‘What’s the Moment Thingy?’– On the Emergence of Subject-Specific Knowledge in CLIL Classroom Interaction

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Abstract Situated in the European CLIL context where mainstream schools may opt for teaching content subjects through the medium of a foreign or second language, this paper explores secondary school physics classrooms, taught through English in Finland. The focus is on the role of classroom interaction in the emergence of subject-specific knowledge during six consecutive lessons, with particular attention to how one key concept in physics, ‘moment’, is handled. This micro-longitudinal approach shows that while the students are struggling between the everyday and the academic meanings of the word ‘moment’ throughout, there are also clear signs of progression. These signs show, for example, in students moving from the initial stages of confusion relating to the meaning and subject-relevant use of the term ‘moment’, via teacher-scaffolded practice, towards appropriating its subject-specific usages.

1 Introduction

This paper is concerned with English-medium instruction in the European context, often labeled as CLIL (content and language integrated learning, for more detailed discussion, see e.g. Dalton-Puffer et al. 2010). It focuses on CLIL physics classrooms in a Finnish lower secondary school where students with Finnish as their first language are taught the majority of their curriculum through English. The main purpose is to address the role of spoken language in developing subject-specific knowledge which is a simultaneous matter of both language and content (see Llinares et al. 2012; Meyer et al. 2015; Nikula et al. 2016a). As foundations for integrated content and language learning are laid in classroom interaction, it is important to complement studies that focus on learning outcomes with process-oriented and situated studies that explore the gradual appropriation of subject-specific language and knowledge. More specifically, this chapter reports on an

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exploratory study on how one key concept in physics, 'moment', is handled during six consecutive lessons. It thus offers what could be called a micro-longitudinal approach to how the concept is, on the one hand, handled by the teacher to support and scaffold learning and how students' appropriation and mastery of conceptual knowledge and subject-specific language gradually emerges, and how this becomes visible in classroom talk (for more detailed discussion on the complexities involved in approaching learning as an interactional-longitudinal phenomenon, see Jakonen 2014, pp. 47–53). The purpose of this chapter is thus to explore the role of language in disciplinary learning.

The term CLIL was adopted in Europe in the 1990s to indicate a specifically European approach to bilingual education. European CLIL differs from the US bilingual education contexts in that pupils in regular mainstream schools are taught content subjects through a different medium of instruction than the regular language of instruction in the school. The purpose of CLIL is thus to strengthen learners' foreign or second language skills. There has been a great deal of political support for CLIL from the European Union (EU) and Council of Europe from the beginning as it has been seen as an important tool in realizing EU goals of increasing European citizens' multilingual skills. While a thorough handling of CLIL is beyond the scope of this chapter (for more detailed discussions, see e.g. Coyle et al. 2010; Dalton-Puffer 2011; Nikula et al. 2013), it is worth pointing out the key features of CLIL that also characterize the present study: CLIL in Europe is in the majority of cases offered through English, it is usually taught by content teachers rather than language teachers who, in the same way as their students, are in most cases non-native speakers of English (see Dalton-Puffer 2011; Eurydice 2006).

2 The Role of Language in Learning

As other forms of content-based education, CLIL has a two-pronged orientation to language: on the one hand, it is geared towards – and often specifically motivated by – the aim of supporting the learning of the instructional language, which is learners' second or foreign language. In a way, then, CLIL can be seen as an alternative EFL teaching approach where the language is learnt through learning content subjects. This orientation is also clearly reflected in CLIL research that has provided ample evidence of the effect of CLIL on learners' general language skills, often compared with non-CLIL peers learning the language during English lessons only (for discussion, see Nikula and Mård-Miettinen 2014). Many studies point to CLIL benefits that pertain particularly to CLIL students' wider lexicon and morphosyntactic resources, with less evident effects however on text-level dimensions such as discourse structuring or on stylistic matters (Dalton-Puffer 2011, pp. 186–187).

On the other hand, CLIL is very much a content-driven form of education, with language learning aims and descriptions of the role of language in learning remaining at worst vague or presented in a very general manner. What is more, given that CLIL teachers are usually non-native speakers of English and content teachers, they

often feel uneasy about their role in language teaching, which may result in potential identity struggles and threats towards professional integrity when they are teaching their subjects in L2 while not identifying themselves as language teachers (e.g. Moate 2011; Cammarata and Tedick 2012). At the same time, Hüttner et al. (2013) show that lack of explicit attention to formal aspects of language during instruction may be regarded as a key success factor by CLIL teachers and students alike.

One reason for the struggles described above is that language tends to be conceptualized, by CLIL practitioners and researchers alike, as a general and decontextualized set of skills rather than inherently connected to different school subjects and disciplines. In recent years, however, CLIL research has started to highlight the specificity of language skills to be attained in each subject (e.g. Llinares and Whittaker 2010; Morton 2010). Often based on systemic functional linguistics, these studies have helped reveal the inherent connectedness of content and language and the functions of language in constructing knowledge and thus the fundamental role of language in all learning (for an overview, see Nikula et al. 2016b). With this, CLIL research aligns with the developments in general educational research and research on other forms of bilingual education where there has also been a growing recognition that the pivotal role of language in the learning of any subject or discipline needs to be more clearly articulated and understood. As a consequence, conceptualizing language-related skills in content subjects as disciplinary or content-area literacies has become increasingly common (e.g. Coffin 2006; Fang and Schleppegrell 2010; Shanahan and Shanahan 2008). The CLIL context offers the curriculum through a foreign or a second language, and is thus a particularly useful context for examining the role of language in learning.

3 On Subject-Specific Language and Its Learning

The subject-specificity of language has many dimensions. The most obvious entry point is the level of lexicon, and the idea that each subject has its own typical terms and concepts is widely accepted (e.g. Mežek et al. 2015). This is true of CLIL teachers as well: Bovellan's (2014) study on Finnish primary level CLIL teachers, for example, shows that CLIL teachers often conceive of their role as language teachers in terms of special terminology. Teachers also find it important to make sure that learners acquire these central concepts.

Subject-specificity, however, goes beyond lexical choices. It also pertains to different ways of constructing knowledge across disciplines, displayed at different levels of language so that words, phrases, clauses and sentences are likely to form different constellations in different subjects and disciplines. On broader terms, and as a result of these constellations, each school subject can be seen to favor certain text types and genres. For example, where accounts and narratives are usual for history, physics may rely more on defining and reporting genres (for overview, see Fang 2012). The work conducted within the systemic functional linguistics

framework in particular has greatly increased understanding of genres as an important means to conceptualize differences in language use across different subjects (see e.g. Coffin 2006; Schleppegrell 2004). This research has also recognized the similarities across subjects as regards the overall trajectory in education which involves steering learners from more everyday to more academic discourse realized, for example, as greater levels of abstraction and as shifts from personal to impersonal style and from everyday to technical language (Forey and Polias 2017). Dalton-Puffer (2013, 2016), for her part, has introduced the construct of 'cognitive discourse function' to refer to ways of organizing and orienting to knowledge. She introduces macrofunctions such as explaining, describing, narrating (and their subcategories) that are available for and deployed in all subjects and discipline areas but are patterned in different ways as a reflection of subject-specific differences in meaning construction.

While the studies referred to above outline characteristics and elements constituting subject-specificity, another line of research has been concerned with exploring how students appropriate discipline-specific forms of language. Because teaching and learning in educational contexts often rely on texts and the school as an institution typically evaluates learners on the basis of their written language production, much earlier research in this area has focused on written language. Achugar and Carpenter (2014), for example, report on multilingual students learning the academic language of history. In CLIL research as well, recent years have shown the emergence of studies with focus on the development of genre-specific writing (Llinares and Whittaker 2010; McCabe and Whittaker 2017).

As regards the role of spoken interaction and classroom discourse in and for learning, CA-based studies in particular have revealed a great deal of how meanings are negotiated and knowledge constructed in and through interaction (e.g. Kasper and Wagner 2011; Seedhouse 2010). However, relatively few studies so far have addressed the role of classroom talk from the perspective of subject-specific language and knowledge construction. Studies that exist have examined teachers' language use in relation to subject-specific genres (Morton 2010) or explored students' expression of content by using SFL informed approaches that focus on how different processes, participants and circumstances are realized in speaking (and writing) (Llinares and Whittaker 2010). Attention to participants' joint knowledge construction has been even more rare (but see Jakonen 2014; Jakonen and Morton 2015) and has focused on specific aspects of subject-specificity such as the joint construction of historical explanation by teachers and students (Llinares and Morton 2010). In this chapter, the aim is to approach the emergence of subject-specific language and knowledge as a phenomenon of classroom talk and interaction (see also Nikula 2015). Focus on spoken language is important as it can provide both rich data and novel insights into situated aspects of content and language integration, i.e. how language resources are appropriated in the processes of concept construction. Such processes play a pivotal role in learners' trajectory towards mastery of subject-specific language.

4 The Study

4.1 Data and Aims

As pointed out above, this study is concerned with how participants appropriate subject-specific aspects of language and how the integrative nature of content and language plays out in details of classroom talk. The data analyzed consist of six consecutive physics lessons spanning 3 days, instructed in English for 7th graders in a Finnish comprehensive school. The lesson length is 45 min and two lessons are combined into a 90-min 'double lesson' with a break in between. The students are 13 years old, all girls, and the group in question is a small one, with only six students. Both the students and the teacher are native speakers of Finnish. The data derive from a larger pool of classroom recordings collected at the University of Jyväskylä, also used in earlier studies (e.g. Kääntä and Piirainen-Marsh 2013, Nikula 2015).

As a whole, the data set involves the class working with several physics concepts and notions (e.g. action and reaction, Newton's third law, stretching, tension, Hooke's law, rotational acceleration, center of mass, frequency, wave lengths). However, the concept of 'moment' turns out to be central during the lessons recorded and one that seems to require a fair amount of conceptual work and joint meaning co-construction, judged by the fact that in the entire set of six consecutive lessons, the concept is dealt with during five. The phases where this happens thus offer fruitful possibilities to examine the appropriation of subject-specific language during a micro-longitudinal trajectory (see Wortham and Reyes 2015 on the importance of extending discourse analysis from single events to linked discourses across events).

4.2 Methods

Discourse analysis will be used to analyze the trajectory of meaning negotiations around the concept of moment, and to examine the role of subject-specific language in classroom talk. Given the aim of the study, what counts as subject specificity is a key concern for the analysis. On the one hand, this in itself is an important empirical question for the study, i.e. it seeks to come to a better understanding of classroom interaction as a subject-specific endeavor. On the other hand, certain entry points are used as starting points to analyze subject-specificity in spoken language and as co-constructed in interaction. These include special terms and concepts but also subject-specific ways of constructing and organizing knowledge as conceptualized, for example, in the construct of cognitive discourse functions such as 'defining', 'explaining' and their linguistic and interactional realizations (e.g. Dalton-Puffer 2013; Fang 2012). In more concrete terms, the analysis has proceeded, firstly, by identifying phases where the concept of 'moment' is either dealt with as the topic or otherwise appropriated in discourse. Secondly, these phases have been analyzed in

the way described above, i.e. starting from the special terms and subject-specific cognitive discourse functions as an entry point but also paying attention to how they relate to the surrounding interactional context.

5 Findings

5.1 Introducing the Concept – 'So Like What Is the Moment?'

During the first lesson recorded and before the first occurrence of the concept moment, the class has discussed homework on action and reaction forces and Newton's third law. They have also conducted a hands-on experiment where the students' task was to balance a wooden plank on an eraser first on its own, then by adding small weights on both sides, finally measuring the distance of weights from the center point in order to, in the words of the teacher, *calculate length times weight on both of these objects*. This balancing, according to the teacher, is an example of a new topic, introduced by the teacher in Extract 1 as follows (see Appendix for transcription conventions):

Extract 1

1	T	and it's a (.) moment is defined as the (.) when you're turning
2		something it's the distance from the (x) point
3		multiplied by the force of turning (.) so for instance
4		um (.) let's think about um (.) when you're
5		fastening a knot or bolt um you will (.) you will
6		be using some some kind of a force (.) and then there is a (.)
7		distance s from the center point of turning so […]
8		so moment equals force times distance

In line 1, the teacher explicitly flags by the use of *a moment is defined* that a definition follows, i.e. this can be interpreted as an intertextual link (Pappas et al. 2003) to the standard academic way of defining moment. Accordingly, the definition is formulated precisely and exactly (lines 2–3), which is typical for physics and science in general. However, this academic and cognitive discourse function of defining (Dalton-Puffer 2013, see discussion above) is nested within more informal and non-technical everyday language used to exemplify and explain the technical definition, seen both in lines 1–2 when the teacher points out that the definition relates to the act of *turning something* and in lines 4–6 when he refers to a concrete everyday example of fastening a bolt.

'Force' is clearly another key term in Extract 1 (lines 3, 6, 8) and in fact the teacher moves on to explain how the way force is used in this connection differs from the way the class has used the term force earlier, thus making an intertextual

link to previous classroom talk, and explaining how it relates to the concept of moment. In Extract 2 the teacher uses mostly non-technical language to do so:

Extract 2

1	T	when previously (.) when we talked about
2		forces um well we considered the forces as something
3		that causes acceleration in in a straight line sense (.)
4		if you want to get moving in straight line you need the
5		force (.) but
		[.]
6		but if you if you need to get something um (.) spinning
7		around (.) um then you want (.) then instead of force
8		we need to consider the moment of the force

In itself, the word 'force' (in the same way as 'moment') is of course familiar to the students from everyday language use. Therefore, it may be a conceptual challenge that a word that they know well from everyday contexts acquires new and precise meanings as part of subject-specific discourse. Such movement towards more abstract levels of thinking is obviously a step that needs to be taken in developing discipline-specific knowledge no matter what the instructional language may be (cf. Forey and Polias 2017), i.e. it is hardly a CLIL-specific feature.

Despite the teacher's explanations, the meaning of moment seems to remain unclear for students as evidenced by Extract 3 which shows a lively exchange concerning the term, first among the students and then between the teacher and the students:

Extract 3

((whispered dialogue between students while T has shortly left the room))

1	LF6	what's the moment (.) what's the moment
2	LF3	I don't know
3	LF4	what
4	LF2	what's the moment
5	LF	I don't know
6	LF3	moment
7	LF2	it's- (I'm not sure)
8	T	ah I think [this] ((teacher re-enters the classroom))
9	LF2	[so like] what **is** the moment
		[…]
10	LF2	is the it says the journey of a force is called a moment so it's [like]
11	T	[yes]
12	LF2	isn't this um moment when something like spins or something
13	T	[yeah]
14	LF1	[you] mean like a hetki /*moment*/ or
15	LF5	moment is [(xx)]

16 LF2 [no:]
17 T no in Finnish it's um (.) momentti or vääntömomentti /torsional moment/
18 sometimes called

During lines 1–7, the teacher is in an adjacent small room fetching equipment for an experiment and while he is away, students engage in a whispered dialogue. It confirms that the girls share mutual uncertainty about the meaning of 'moment' so once the teacher walks back in, LF2 in line 9 directs a question to him, the emphasis on *is* highlighting its urgency. Interestingly, it is the same student that then starts offering an explanation, first by making an explicit intertextual link to the textbook, signaled by *it says* (line 10), then in line 12 offering a candidate interpretation that shows she realizes the connection of the term to spinning. However, the hedged manner in which she formulates the explanation signals that she is not fully committed to its correctness. As if to echo this uncertainty, L1 joins the discussion in line 14 by inquiring about the correspondence of the word to the Finnish word *hetki* ('moment'), showing that she operates with the everyday meaning of the word rather than with its use as a physics concept. Both the elongated contradiction by a fellow student (line 16) as well as the teacher turn in line 17 quickly refute this correspondence to the Finnish word; the teacher further clarifies this by offering the technical term for moment in Finnish.

It thus seems that the first attempts by the teacher to define the concept of moment have not yet resulted in noticeable advancement in subject-specific knowledge on the part of the students. The rest of the lesson is dedicated to a hands-on experiment that involves spinning a wheel to show how its speed is dependent on the place from where it is turned, i.e. exemplifying different moments of turning force.

5.2 Repeating and Specifying the Definition – 'What Is It Like the Balanced Moment?'

Making students understand the difference between 'force' and 'moment' is a key matter in the teacher's agenda. He begins the second lesson by returning to this definitional issue as described in Extract 4; he has first prefaced this by an announcement that there are couple of things he wants to say about moment:

Extract 4

1 T so one is this idea that (.) for (.) when in straight line motion (.) you need force
2 and for spinning motion you need moment (.) I think we should write down that
3 (.) moment (.) causes rotational acceleration ((pause while writes on the blackboard))

4 just like a force causes (.) linear acceleration ((writes on the blackboard))
[…]
5 T but this is the main point (.) anyway […] when there's opposite moments who
6 cancel each other so (.) there is no acceleration

In other words, the teacher again contrasts moment with a straight line motion, emphasizing that moment causes *rotational acceleration* and force *linear acceleration* (lines 3–4). Note how the everyday formulations 'moving in a straight line' and 'spinning around' used by the teacher earlier are now replaced by the more technical and subject-appropriate expressions, linear acceleration and rotational acceleration. This indicates a gradual progression towards the use of subject-specific expressions on the part of the teacher. However, the teacher never refers to the technical, subject-appropriate nature of such language explicitly; the importance of these formulations is rather signaled by the fact that he writes them verbatim on the blackboard for the students to copy in their notebooks, while he does not copy the everyday expressions on the board. In intertextual terms, then, Extracts 1, 2, 3, and 4 show that the teacher is scaffolding learning by juxtaposing informal and academic language and by highlighting the importance of the latter by rendering it into written definitions on the blackboard.

Even though the teacher summarized in Extract 4 the difference between force and moment as *the main point* (line 5), he nevertheless proceeds by introducing – as shown in Extract 5 – yet another definitional feature of moment, that it also *has direction*s (line 2). He illustrates this by drawing curved arrows on the blackboard where he has earlier drawn a sketch depicting a wrench around a bolt to describe turning motion, i.e. utilizing both visual and verbal aspects of meaning making.

Extract 5

1 T yeah I think one thing we should add to this picture is that
(.) because just like
2 forces and (.) velocities and other stuff a moment also has directions
(.) but the
3 direction is not (.) a line pointing somewhere but it's a (.) for instance
in this case
4 um (.) we can describe the direction of the moment (.) the direction
of turning
[…]
5 T so in (.) in this kind of cases you can (.) the direction can be either
(.) this way
6 ((pause)) or this way ((draws two curved arrows while speaking))
7 so in this case it's (.) clockwise (.) [and]
8 LF2 [oh] yeah (.) clockwise
and counterclockwise
[…]

9	T	clockwise and (.) then anticlockwise (.) balanced moments mean there is (.)
10		no (.) rotation or actually no rotational (.) acceleration […]
11		so basically what we did with the seesaw thing here is that (.) we had two
12		moments (.) which were equal in in magnitude (.) but in opposite directions […]
13	LF1	so like what kind is the balanced moment
14	T	sorry
15	LF1	what what is it like the balanced moment
16	T	well (.) um actually I think we're going to use this again so may I borrow an
17		eraser again ((the class proceeds to a hands-on experiment))

In addition to the new information of moments having direction (lines 2–3), two qualities of these directions are also introduced in the teacher's explanation, i.e. clockwise and anti-clockwise as well as their role in resulting in *balanced moments*, i.e. the state where there is *no rotational acceleration* (lines 7–10). From the learners' point of view, introducing these new concepts adds further levels of abstraction to the already abstract notion of moment. While it seems that some of the students comprehend the core idea that the direction of turning can be in different directions (line 8) the meaning of moments being balanced remains unclear as suggested by a student's questions on lines 13 and 15. It may be because of this uncertainty on the part of students that the teacher decides to repeat the seesaw experiment with a plank balanced on an eraser that the class has already tried, talking through the experiment and using pointing gestures in conjunction with deictic expressions *somewhere there*, *this way*, *there*, *this one* (lines1–4) to explain in a very concrete manner what the term moment means as depicted in Extract 6:

Extract 6

1	T	so if you put one weight um somewhere there (.) then that is now causing um (.)
2		(.) a moment that is turning this way (.) so (.) you need some (.) you need to
3		balance it with something (.) if you put the the other weight there (.) yeah so
4		now this one will be causing a (.) moment in the other direction so it will be
5		balanced

As Extracts 4, 5, and 6 show, in order to scaffold the appropriation of subject-specific knowledge and patterns of language involved, the teacher draws on a set of different intertextual resources: non-technical everyday language, academic language both in spoken form and written on blackboard as well as drawing,

gesturing and pointing as intertextual resources beyond linguistic means (cf. Lemke 2004, pp. 10–12).

5.3 *Calculating Moments – 'What's the Moment Thingy?'*

After students have succeeded with balancing the plank, the teacher instructs them to start measuring the distance between weights and the center point, calculating the mass of weights based on their distance, and eventually calculating the moments for both sides of the plank. In other words, rather than discussing the concept, the students are now directed to problems through which they are supposed to learn how to calculate moments.

During this calculating task, the students are working in pairs and there is a great deal of overlapping speech and a sense of shared meaning construction. The girls are often comparing the results of their calculations and helping each other out, also frequently checking information from the teacher. Extract 7 is from a situation where the students have measured distances and weights and the teacher prompts them to start calculating the moments:

Extract 7

1	T	yeah I think you can start um (.) start calculating the
2		moment and you have to convert this into (.) a weight first
		[…] ((students are calculating))
3	T	okay now you (.) (x) convert those into weights
4		and then multiply by distance um if you got an answer (.) come (.) write
5	LF1	ouch no I mean with the weight (.)
6	T	well you can you can write the weight as well (.) but we need
7		eventually we need the moment
8	LF1	yeah but if you first need the weight
9	T	yeah but I don't think you can calculate this they're in- all in a row
		[…] ((L2 writes the result on the blackboard, then turning to T asks))
10	LF2	what's the moment thingy (.) unit
11	T	well think about what units we started with it's (.) is new-
12		it's newtons times meters so (.) n m

In lines 1–2, the teacher explains what the students should do to calculate the moments. There seems to be some confusion on what the students should write on the board, LF1 referring to weight (line 5) and teacher pointing out that eventually the moment is needed (line 7). LF2 walks to the blackboard and writes her result after which she turns to the teacher to ask *what's the moment thingy (.) unit* (line 10). With this question, the student seems to have taken some steps in appropriating subject-specific language: rather than inquiring about the meaning of the concept as such, she seeks confirmation about the unit to mark moment, thus showing awareness of subject-specific conventions for conveying information.

Once the calculations have been finished with two figures written on the blackboard the teacher checks the answers. Having confirmed their correctness he sums up the task by drawing curved arrows next to the two figures to indicate which of them is for the clockwise and which for the anti-clockwise moment. This seems to cause some confusion among the students as shown in Extract 8, the connection between the concept of moment and rotational acceleration still remaining unclear:

Extract 8

1	T	this moment was in clockwise direction and in this was
2		anticlockwise (.) so and they're almost (.) the same
3		magnitude so they (.) almost (.) balance each other
4	LF3	so how do you know that
5	LF5	I don't really get that twisting thing
6	LF3	cause it's like clock[wise and anticlockwise]
7	LF5	[not twisting thing but um like] that
8	LF3	it's [clockwise] and anti[clockwise] ((indicating this by hand gesture))
9	LF4	[twisting] [anticlock]wise is [the one that (xx)]
10	LF5	[um yeah (xxx)]
11		yeah this [(x)]
12	T	[so] it doesn't matter what words you use
13		because um (.) it's a lot clearer if you draw something like
14		this to indicate the directions (.) so I think um
15	LF1	but how could it have that kind of direction if they're
16		just like (.) being
17	T	well they are not moving anywhere because they're balanced (.) but
18	LF3	yeah how can they then go [like (xxx)]
19	T	[but this but this one thing is] pushing
20		um (.) pushing the balance to this way (.) and the other is
21	T	push[ing it] this way ((T using hand movements to indicate directions))
22	LF1	[**ooh**]
23	LF3	oh yeah=
24	LF1	=so cause that um the (.) the one which distance was
25		ou point two- twenty three was on this side that's why it goes like this=
26	T	=yeah
27	LF1	and the other one (.) [what if you would have put this on] this side
28	LF3	[was it (that side) (xx)]
29	LF1	would it um would've it gone like this
30	T	yeah
31	LF1	okay
32	LF5	oh yes
33	LF3	oh now I get it yeah now I get it

Extract 8 is also a good example of joint construction of subject-specific knowledge. When the teacher again reintroduces the idea of clockwise and anti-clockwise moments resulting in balancing (lines 1–3), two students express bafflement but for

different reasons: while it is unclear for L3 how the teacher could determine which directions the two figures represent (line 4), LF5 conveys on line 5 that she finds the whole *twisting thing* unclear, this colloquial expression clearly indexing her non-alignment with academic language use. Interestingly, it is a peer, LF3, who starts clarifying this matter, replacing the everyday expressions by more subject-relevant formulations *clockwise and anti-clockwise* (lines 6 and 8) and indicating by gesturing what they mean. The teacher picks up from there to again explain the directions of turning. This also prompts a question, this time from LF1 whose question in lines 15-16 suggests that for her, there is a contradiction between the idea of turning and something being balanced (and motionless), i.e. there is apparent tension between academic and everyday meanings. The teacher accompanies his verbal explanation on lines 20–21 by gestures to illustrate the opposite directions of turning. The emphatic *ooh* (line 22) by LF1 signals a realization and this is supported by her immediately offering a candidate explanation to the very question she asked a moment ago, also hypothesizing (lines 27–29) to check her interpretation. Once the teacher confirms this, both LF1 and LF5 signal comprehension (lines 31–32), followed by LF3 being even more explicit about this with her *oh now I get it now I get it*. In sum, then, Extract 8 shows how appropriating subject-specific knowledge (the idea of moments having directions) is inextricably linked to appropriating subject-specific ways of using language (the terms clockwise and anti-clockwise).

5.4 *Applying the Concept – 'So a Moment Is Only for a Rotate?'*

Towards the end of the second lesson during which moment is a topic of classroom talk the teacher introduces other, related concepts, the center point of gravity and stability (see Extract 9). He explains stability by first making an intertextual link both to the textbook and to a balancing task the students had just done with a plank (lines 2–4) and also gives an example of a tilting chair from everyday life (lines 6–10), using the term moment on both occasions (lines 4, 10).

Extract 9

1	T	I'm just going to (.) talk a few things about this center of gravity idea (.)
2		well this actually relates to (.) the stuff about stability (.) on page thirty nine
3		because um (.) this thing we were just balancing um (.) it was all about (.)
4		um getting it stable if it's (.) so if you have (.) too much moment in one direction
6		then things will tip over (.) and in the same way (.) in everyday life (.)
7		we want our things to be stable so they will not be tipping over
8		for instance um if the (.) if the chair is being tilted too much backwards (.)
9		it will have a- (.) then it will not be balanced because it'll have (.)
10		more moment into this direction

As the extract shows, the way the teacher now uses the term moment seems to treat it as given that students understand the term and its connection to directions of turning. The same applies to another extract from the following day's third lesson when homework is being reviewed and the teacher starts explaining how it is possible to calculate the weight of a balanced plank (see Extract 10). In this process he, firstly, prompts students' views on what needs to be considered when *calculating the moments* (line 1) without making the concept of moment itself focal and, secondly, explicitly refers to moment as participants' shared knowledge, as something *we know* (lines 8–9).

Extract 10

1	T	and now (.) because we're (.) we're calculating the moments so what is (.)
2		what is the distan- one more distance we have to calculate
3	LF2	from the center point to the (.) that
4	T	yeah
		[…]
5	T	so um (.) the weight of the (.) plank is (.) this force which we
6		can call f (.) and now the (.) it looks a bit complicated but
7		we know that we don't need to kn- know two things because (.)
8		we know the moment of this force because we have the distance
9		and (.) the moment has to be the same on this side

However, the assumption that students have advanced to this level in their appropriation of the concept of moment seems somewhat premature, judged by the exchange in Extract 11 that takes place immediately after the teacher's explanation above:

Extract 11

1	LF1	so is mo- is the moment like a force
2	T	moment is the force times (.) um the turning force times
3		the distance from the (.) center of turning (.) so it's a bi- it's a bit
4		like force but it's (.) different (.) so as I said um last time
5		when you're when you need to (.) um move something in
6		a straight line (.) you need a force (.) but when you need to
7		move something um (.) that is (.) you if you need to get
8		something (.) rotating (.) then you need (.) a moment
9	LF1	so a moment is only for a rotate
10	T	yes (.) cause in this case we're (.) we're sort of looking at the (.)
11		rotation around the point of support but because we have
12		balanced (.) the two moments then there is no rotation

The question in line 1 shows that at least some of the students still struggle with the concept of moment and its relation to force. Again, there is evidence of intertextual links in that the teacher, firstly, draws on the exact language of standard scientific

definition (lines 2–3) and, secondly, refers explicitly to his own earlier explanation (marked by *so as I said last time*). This reflects the teacher's effort to once again explain the difference between 'force' and 'moment' through reference to movement in a straight line versus rotation, mobilizing both everyday and academic language resources to do so. This leads LF1 on line 9 making the correct conclusion that moment is only used for rotation, this being formulated so that it also functions as a confirmation check addressed to the teacher. Compared with a student's hedged question *isn't this um moment when something like spins or something* when the concept was first introduced, this formulation conveys a better grasp of the concept and the language used to express meanings in physics.

The Extract above (11) from the third lesson is among the last occasions when moment is topicalized in the data set of six lessons. During the fourth lesson the class moves on to a new topic, Hooke's Law; the lesson is dedicated to a hands-on experiment with a string and weights to exemplify Hooke's Law and the concept of moment is not used. The topics of the last two lessons include wave lengths and frequencies. However, there is a single reference to the concept of moment, during the fifth lesson as shown in Extract 12:

Extract 12

1	LF2	is it frequens- frequency like force but it's like a (xxx)=
2	T	=no it has nothing to do with force it's just (.)
3		it's called f because it starts with f but=
4	LF2	=yeah but I mean like=
5	LF6	=so it was [like this]
6	LF2	[cause moment] is the force that goes this way
7		is- is frequency the force that goes like ((unclear due to noises))
8	T	aa (.) no frequency is not a force

What is interesting in this occurrence is that it is introduced by a student, signaling both awareness of the core idea of moment as involving rotation, i.e. progression in subject-specific knowledge, as well as courage on the part of the student to appropriate the technical language of physics for her own communicative purposes.

6 Discussion and Conclusion

The purpose of this chapter has been to explore the emergence of subject-specific knowledge and appropriation of the relevant language in CLIL physics lessons from the perspective of spoken language. More specifically, it has focused on how one key concept, 'moment', is taught, used and discussed during six consecutive lessons, thus presenting a micro-longitudinal analysis of a learning trajectory. The findings support the view that there is a need to reorient to language used and learnt in CLIL classrooms from subject and content-area specific perspectives: as all the extracts

above clearly show, the participants are "talking physics" rather than engaging in mundane talk. This shows most obviously in the prevalence of special terms and concepts throughout. These are often abstract and technical terms, and also in complex connections with one another. For example, what seems to be at issue throughout the trajectory of learning is not only appropriating the key term 'moment' but also the way it relates to other concepts, most notably 'force', 'balanced moments', 'clockwise and anti-clockwise direction'. As the learner questions during the lessons indicate, this is a complicated process during which they are struggling to comprehend the meaning of moment and its relation to the other concepts. At the same time, the quality of student questions also changes from questioning the meaning of the concept to more specific aspects of it (such as the units used in calculations or its connection to rotation), which signals gradual appropriation of the term and its use in ways specific to physics. Moreover, the initial confusion between everyday and technical meanings of the term are replaced by student contributions that acknowledge moment as a type of force, yet seek clarifications about its more specific meanings. In other words, even though students seem to struggle throughout with comprehending the concept of moment, there are also signs of progression.

The results also indicate that an important reason for difficulties in appropriating the concepts of physics relates to the fact that many of them are also words used in everyday language. There is thus the challenge of familiar words acquiring subject-specific meanings, sometimes seemingly counter-intuitive, e.g. opposite and equal directions of turning meaning that there is no observable movement. As was shown in the extracts, the teacher uses multiple means to help students overcome the challenge. He repeats and reiterates several times the definition of moment and the difference between force as linear acceleration and moment as rotational acceleration. When doing so, he draws on everyday as well as academic registers, makes reference to his own earlier talk and uses visual and gestural resources. However, the role of language in learning remains implicit in that he never makes the difference between everyday language and the language of physics a point for discussion in the group. Thus Vollmer's (2008, p. 249) point that subject-specific language tends to remain "implicit or even secret knowledge on the part of subject teachers or pedagogical institutions" rather than being explicitly dealt with seems to hold true in this data as well.

According to Fang (2012, p. 22), a feature typical of the language of science is that it is used to "construe theoretical explanations about the natural world through dense nominal syntax with technical and abstract vocabulary". This is also visible in the current data: the teacher often explains the phenomena under discussion using dense, technical and abstract definitions that represent standard academic formulations such as *moment is the turning force times distance from the center of turning*. Operating with such abstract definitions alone would probably make it very difficult for students to comprehend the topic at hand. This is clearly recognized by the teacher who often accompanies the abstract definitions by concrete explanations and descriptions to clarify the phenomenon. In this way, the cognitive discourse function of defining that in theoretical descriptions can be treated as a separate entity (cf. Dalton-Puffer 2013) may in language use be nested in other functions, extend over long interactional sequences, and embed descriptions, explanations and even other definitions.

This study has been exploratory, focusing only on one specific concept and its role in the gradual emergence of subject-specific knowledge and appropriation of subject-relevant language. As the findings suggest, an intricate web of resources is drawn on by the teacher to scaffold learners towards subject-specific knowledge, consisting of everyday informal language, more technical and precise academic language, forging connections between ongoing and previous classroom talk and activities, as well as deploying visual and gestural means. However, what also characterizes the process is that subject-specific language is not brought to the focus of explicit attention during the lessons, i.e. the role of language in learning remains largely invisible. As I have argued elsewhere (Nikula 2015, p. 25), an important aim for further research, then, is to find ways to support CLIL teachers as content specialists to become more aware of the role of language in disciplinary learning and of their own role in language education to steer learners towards subject literacies. Such language orientation needs to be functional, geared towards content-specific literacies and, borrowing the words by Fang (2012, p. 32), oriented towards "cultivating disciplinary habits of mind", with a clear understanding of the key role that language plays in this.

Appendix: Transcription Conventions

overlapping [speech] [text]	overlapping speech
(.)	a pause
text=	latching utterances
=text	
text	emphasis
exte:nsion	noticeable extension of the sound or syllable
cut off wo-	cut off word or truncated speech
[…]	cut in transcript
((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
/text/	English translation of Finnish word

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