interactin with each other, and also with their non-living things enbironment.	6,2
G) An ecosystem is an erea with lots of living things interacting with each other. it also includes non-living environments with are: the weather, the climate…	10

Interestingly, the definition marked as 'D' is the most similar to that found in the students' textbook: "An ecosystem is a community formed of a habitat, living things and the interactions between the different living things themselves and the habitat", but was ranked relatively low by the teachers. This shows that students are expected to produce language that even their textbooks do not model. Also, this definition is not unpacked and, thus, does not reveal the students' understanding of the concept.

In the discussion with the teachers on the results of their judgment, both agreed that the definition had to be as complete as possible, and should include certain components; in this case, both 'living' and 'non-living things' needed to be mentioned: *"La definición tiene que ser lo más completa possible, entonces incluir 'living things' y 'no living things'. Eso solo lo incluyen las dos últimas, por lo tanto, podrían ser casi intercambiables" (The definition has to be as complete as posible, thus include 'living things' and 'no living things'. These are only included in the two last ones, so they are almost interchangeable).* That is the reason why F and G were rated higher. The fact that 'G' was rated the highest is possibly related to the students' use of examples for 'area', thus unpacking its meaning, although the teachers did not refer to this in the discussion. They also regarded some forms of semi-formal definitions as unacceptable, this being the reason for considering definition 'A' worse than all the others: "*Nunca puedes poner en una definición 'is like a'" (You can never define using 'is like a').* More importantly, though, in terms of content matter, the CLIL teachers (both English and Science specialists) found the definition to be erroneous in 'A' in that an ecosystem is defined as a food chain: "*Es un concepto erróneo, porque está hablando de cadena alimenticia, no del ecosistema, entonces eso es confundir un concepto con otro" (It is an erroneous concept, as he/she refers to the food change, not to ecosystems, so he/she*

is confusing one concept with another one) Interestingly, there was tension between favouring conceptual synthesis or condensation of meaning (SD+) and being specific (SD-): *"Para mí la capacidad de síntesis que tenga un alumno a la hora de definir a lo mejor vale hasta más que enumerar un montón de elementos. Sin embargo, desde el punto de vista del profe, a lo mejor, estamos dando prioridad a que especifique exactamente" (For me a student's capacity of synthesis in defining is perhaps more valuable than enumerating a lot of elements. However, from a teacher's perspective, perhaps, we are prioritizing that they specify exactly).*

7. Discussion and conclusion

The analysis of CLIL primary school students' definitions in science has shown no differences in the type of definitions used by the students in the language of instruction (English) and the L1 (Spanish). Most of the definitions were formal and revealed few expansions, regardless of the language used. These results align with those obtained in a previous study on these same students' definitions in History (Author 2 & Author 1, 2020), where students used the same definitional structure in both languages (semi-formal). This finding stresses the role that field/topic plays in the type of definition produced (semi-formal in History and formal in Science). In contrast, the fact that students studied Ecosystems in English or that their mother tongue was Spanish did not seem to play a major role in the type of definition produced, pointing to language interdependence being at play (Cummins, 1981; Cummins et al., 1984). Interestingly, some differences were observed in students' definitions across modes (written and oral), particularly in the use of more expansions in the spoken mode. A closer look at the oral data using SFL and LCT showed that the definitions co-constructed with others (peers/interviewer) had more details through expansions and motivated repacking meaning into technicalized terms, unlike in written definitions. The oral production of definitions or other CDFs in interaction with the teacher or a peer could be an interesting pedagogical tool for teaching and assessing students' understanding of academic concepts, especially in the case of young students, who may have not been sufficiently encouraged or taught to elaborate yet. As argued in previous research on school science (e.g. Mortimer & Scott, 2003), students' active participation in the co-construction of academic knowledge may contribute to a fuller interpretation and understanding of their classroom experience and provide teachers with better evidence of their scientific knowledge. This view of learning science in communities of practice and interaction is particularly relevant in the case of definitions, which are often learnt by heart by students from textbooks and their teachers. Allowing students to define concepts orally and co-construct them with their peers may help them to show their understanding of concepts. This is even more relevant in CLIL contexts, where the use of an L2 is an added challenge to the scientific verticality and abstractness characteristic of science classrooms, and at primary school level, as academic concepts and language are particularly challenging at an early age, in both bilingual education/CLIL and non-CLIL contexts.

This study has also tentatively illustrated the potential value of applying LCT and Maton's (2013) concept of semantic waves, moving from SD+/SG- to SG+/SD- and

viceversa, in both CLIL research and pedagogy. While SG+/SD- allows teachers to see to what extent students understand the scientific concepts and, thus, scaffolds them in the challenge of referring to abstract complex issues, once the concept is clear and understood, it is necessary to bring students back to academic register through SG-/SD+. As argued by Lin (2016):

> The key point in deconstructing/analysing academic texts is, thus, to heighten the academic language awareness of both (content/language) teachers and students so that each individual experience (or encounter) with a curriculum text becomes a learning opportunity to infer the linguistic resources (e.g. vocabulary and sentence patterns) useful for achieving functions, and these resources can come in useful when students are constructing texts of/on their own (p. 43).

The fact that definitions tend to appear in the written format in textbooks and thus typically exhibit SG- and SD+ point at the interest in teachers and students unpacking and repacking written definitions in oral discourse, as shown in this study. Following other studies on CLIL (Lo, Lin & Liu, 2020), the concept of semantic waves is key for helping CLIL teachers to guarantee students' learning of academic language to express (and, thus, learn) academic content (and language) in specific school disciplines.

Thus, in the light of our results from the analysis of students' definitions, there are a number of pedagogical implications that can be derived: 1) work on students' production and learning of CDFs in one language can be transferred to another language, so the fact that the language of instruction is the L2 does not seem to have a negative effect on students' production of the same CDF in the L1; 2) eliciting CDFs like *Define* in different modes (writing, orally, co-constructed) offers students the opportunity to show their knowledge of the scientific concept in different ways; 3) the use of semantic waves to analyse students' definitions seems a useful pedagogic tool for uncovering their understanding and tracing the semantic shifts in their expression of scientific concepts.

Finally, this study has shown the importance of involving CLIL teachers in research studies like this. For students to become familiar with the discourse characteristics and register expected from them in different situations, more explicit instruction for definitional purposes is required. The seminar carried out with the teachers had a reciprocal benefit: it allowed content and language teachers to reflect on content and language integrated issues and it helped researchers relate their evaluation of the linguistic features used by students to express different CDFs with teachers' assessments. In the present study, the teachers showed the importance of details and completeness, which were particularly present in the expansions of oral/co-constructed definitions. Interestingly, accuracy in L2 was not a priority for these teachers (who were both content and language specialists).

As pointed out by Sato and Loewen (2019: 7), "… researchers need to provide tools or techniques that can actually be evaluated by teachers". Recent work in general education is increasingly advocating comparative judgement, claiming that this approach achieves higher levels of reliability than absolute judgements using marking scales and rubrics (Jones & Wheadon 2015; Pollitt, 2012). This method can contribute

to developing assessment literacy (Xu & Brown, 2016) among CLIL practitioners. It can also contribute to a greater involvement and contribution of CLIL practitioners in the research process. In this respect, the present study constitutes a first step, illustrating a promising way forward for assessment in CLIL, with different teams of raters. In the present study the raters were two teachers who were both content and language specialists, whose judgement scales were discussed in relation to the analysis of definitions carried out by the researchers. Future studies should follow along these lines, incorporating different groups (subject specialists, language teachers, applied linguists) to rate samples of students' texts produced in response to content-based tasks, building, then, communities of practice where teams of CLIL (content and language) teachers and CLIL researchers can work together.

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