Hands-on tasks in CLIL science classrooms as sites for subject-specific language use and learning

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1. Introduction

This paper is concerned with the context of content and language integrated learning (CLIL) where L2 is used for instruction and where content and language learning objectives merge (for CLIL overviews, see e.g. Dalton-Puffer, Nikula & Smit 2010; Dalton-Puffer 2011). It explores Finnish secondary level students' engagement in hands-on tasks in CLIL science (chemistry and physics) lessons instructed in English, with a guiding assumption, advocated by earlier systemic functional research in particular, that different subjects have their characteristic ways of using language to make meaning (see e.g. Coffin 2006; Schleppegrell 2004) and that therefore, given the content-based nature of CLIL classrooms, language learning in these contexts should best be approached as attainment of academic and subject-specific vocabularies, genres and ways of constructing knowledge (see e.g. Nikula 2012; Llinares, Morton & Whittaker 2012; Morton 2010). In this article, attention will be paid to opportunities that hands-on tasks entail for using and learning subject-specific language.

Another choice of perspective, influenced by sociocultural and language socialisation orientations towards language learning in particular (e.g. Duff & Talmy 2011; Lantolf 2000; Lantolf & Thorne 2006; Zuengler & Cole 2005), is seeing learning as social, contextual, participatory and interactional, therefore best examined by close attention to how CLIL students and teachers use language and engage in negotiations to reach shared understandings. Language socialisation perspectives in particular, as Zuengler and Miller (2006: 40) point out, also highlight the interconnectedness of linguistic and cultural learning. In the case of CLIL classrooms, such cultural learning, apart from concerning the general educational and academic culture, also pertains to what could be called subject-cultures, i.e. the need for learners to become socialised into various subject-cultures and their ways of using language. In this article, subject-culture specific language will be studied in the context of language use in hands-on tasks. Learning, for its part, is approached from the perspective of the type of opportunities that hands-on situations seem to offer for learning rather than seeking to identify eventual learning outcomes. As earlier CA-for SLA research in particular has demonstrated, even if interactional data can exhibit participant orientations to learning objects and learning, attesting what in interaction counts as evidence of learning is a more problematic matter (see e.g. Kasper & Wagner 2011; Seedhouse 2006).

Exploring CLIL classroom tasks from the perspective of subject-specific language is important not only from the perspective of learners and their developing language repertoires but also from the perspective of teachers and their ways of making subject-specificity salient. In the European context, CLIL teachers are usually subject teachers rather than language teachers. It has been noted several times earlier (e.g. Dalton-Puffer 2011) that despite the purported double focus on language and content, CLIL is usually content-driven, with the role of language often remaining ambivalent and teachers emphasising their roles as content teachers (e.g. Bovellan 2014). However, given that CLIL classrooms also entail language learning it would be important for teachers, in the same way as Cammarata and Tedick (2012: 257) argue about immersion teachers, to "revisit and reshape their teaching identity – that is envisioning themselves not only

as content teachers but language teachers as well". With the focus on subject-specific language, a main argument throughout this article is that it is useful to envision CLIL teachers' language teacher role in a different manner from foreign language teachers given their specific role in supporting learners' socialisation in the genres and registers of their subjects (e.g. Llinares, Morton & Whittaker 2012).

2. CLIL, tasks and the concept of language

It can be argued that there is a close affinity between CLIL and task-based approaches to language learning because a central concern for both is to enhance language learning by engaging students in meaningful language use. In fact, if we consider the core criteria that Ellis (2009:223) suggests as essential for a language-teaching activity to be called a task, namely the primacy on 'meaning', existence of some kind of 'gap' (for information, to express opinion), learners largely relying on their own resources to complete the activity, and a clearly defined outcome other than the use of language, CLIL classrooms can certainly be called task-based environments, and the connection between task-based pedagogies and CLIL has indeed been brought up by researchers (e.g. Escobar Urmeneta & Sánchez Sola 2009; Lorenzo 2007).

However, when considering language learning more specifically, the difficulties of mapping task-based language teaching and CLIL emerge. As pointed out above, despite the dual focus on content and language, CLIL teaching tends to be largely content-driven, scheduled as content lessons, and usually taught by subject specialists rather than language teachers (see Dalton-Puffer 2011). This means that explicit attention to language matters is relatively rare, or at least not necessarily systematically planned in the way for example Lyster (2007) advocates for immersion classrooms by what he calls a counterbalanced approach which involves planned attention to both content and language matters. Hüttner, Dalton-Puffer and Smit (2013) suggest that, as far as CLIL teachers' and students' beliefs are concerned, both groups perceive of the absence of explicit language management as a success factor that sets CLIL apart from foreign language instruction. As pointed out above, such lack of overt focus on language matters in CLIL classrooms may also relate to teacher identity issues, CLIL teachers often occupying a somewhat uncertain position towards language teaching which they tend to see as a separate endeavour from content teaching (Skinnari & Bovellan, forthcoming).

One probable reason for the uneasiness around language issues in CLIL derives from the way language learning and skills are conceived of and conceptualised: the language-as-system view prevails and language learning outcomes of CLIL tend to be seen in terms of general language skills (see Nikula & Mård-Miettinen, 2014). However, an increasing number of researchers are arguing for the need to approach language skills to be attained in CLIL classrooms from the perspective of subject-specific skills and literacies (see e.g. Llinares et al., 2012; Morton, 2010; Nikula, 2012). As mentioned above, this viewpoint has been promoted by researchers using approaches rooted in Systemic Functional Linguistics in particular but, as Dalton-Puffer, Llinares, Lorenzo & Nikula (2014: 216) argue, CLIL research in fact quite often *has* emphasised the need to acknowledge the field-specificity of language or, in the words of Lorenzo (2007:510) the 'language muscles' developed by each subject. Such contentions are, of course, not specific to CLIL but relate to other attempts to conceptualise the role of language in education, such as Cummins' (1979) well known distinction between basic interpersonal communication skills (BICS) and cognitive academic language proficiency (CALP). Another example originating from the US context is the application of the so-called SIOP Model (Sheltered Instruction Observation Protocol) to assist teachers in integrating instruction of content concepts with academic language (see e.g. Eshevarria et al. 2000). The work carried out under the label language across the curriculum on language demands of different subjects is also worth mentioning (e.g.

Corson 1990), especially as the role of language in education is becoming a more and more important consideration worldwide due to challenges posed by the increasingly diverse student populations (e.g. Little, Leung & Van Avermaet 2014; Vollmer 2007).

3. On subject-specific language

The conclusion that subjects have their own 'languages' needs to be complemented with descriptions of what this means in practice, i.e. what exactly makes language subject-specific? Specialised terminology and concepts form an obvious starting point and CLIL teachers in fact are usually aware of the need to pass on the key terminology in the target language (Bovellan 2014). The idea of specialised vocabulary can further be elaborated by drawing on the work by Beck, McKeown and Kucan (2002) who in their three tier model make a distinction between different types of specialised vocabulary, arguing for the need to distinguish, in addition to tier one basic words, between tier two words that are high-frequency high utility, cross-curricular words and tier three words that are low-frequency and domain and area-specific. In the context of CLIL science classrooms, in other words, tear two would include general academic terms and tier three subject specific science terms.

However, there are also matters beyond vocabulary that relate to different ways of constructing knowledge in different subjects. Genre pedagogy has been an important approach to tackle this. Coffin (2006), for example, has shown that secondary level schooling in history involves development from 'recording genres' via 'explaining genres' to 'arguing genres', this also showing at linguistic level as increased complexity, abstraction and more sophisticated use of subject-specific lexis. Schleppegrell (2006: 114-137) has explored the common genres in science and history, finding that both subjects share abstract academic functions but entail genre differences due to science being geared towards theorising experience and history towards interpreting experience.

A further perspective to subject-specific language is offered by Kostopoulou (2014) who describes a corpus-based approach for exploring subject-specificity in textbooks for six different subjects. Using corpus tools she carried out frequency analyses of content words, their collocates, and 4-word clusters and found clear variation across subjects in each. Content word preferences reflected the different topics and themes of the subjects, collocate analysis showed subject-specific patterns in ways that even the same word may 'pair up', and 4-word cluster analysis pointed towards genre differences across subjects. Such analysis is valuable in highlighting how subject-specificity may also reside in patterns of language that extend beyond special terminology.

As regards earlier CLIL research on subject-specific language, Llinares and Whittaker (2010) have investigated Spanish CLIL and L1 learners' written and spoken skills in relation to the demands of the genres and registers of history. They observed shortcomings in both groups' development towards history genres. As regards preparing teachers for CLIL, Llinares, Morton and Whittaker (2012) discuss the different roles of language in CLIL and also dedicate a section of their book on the language of academic subjects in CLIL. Lorenzo (2013), for his part, introduces the idea of a 'genre map' which may help CLIL teachers orient both to the types of genres and registers in their subject. At a more theoretical level, Dalton-Puffer (2013) argues for the need to establish a zone of convergence between content and language pedagogies by introducing a model of cognitive discourse functions (CDFs) that can be used to identify subject-specific patterns of creating knowledge in the classroom.

There are fewer studies on subject-specific language use in CLIL classroom discourse. Nikula's (2010) case study comparing a biology teacher's lessons in Finnish and in English showed that even though subject-specific language was not explicitly brought in focus in either classroom, the teacher showed subtle but systematic variation in register features in Finnish to signal shifts between the language of biology and language for classroom management. In another case study, Nikula (2012) observed group work situations lower secondary level CLIL history classrooms and found that even if students' talk, overall, was characterised by everyday language, they also showed some awareness of subject-specificity e.g. when correcting peers to direct them towards more academic vocabulary. Llinares and Morton (2010), for their part, focused on historical explanations in whole-class classroom discourse and in interviews on the same topic and found more opportunities for the production of explanations in interviews.

4. The study

4.1 Discourse analysis of subject-specific language use and learning in hands-on tasks

This study uses discourse analysis to examine language use in hands-on tasks to explore their role as sites for using and learning subject-specific language in science classrooms. This involves close attention to details of talk and to the relationship between talk and its context more generally. As regards subject-specificity of language, on obvious entry point is to observe participants' use of terminology and concepts typical for the subject in question. In addition, subject-specificity may also reside in patterns of speech and 'the company words keep' in subject-specific ways (cf. Kostopoulou 2014) as well as in ways of constructing knowledge which also influences the types of actions preferred in each subject.

As regards tasks, the main focus is on exploring hands-on tasks, i.e. ones involving students working on topic-related practical experiments. However, as hands-on tasks are typically both prepared beforehand and wrapped up afterwards, this paper follows Lorenzo (2007) in also acknowledging the importance of pre-task and post-task phases. According to Lorenzo (2007: 507), the pre-task preparation phase serves the purpose of "bringing the language to the students" and can contain various activities to sensitise students to the language of the subject, not only in terms of specialised vocabulary and concepts but also in terms of grammatical structures involved in meaning-making that may differ from L1 conventions. The task itself is meaning-oriented and content-driven and provides opportunities to make use of language-related knowledge established in the pre-task phase. The post-task phase serves as a site for critical reflection on language and engagement in metalinguistic work (Lorenzo 2007: 210). This three-way division will be used in the following as a framework to structure the analysis.

4.2 Research questions and data

This paper seeks to address the following research questions:

- What kind of opportunities do hands-on tasks in CLIL science classrooms offer for using subject-specific language?
- How do teachers support learners' subject-specific language use during hands-on tasks and pre- and post-task phases?

The data consist of six 45-minute lessons of physics and chemistry lessons, held as three 90-minute double lessons. The recordings were made in two Finnish lower secondary schools and derive from a larger CLIL classroom corpus collected by the University of Jyväskylä. The students in both groups are 13 year old and

attend grade 7. Their schools offer a CLIL strand with the majority of subjects taught in English; participation in CLIL strands is voluntary. The CLIL strands follow the Finnish national core curriculum for basic education. Most of the students have attended Finnish-speaking primary school (grades 1-6) before the CLIL provision, but some have spent periods abroad with their families. Students are native speakers of Finnish apart from one English-speaking student in the chemistry group. Both teachers are native speakers of Finnish, aged around 30. The groups studied are quite small, with 13 students in chemistry lessons and 6 in physics lessons. In both classes, hands-on activities are in most cases carried out as pair work or in groups of three. The following list provides examples of hands-on tasks in the data:

Physics lessons :

- Students balance a wooden plank on an eraser, in the first phase on its own, in the second phase with added small weights on both sides. The purpose is to familiarise students with forces and the concept of moments.
- Students hang a succession of different small weights in a metal string and measure the extent of the stretch. The learning objective is Hooke's Law i.e. that the force needed to extend a spring by a certain distance is proportional to that distance
- Two students stretch a slinky between them on the floor and make waves that the third student is timing and counting. Learning objectives relate to frequency and wave lengths.

Chemistry lessons. All the hands-on tasks during the three double lessons observed relate to the larger topic of separating mixtures:

- Students mix water and copper sulphate in a petri dish, then heat the liquid with a Bunsen burner as an experiment in crystallisation.
- Students have a mixture of water and food colour in a test tube which they heat with a Bunsen burner to do distillation.
- Students do a paper chromatography where they draw coloured dots on a filter paper, place it in a beaker of water so that the end of the paper touches the water and starts absorbing it.

5. Analysis

5. 1 Pre-task phase

As mentioned above, CLIL classrooms are typically geared towards content learning and not necessarily designed with explicit attention to language matters and CLIL learners' (subject-specific) language learning in mind. Therefore, it is interesting to see what the data suggest about Lorenzo's (2007:508) point that the pre-task phase is one for bringing language matters to students' attention alongside new content information.

The two teachers differ markedly in their handling of the pre-task phase. In chemistry lessons, the teacher uses the pre-task phases to give quite detailed instructions for the hands-on tasks and also to introduce the theory behind them. Usually, this involves detailed description of the procedure and the equipment used, as well as explicit references to the type of phenomenon in chemistry that the experiment relates to. Extract 1 is an example of this, it is from a situation in which the teacher has just framed the topic of the day as *separating mixtures […] and we will spend today's lesson probably tomorrow's lesson as well on this.* She gives the following instruction to the students as a preparation for their hands-on task, showing students the relevant equipment and substances while talking:

Extract 1

1	T	first you need to (.) add there (.) about one or two
2		centilitres of water (.) and again about room temperature
3		(.) and then we (.) or you (.) add (.) copper sulphate (.)
4		that's blue (.) you will see (.) when you come and get it (.)
5		blue powder there is big lumps since it gets- (.)
6		some moist gets in (.) and they stick together (.) there is
7		(xx) powder (.) (it belongs to on that one) so please don't take
8		that into your own place (.) come here and (.) get some (.)
9		and keep adding (.) ((coughs)) sulphate until it doesn't dissolve
10		you can clearly see there is tiny crystals

As regards subject-specific language, this pre-task instruction contains many terms typical and relevant for chemistry, both more general-academic i.e. tier two words according to the model of Beck el al (2002) (e.g. centrilitre, temperature, dissolve, crystals) and others that are more specialised and connected with chemistry (e.g. copper sulphate). This means that students are at least exposed to content-specific language, both through the teacher's talk and the textbook where the experiment is also explained even if she does not explicitly direct students' attention to subject-specific aspects of her talk. However, as shown in Extract 2, there are occasions when the teacher acknowledges the potential difficulty of the language of chemistry for learners by explaining some of the technical vocabulary to them. The extract shows how the teacher uses everyday register to explain the concept of separating mixtures, consisting of water and food colour in this case, as them *wanting that water back* (line 2) and seeking to *kind of clean the water* (line 3).

Extract 2

1	T	and what we're going to do is separate (.) so now I've just added some colour in that
2		water (.) just water (.) but for some reason you want that water back you have the
3		colour (.) and this is how we can do it (.) we kind of (.) clean the water

A repeated feature in the chemistry teacher's pre-task phases is that she reminds the learners of the importance to write down their observations, this way orienting them to this general-academic cognitive discourse function (cf. Dalton-Puffer 2013) that is prevalent in the discourse of subject chemistry and thus its subject-specific practice (e.g. *and remember to write down your observations*). As we will see below, this becomes an even more important matter during the task phases proper, and can be interpreted as the teacher steering students simultaneously towards appropriate ways of acting and towards subject-specific genres and registers.

The physics teacher adopts a very different approach in pre-task phases; he does not go into similar depth and detail to introduce the theme and its concepts and terminology. Instead, he usually begins by explaining the activity and then letting students to do the hands-on task before covering the related topic at any length. Extract 3 is an example from a lesson where the topic involves calculating forces, rotation, and moments, but which are not brought up as concepts at the outset. In this pre-task phase the teacher uses everyday register to announce that *about effects* (line 1) is the general theme in the task to come and then in the instruction phase refers to the need to *balance this thing* (line 8) but does not provide a justification for doing this:

Extract 3

1	T	what we are going to do next is about effects and we'll skip a few pages
2		because this is going to be in on page thirty six in your book [..] but before we do

3		before we go any further with this um we should try a little experiment
4	T	um which is well basically the idea on page thirty seven
5		[…]
6		((teacher goes to the side room to get a wooden plank and small weights, then
7		starts setting up an experiment which he shows first and then students repeat))
8	T	so first of all um (.) I need to balance this thing somehow um without (x) any […] can I
9		borrow an era- eraser for this one um very small one if possible you should try and
10		balance this

A similar case in Extract 4 comes from the beginning of the second part of a double lesson. At the end of the first half, the teacher has commented that he will prepare a practical and when the class returns, he has brought in a number of clamp stands with strings attached plus a number of weights. Again, the teacher uses the pre-task phase to instruct the learners about the activity and uses mainly everyday register when doing so, not yielding information about the phenomenon in physics it serves to illuminate or about its associated specialised terminology. The only more subject-related references are to *the distance of stretching* (line 3) and to the general academic function of *measuring* (line 4):

Extract 4

1	T	we'll try and (.) and start with um (.) no weights and then add some (.)
3		as many as we can and then (.) take the distance of stretching after each point
4		so (.) we're not measuring any- the length of the spring but just the (.)
5		adj- adjust the ruler so that we can (.) follow just one point (x) of the spring.
		where it's moving

The two teachers' different orientations in the pre-task phase have implications for subject-specific language. In the pre-task phases of chemistry lessons, subject-specific language plays a bigger role as they include both explaining the upcoming task and introducing the relevant chemistry phenomenon and its associated specialised concepts and terminology. In physics lessons pre-task phases involve explaining the hands-on task with minimal reference to underlying theory. Students are not using subject-specific language in pre-task phases of either chemistry or physics lessons, but do get more exposure to it in the former. The difference may lie in teachers' different pedagogical preferences but perhaps also in the subjects themselves: in the chemistry lessons observed students work with potentially dangerous substances and equipment (chemicals, Bunsen burners, chemistry glassware) which for obvious safety reasons necessitate careful instructing. In physics lessons the use of planks, erasers, small weights and strings does not seem to require similar precautions.

5.2. Hands-on tasks

Moving on to the hand-on task phase and the language use involved, a major observation concerning both chemistry and physics lessons is that typically students' language use is highly indexical and contextual and dependent on the details of the hands-on task itself as well as the accompanying actions of the peers. Extract 5 from a physics lesson is an illustration of such indexicality. It is comes from a situation in which students are working together to balance a wooden plank on an eraser while placing small weights on both sides:

Extract 5

1	LF1	you have to move it further
2	LF2	all the way to the end

3	LF	just a-
4	LF2	okay a little more (.) (like) this one.
5	LF	oh yeah
6	LF	what
7	LF	more this one
8	LF3	I mean yeah that's right
9	LF1	no more that one

As can be seen, talk is highly indexical (e.g. *this one*, *that one*, *it*) and consists of short utterances that relate to the activity of placing a weight as peers are instructing their fellow student on their placement. Extract 6 is a very similar example from a chemistry classroom: students are pouring water in a glass beaker when the teacher reminds them of the little amounts needed. As a reaction, students show their beaker and seek the teacher's confirmation of the right amount, the accompanying talk being, again, highly indexical (see lines 2, 5, 6, 9):

Extract 6

1	T	and remember one or two centilitres only (.) too much
2	LM1	so this much
4	T	yeah
5	LM1	it's too little
6	LM2	no it's not=
7	LM1	=let's put a little bit more
8		(7.5)
9	LM2	and mix it with this

Similar observations have been made earlier about task-based language by Seedhouse (1999:152), for example, who notes "a tendency towards minimalization and indexicality" and argues that it may be a problem for L2 pedagogy because such interactions do not show evidence of students linguistic skill being stretched or challenged. This may well be the case from the perspective of ensuring opportunities for maximum target language use in language classrooms but from the viewpoint of accomplishing the task in a content lesson, such minimal language use is functional, the economy being explained by the constant interplay between language and other forms of meaning-making: gazes, gestures, postures (see e.g. Kääntä & Piirainen-Marsh 2013; Seedhouse & Almutairi 2009).

As regards hands-on tasks as sites for using and learning subject-specific language, the tasks mostly involve everyday language rather than concepts and constructs of science used in a sophisticated manner. However, this is not to say that subject-relevance is absent from hands-on tasks; the data in fact provide a more nuanced picture. For example, it is usual for students to engage in dialogue with the teacher during the hands-on tasks which often provides opportunities to engage in 'chemistry talk' of 'physics talk'.

As regards the chemistry teacher, steering learners towards subject-specificity happens in two ways: scaffolding the use of relevant terminology and drawing attention to processes of knowledge construction typical of chemistry. In extract 7 it is noteworthy how, during a hands-on task that involves separating mixture of water and food colour into its component parts, student LM6 is active in initiating the questioning sequence whereby he is checking the appropriate chemistry expressions (lines 1-2, 4, 8) and receives scaffolding from the teacher (lines 3, 5, 9):

Extract 7

1	LM6	water mixed with- (.) what's the aahh (.) substance that-
2		substance that you mix with the water
3	T	food colour
4	LM6	water and food colour (.) and we're trying to-
5	T	separate them
6	LM6	we're trying to separate them
7		((7 sec))
8	LM6	and the water will evaporate right?
9	T	yes

The teacher also clearly orients to the typical language of chemistry by repeatedly reminding the students during the hands-on tasks of the necessity to both 'observe' and 'write down' their observations. It is noteworthy that there are 15 occurrences of the verb 'observe' in teachers' talk during the 6 chemistry lessons (and none during the physics lessons). In other words, teacher's language use highlights the importance of this academic function for chemistry rather than the meaning or form of the language item 'observation' itself becoming an issue, which indicates prioritising content over form. Extract 8 serves as an example of the teacher talk highlighting the importance of observation (lines 1, 3, 6, 10) :

Extract 8

1	T	you need to just observe will this dissolve into that solution or not (.)
2		and after that we will see what happens when we start heating it (.)
3		so temperature rises (.) increases (.) and you should observe (.) will (.)
4		the rest of the copper sulphate in the bottom dissolve or not
5		what happened (.) what did you write down (.)
6		observations? (.) Pekka
7	LM4	it dissolved
8	T	yes (.) and (.) then (.) you (.) poured some of it to petri dish
9		and next time we will see (.) what's happened to them
10		and then you can write down the observations of that part

The emphasis on observation clearly does not go unnoticed by the students as also they use the word 'observe' 12 times during the chemistry lessons. In line with sociocultural and language socialisation orientations, then, the CLIL classrooms observed serve as an arena to use subject-specific language, the students echoing and recycling the teacher's words also suggesting there are opportunities for learning. Extract 9 is from a pair work with two boys boiling a mixture and it shows that they are making the importance of observation as part of an experiment explicit, even if rendering it in a more colloquial form as 'looking at' the mixture (lines 1, 5); they also clearly orient to the teacher's repeated advice to write down observations (line 8):

Extract 9

1	LM1	look at our mixture is already coming (xx)
2	LM?	wait (.) what what what
3		((unclear talk for about 10 seconds))
4	LM6	the water's travelling up
5	LM1	hey look
6	LM?	(xx) ettei mee yli /'so that it does not go over'/

7		((unclear talk for about 5 seconds))
8	LM6	hey put that down to note (.) water is travelling up

In Extract 10 the students are not only engaged in observing but by commenting the process also 'doing observing' (lines 1, 4), i.e. discursively constructing a stance whereby they acknowledge that this behaviour is expected and appreciated in the given context:

Extract 10

1	LM3	observations (.) done (.) hey Mikko
2	LM4	and this one (.) four
3	LM5	what
4	LM3	I've done my observations
5	LM5	okay (.) (great)

As regards the physics lessons, it was pointed out above that the teacher's strategy is to let students begin hands-on tasks with no or few references to background theory or to specialised vocabulary. Nevertheless, whether it is a matter of balancing wooden planks with weights, attaching small weights to strings or shaking a slinky to make waves, the teacher's comments and questions to learners make salient the need to include as part of those hands-on tasks the act of 'measuring' and also at times 'calculating'. In a similar manner to the chemistry teacher above, the teacher is thus orienting to the general academic functions that are typical of his subject, the relevance of this action shown in the 37 times that the teacher uses the word 'measure', either in the verb form or as noun measurement, and the 11 times of using the word calculate/calculation (with no occurrences of either in chemistry lessons). Extracts 11 and 12 serve as examples of the teacher orienting learners to the act of measuring, the latter in fact quite explicitly emphasising the overall importance of measuring and calculating by referring to it as the *basic stuff* in physics (line 2):

Extract 11

1	T	and what you should try and do is erm
2		to measure the centre point of these (.) weights so if
3		you look at it from the top (.) you (.) you should
4		measure the centre

Extract 12

1	LF3	I've already forgotten them because we got so much new stuff.
2	T	but it is basic stuff like measuring and calculating which
3		I think we've been practising anyway.

Again, as in chemistry lessons, the students orient to this content-appropriate action not only by physically doing it but also by using the core terms of measuring and calculating in their speech. There are 21 occurrences of 'measure' and 15 instances of 'calculate' during the six lessons (and no occurrences in chemistry lessons). This can be interpreted as the physics lessons observed providing students opportunities for using subject specific language, which should also be conducive to learning. Extracts 13 and 14 serve as examples of students both using these words and orienting to their role as important elements of their hands-on tasks:

Extract 13 (measuring spring with a weight attached)

1	LF	well (.) you have to (hold) this
2	LF5	here I can measure it. (xx)
3	LF3	I can ho- hold it

Extract 14 (measuring wave pulses in a slinky experiment)

1	LF4	so how do we calculate this time
2	LF4	=do we (.) do it like
3	L1	okay le[t's find out the aa]
4	LF4	[how fast that goes] like back and forth

Interestingly, however, the most common way for the students to refer to their acts of measuring and calculating is by using the more everyday word of 'count' (used 64 times by the students and 2 times by the teacher). This suggests that it may take time for the more academic versions to become part of their active vocabulary. Extract 15 serves as an example, with the word 'count' being used in lines 1, 2 and 6.

Extract 15

1	LF2	yeah but there's the (one) counted over here
2	LF1	[well I count this] one
3	LF4	[hey Neea]
4	LF1	yeah but still lot
5	T	[so now we]
6	LF2	[(xx)] count the velocity first
7	T	we're measuring the speed again but with a different length
8	LF4	okay

Extract 15 also displays the co-existence of more academic and colloquial registers in that while the students keep using the word 'count', the teacher in line 7 uses 'measure'. Two different language varieties, the academic and the everyday, thus come into contact. This happens also in students' language use as indicated by extract 16 where in lines 1-2 and 4, LF2 reads out loud instructions from a work sheet using its academic style and in lines 7-8 renders this into everyday language as *you do once this and tell us when it comes back* as an instruction to a fellow student. This very act of reinterpreting and recasting signals her understanding of the academic content and sensitivity to register differences and supports the point made by Garcia and Li Wei (2014: 79) about language internal translanguaging: "New language practice can only emerge in interrelationship with old ones"

Extract 16

1	LF2	send a short pulse along the string it should (.)
2		[reflect back the wave and] return to you
3	LF4	[so the length divided by ten]
4	LF2	measure the time for this (.) calculate the velocity (.)
5		okay Julia now you can do it
6	LF6	okay
7	LF2	here (.) so you do like once this
8		and then you tell us when it comes back (x)

The discussion above has shown how hands-on tasks are typically closely tied to other semiotic means in the process of the concrete act of doing, so they rarely call for extended production of subject-specific

academic language. Hands-on tasks are hence more about *doing* physics and chemistry than *talking* physics and chemistry. However, we have also seen how teachers subtly and quite skilfully steer students towards subject-relevant acting during tasks and this also has repercussions for subject-specific language, not that much from the viewpoint of specialised technical concepts but rather relating to ways of constructing knowledge and orienting to the world typical for the given subject. In other words, in terms of the vocabulary model by Beck at al. (2002), the more general academic tier two expressions seem to prevail in hands-on tasks rather than the more specialised and subject-specific tier three concepts.

5.3 Post-task phase

Lorenzo (2007: 510) argues that post-task phases are important for offering the possibility to critically reflect language and engage in metalinguistic work. In the present data, the post-task phases seem to be important for making connections between the more science-related phenomena and tasks as their illustrations. Again, the two teachers adopt different strategies for dealing with this phase.

In chemistry lessons, the post-task phase typically consists of a whole-class discussion on hands-on tasks. Given that the theory was introduced before the task, the post-task phases serve as an opportunity to return to the main points made earlier. The chemistry lessons often ended with the completion of the hands-on task and students washing the dishes and cleaning the tables, so the post-task phase usually took place during the following lesson, and was combined with homework questions relating to the task. As regards students' use of subject-specific language, the difference to the highly indexical talk in hands-on tasks is clear in that they use more tier three special terminology and concepts in post-task phases as shown by Extracts 17 and 18:

Extract 17

1	T	so (.) observations (.) when you (.) added that (.)
2		potassium (manganate) to the test tube (.) where you had saturated
3		the mixture of copper sulphate and water (.) what did you notice (.) Simo?
4	LM1	well it turned totally blue
5	T	yes (.) what else (.) Leenamaija?
6	LF1	after we had it all the sulphate dissolved (xx)
	T	yes
		[...]
7	T	what happened (.) when you started heating (.) that saturated (.) copper sulphate
8		solution (.) what happened (.) what did you write down (.) observations (.) Mikko?
9	LM4	it dissolved

Extract 18

1	T	let's talk about what we did yesterday
		[…] ((classroom management talk, teacher asking students to close books))
2		separating mixtures (.) mention (.) some ways to separate
3		mixtures (.) Sanna
4	LF2	evaporate (.) well other- like (.) salt is in c- evaporate I mean (.) like filter it
5		or (.) salt (or water)
6	T	yes so there was two (.) by filtrating by evaporating (.) what else (.) Matti
7	LM4	crystallizing
		[..] talk about different ways of separating mixtures continues, then T asks students to explain concepts
8	T	residue? ((pause)) Markus

9		((a pause))
10	LM3	well it's solid (.) well (.) being separated from a liquid (.) by filtering
11	T	yes

In Extract 17 it is noteworthy how LM1 uses everyday language in line 4 when referring to the mixture with *it turned totally blue*. The teacher acknowledges the response but continues in line 5 with *what else,* thus indicating that a more subject-specific formulation is needed even if she does not in explicit terms explain what in student's response is problematic. When LF1 in 6 provides an answer that contains subject-specific and topic-related vocabulary, the teacher accepts the response. In Extract 18, the subject-specific language relates to students using specialised vocabulary of chemistry to list different ways of separating mixtures (lines 4, 7). They also provide definitions for specialised terminology, the definition in line 10 in itself containing specialised academic lexicon. The fact that students are expected to explain and thus show their understanding of these processes and phenomena suggests that these are also expected learning objects. The post-task phases offer opportunities to both use and explain subject-specific language, i.e. to deal both with content and language matters.

In physics lessons, the post-task phase seems to be especially crucial from the viewpoint of using and learning subject-specific language as it is here that the teacher introduces the underlying theory and its terminology and connects these to the hands-on tasks. Extract 19 shows a part of a much longer sequence from a discussion on a task where the students had hung subsequently heavier small weights on a string, measured the string length, marked the results in a table of measurement, and produced a graph whereby the measurement results formed a (more or less) straight line:

Extract 19

1	T	we had these newton's laws and stuff and this also has
2		a fancy name called hooke's law
3	LF1	yeah
4	LF2	what? hooke's law?
5	T	so this means that extension [is proportional to the force.]
6	LF2	[(x) hooke's law]
7	LF	hooke's law
8	LF	hooke's law
		[…]
9	T	and (.) this is one example um (.) [of these]
10	LF2	[is that] (.) I'm sorry is that pra (.) or pro=
11	LF	=pra
12	T	proportional=
13	LF2	=okay
14	T	so you will find that ma- in in physics in you have many things that are one thing is
15		[proportional to the other.]
16	LF6	[(xxx)] <u>propo</u>
17	LF2	[pro]=
18	T	=which for instance means that if you double the-
19	LF6	pro
20	LF2	[pro]
21	T	[double] the one quantity then the other will be doubled as well
22	LF2	extension is proportional
23	LF6	what does that proportional mean
24	T	you mean in finnish.

25	LF6	yeah
26	T	it's suoraan verrannollinen /'directly proportional'/
27	LF2	suoraan /'directly'/
28	LF6	suoraan= /'directly'/
29	LF2	=verrannollinen /'proportional'/
30	LF6	(xx) ymmärrä mitää / 'don't understand anything'/
31	LF2	ei /'no'/ (xx) extension
32	T	well (.) well basically proportional means the straight line relationship so=
33	LF6	=okay
34	LF5	straight line (.) in a straight line

The extract shows that negotiation is needed for learners to comprehend what 'extension is proportional to the force' means. Students are active in indicating their miscomprehension (lines 10, 23, 30) and the teacher explains the language of physics through everyday language (e.g. lines 18, 21, 32). It is also one of the rare occasions where participants make direct references to language. This if first done by the teacher when he in lines 2-5 refers to the 'fancy name' of Hooke's Law and then explains its meaning. In line 23, student LF6 inquires about the meaning of the word proportional. The teacher first provides the requested Finnish version on the word but when LF6 still expresses non-comprehension in line 30, also explains its meaning, thus attending both to language of and content in physics. This post-task episode is thus a clear example of shared understanding gradually emerging through negotiation, and it also shows the importance of the joint work by the participants to make subject-specific language clearer to the students.

Extract 20 comes from a post-task phase where, again, a completed task is being discussed. As the extract shows, particular attention is paid to students reaching understanding of the core concepts, the term 'frequency' receiving particular attention:

Extract 20

1		the important thing here was (.) that- getting to know these concepts of (.)
2		wave length and (.) frequency (.) (and) which I hope you know at this point
		[…]
3	LF4	what did it mean that amplitude describes what?
4	T	well amplitude is this (.) the size of the waving and (.)
5		it's (.) is really the strength or
6	LF4	okay
		[…]
7	T	so for some waves I'd like you to remember the fact that (.) a higher pitch
8		is always a (.) greater frequency (.) and now (.) I hope you can tell me again (.)
9		what is meant by the term frequency
10	LF1	(x) (.) what did [you say]
11	T	[Maria]
12	LF2	isn't it how fast the waves (.)one wave goes
13	T	aa (.)[kind of]
14	LF2	[like a] flick (.) how one wave goes like
15	T	usually the word fast is reserved for high (.) velocity or high speed (.)
16		but frequency (.) frequency (.) is not about speed it's
17	LF1	[how many things the]re's
18	LF2	[how many times] how many (x) the times something goes back and forth
19		in a second
20	T	yes

Students are again actively engaged in checking information (line 3), with the teacher responding by explaining in everyday language (lines 4-5). The extract also shows the teacher steering students towards subject-appropriate formulations: when LF2 in line 12 explains the word frequency as how 'fast' a wave goes, the teacher's response in line 13 functions as an implicit signal that the rendition is not fully acceptable. LF2 makes another attempt in line 14, after which the teacher makes explicit reference to language by explaining in lines 15-16 that 'fast' is a problematic word because of its associations with velocity or high speed, his contention *but frequency is not about speed* (line 16) resulting in LF2 providing an appropriate explanation (lines 18-19). This example illustrates the impossibility of separating language and content: the student substituting 'how fast waves go' by 'how many times something goes back and forth in a second' is simultaneously a matter of both language and conceptual readjustment.

6. Discussion and conclusion

This paper has explored hands-on tasks in CLIL physics and chemistry lessons from the perspective of the opportunities they provide for subject-specific language use and learning. In addition to the hands-on tasks themselves, attention was also paid to pre- and post-task phases. The results confirm earlier suggestions by CLIL researchers about the strong content orientation of CLIL (e.g. Dalton-Puffer 2011): the tasks are clearly designed to support content learning. As regards attention to language, it can be argued that If the tasks are approached from general focus-on form perspectives, that is, concerned with participants attention to linguistics elements (for more discussion see e.g. Ellis 2001, Loewen 2005), CLIL classroom tasks do not appear as language-oriented activities at all. Yet when adopting the perspective of subject-specific language which epitomises language and content integration, it is clear that language matters do feature in tasks. Firstly, both teachers were found to scaffolding students' performance in ways that oriented to subject-specific ways of acting. The clearest examples of this were the recurrent references to 'observing' and 'writing down' in chemistry lessons and to 'measuring' and 'calculating' in physics lessons. These often occurred in pre-task phases but also during the hands-on phases that, on the whole, were not the most conducive to subject-specific language use due to their immediacy and reliance on artefacts and on nonverbal aspects of communication. Although 'observing' and 'measuring' as such belong to the realm of more general academic discourse functions, their concentration in specific subjects only indicates an orientation to subject-specific registers and genres. As regards more specialised terms and concepts, the post-task phases in particular were an arena where teachers prompted students to make use of subject-specific terms and concepts; they were also shown to reject student responses expressed in everyday language.

The findings thus suggest that pre- and post-task phases complement hands-on phases in providing more opportunities for engagement in subject-specific language. The teachers deployed somewhat different strategies in these phases. The chemistry teacher's strategy was 'sandwiching' as the students were in pre-task phases familiarised with the theme of the lesson and its associated theory and special terminology, with the already familiar theory being revisited in post-task phases when the results of the experiment were reviewed and discussed. The physics teacher provided minimum of background theory and terminology in pre-task phases which mainly consisted of instructions delivered in everyday language for the hands-on tasks. In the post-task phase, the topic of the lesson and the related theory and concepts were connected with the task and its measurements and calculations. Interestingly, there was a great deal of student engagement on these occasions, indicated by student-initiated queries about the meaning of terms and concepts which resulted in sometimes lengthy meaning negotiations, and, consequently, in opportunities for using and learning subject-specific language. There are thus different strategies teachers

can employ to make subject-specific language relevant. Whether there are differences also in their relative success remains an empirical question for further research.

It was pointed out at the beginning that CLIL teachers' attitudes to explicit language teaching have been somewhat ambivalent, perhaps because language orientation may be perceived as calling into question professional identities and boundaries between language and content teachers, CLIL teachers often downplaying their role in language teaching (e.g. Bovellan 2014). However, such contentions are probably rooted in conceptions of language that emphasise its generic, context-independent structural properties. This study has indicated how CLIL teachers' expertise in their own subjects shows in them being skilled in subject-specific ways of expressing meanings and constructing knowledge. However, the findings also suggest that even though teachers and learners orient to language matters during CLIL tasks, these are rarely brought into explicit focus, learning subject-specific language thus remaining a matter of socialisation rather than explicit teaching.

In other words, under the surface the potential exists for adding more explicit language focus in CLIL, but its realisation may be hampered if teachers' orientations to language foreground its formal and structural properties and language as a decontextualised system, such a view not tallying well with the realities of content teaching where language plays a crucial role in all meaning making and knowledge construction. Awareness-raising of the interconnectedness between language and content matters is thus clearly needed in lines suggested for example in by Llinares, Morton and Whittaker (2012) and Lorenzo (2013), i.e. by sensitising CLIL teachers to the typical genre and register features of their subjects. It is probable that CLIL teachers could also benefit from working on interactional data excerpts such as the ones in this article, to illustrate that attention to language is not an extra demand on them but rather something that they already orient to in classroom interaction but could be trained to do in a more systematic and planned manner. Additionally, awareness-raising is needed of the relationship between language teachers and CLIL teachers: the latter are different types of language teachers whose responsibility is to make the language of their subjects visible and approachable to students. Hence the crucial question for CLIL teachers is 'What language is most relevant for meaning making in my subject?' Fuller awareness of this may be a key factor to help CLIL teachers reach a clearer sense of their special remit in the realm of language education.

In conclusion, it is important to note that an obvious limitation of this study is that it is a small-scale investigation into subject-specific language use by only two teachers and a rather small number of their students in hands-on task activities. It is clear that more extensive research is needed across different subjects and educational contexts in order to arrive at a more nuanced understanding of the complexities of the relationship between language and subject-cultures, and of the roles of subject-specific language in CLIL classroom discourse. However, as an exploratory study into an aspect of CLIL teaching that has received relatively little research attention so far, this study has sought to explore the usefulness of subject-specific language for CLIL research, with the hope of generating new ideas and suggestions for areas of inquiry for future research in the field.

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APPENDIX

TRANSCRIPTION CONVENTIONS

overlapping [speech] [text]	overlapping speech
(.)	a short pause that is not timed, less than a second
(2.5)	a pause, timed in seconds
text= =text	latching utterances

exte:nsion	noticeable extension of the sound or syllable
cut off wo-	cut off word or truncated speech
[…]	cut in transcript
?	question, questioning intonation
((text))	transcriber's comments
(text)	transcriber's interpretation of unclear word(s)
(x)	unclear speech, probably a word
(xx)	unclear speech, probably a phrase
(xxx)	longer stretch of unclear speech