CLIL Physics in Italian Secondary Schools: Teaching Materials and Methodological Issues

Annarita Tavani

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1. Introduction: aim and scope

This research examines materials in use in Italian secondary schools for the teaching of CLIL physics. The corpus – a small-sized one due to the current scarcity of didactic aids for CLIL physics on the Italian market – consists of teaching units in English attached to four course books, either in print or as digital resources downloadable from the educational web platform made available by the relevant publisher for students who have purchased a given textbook. This corpus is studied against a control corpus made up of two physics course books published in the UK and South Africa, with a view to identifying similarities and differences in the discourse of scientific instruction originating in English-speaking countries and in an EFL CLIL setting. The research question focuses on the suitability of ad hoc CLIL materials for the didactic purposes ideally served by Content and Language Integrated Learning and may be worded as follows: are the teaching materials designed for CLIL classes of physics – having Italian as the majority language – suitable for an integration of disciplinary content and vehicular language (English) in the presentation and practice phases of the teaching process? More specifically, does the choice of presentation techniques and consolidation activities in the CLIL teaching units conform to the rationale of Content and Language Integrated Learning? A second research question concerns a further general issue, namely, the students' acquisition of the basic communication skills – both receptive and productive – of the international discourse community (Swales 1990) whose disciplinary area they are being instructed in. The underlying hypothesis is that the teaching materials should ideally incorporate discursive features of the relevant discourse area – instruction in physics – showing the highest possible convergence with materials used to instruct native speakers of English. In particular, I will try to ascertain whether CLIL materials respond to the lexical, syntactic and textual requirements of the discourse of scientific instruction, both in terms of micro-linguistic choices and in the overall cognitive organisation of texts.

Within the framework of CLIL studies (Genesee 1994; Marsh and Langé 2000; Dalton-Puffer 2007; Coyle, Hood, and Marsh 2010; Llinares, Morton, and Whittaker 2012), I rely on the methodological tools provided by discourse analysis, with a special focus on the analysis of LSPs (Gotti 2003; Garzone 2006; Gotti 2008), while the cognitive functions enacted in the corpus texts are explored through the analytical framework developed by text grammar (Werlich 1983). Both the corpus, i.e. the materials in use in Italian schools, and the control-corpus, i.e. the materials in use in English-speaking countries, are examined through a qualitative close reading procedure, which appeared to be best tailored to a planned multi-level analysis focusing on lexis, syntax and textual organisation and also considering the need to develop didactic strategies of 'scaffolding' language acquisition in CLIL students [1] of physics.

Section 2 examines the CLIL materials with a view to ascertaining their suitability for the purposes of language scaffolding, more specifically, for the scaffolding of Content Obligatory Language – Basic Interpersonal Communication Skills or BICS – and Content Compatible Language – Cognitive Academic Language Proficiency or CALP (Cummins 1984). Techniques aimed to teach terminology, so as to make language input and disciplinary content comprehensible [2], are scrutinised against corresponding techniques adopted in native English and South African textbooks. Strategies for presentation of content and consolidation of language are also investigated in an attempt to assess their impact on the acquisition of BICS (Basic Interpersonal Communication Skills) and CALP (Cognitive Academic Language Proficiency), which should ideally include the ability to autonomously re-use acquired language, thus serving the purpose of integrating content and language learning. In section 3 the focus shifts

1 For the concept of 'scaffolding', see Miller 2012.
2 For the concept of 'comprehensible language input', see Krashen 1985.

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to a study of some features of the discourse of scientific instruction. In particular, section 3.1 examines a pair of lexical items in the two corpora, aiming to ascertain the degree of convergence between corpus and control-corpus on some crucial terminological issues. Section 3.2 goes on to analyse two syntactic structures which are distinctive of LSPs for purposes of thematisation and depersonalisation, that is to say nominalisation and passivisation. A close reading of corpora will provide scope for contrastive analysis of these microlinguistic features and thus for assessment of the adherence of CLIL materials to the syntactic standards of the discourse of scientific instruction. Finally, section 3.3 introduces a study of CLIL texts which relies on the categories developed by text grammar, with a view to comparing the textual profiles emerging from those materials with the alternation of text types traceable in textbooks published in English-speaking countries, in an attempt to assess more extensively the suitability of existing teaching aids for an integration of Content and Learning.

2. Language acquisition through CLIL physics

The rationale for CLIL is grounded on the double assumption that extensive exposure to L2 is the best way to acquire language and that acquisition of disciplinary content may also profit from an approach which necessarily requires the adoption of scaffolding strategies and a firm anchorage in the students' background knowledge and experience. This section examines CLIL physics materials with a view to assessing their ability to provide context-embedded activities aimed at stimulating meta-cognition as well as tasks designed to further vocabulary acquisition and an awareness of terminological issues. Classroom use of L2 and content-oriented language practice are crucial areas of the learning process and should therefore be the basis of all content and language integrated teaching.

In order to favour the acquisition of both Basic Interpersonal Communication Skills and Cognitive Academic Language Proficiency, CLIL teachers must make sure they provide comprehensible language input as students only acquire what they understand (Krashen 1985), and they need to embed language in context. Indeed, evidence shows that cognitively demanding tasks are made more accessible to students when they are 'scaffolded' or supported by context in the form of non-verbal input – vocal features of teachers' talk, gestures, facial expression, visual aids, etc. – alongside information on contextual elements, that is to say, on the

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communication situation, as well as additional verbal input schematising content, e.g. through mind maps [3].

CLIL materials usually teach terminology to make it comprehensible by simply listing terms and pairing each item with either a translation or a definition, the latter being a common strategy in the discourse of both science popularisation (Calsamiglia and van Dijk 2004; Garzone 2006) and science instruction. *Pearson for CLIL Physics* (textbook 3) occasionally teaches terminology, e.g. at the beginning of the first teaching unit, where both a definition and a brief explanation of the terms 'kinematics' and 'dynamics' are provided:

> (1) *Kinematics* is the study of the characteristics of motion in terms of position, displacement, velocity and acceleration over time. In this module, motion will be considered from a new perspective: dynamics.
> *Dynamics* tells you what causes a body to rest, or why it moves at a constant velocity or a constant acceleration. The most important question in this module is 'why?' The three fundamental laws of dynamics are Newton's three laws of motion. (Bianco et al. 2012)

Unexpectedly, the South African opencourseware textbook *The Free High School Science Texts: Textbooks for High School Students Studying the Sciences Physics Grades 10-12* (textbook 5) does not introduce a definition of the terms in question; indeed, it does not use the terms at all, if we overlook the fact that 'dynamics' occurs once as a pre-modifier of the head noun 'trolley' in a noun phrase used in the instructions for an activity investigating Newton's Second Law of Motion. No difference emerges between the concepts of kinematics and dynamics, the two being subsumed under the less specialised umbrella term 'motion'. Conversely, *Pearson for CLIL Physics* (textbook 3) fails to define 'kinetic energy', while the opencourseware textbook (textbook 5) provides a simple definition of the term, followed by explicatory text meant to foster comprehension:

> (2) *Definition: Kinetic energy*
> Kinetic energy is the energy an object has due to its motion.
> Kinetic energy is the energy an object has because of its motion. This means that any moving object has kinetic energy. The faster it moves, the more kinetic energy it has. Kinetic energy (KE) is therefore dependent on the velocity of the object. The mass of the object also plays a role. (FHSST Authors 2008).

[3] For the concept of 'context-embedded tasks', see Cummins and Swain 1986.

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Definition and explanation are regularly followed by exemplification – in the form of problem-solving activities. Activities are labelled, which clarifies their role as resources of the discourse of popularisation and 2nd level instruction, as in the following example:

(3) *Question:* A 1 kg brick falls off a 4 m high roof. It reaches the ground with a velocity of 8,85 m·s−1. What is the kinetic energy of the brick when it starts to fall and when it reaches the ground? (FHSST Authors 2008)

The question is followed by a model answer.

(4) *Physics* (textbook 4) published by Mondadori Education teaches vocabulary through visual input accompanied by labelling terms – e.g. the photo of a ferromagnet and a superimposed 'spidergram' consisting of the label 'ferromagnet' plus a number of nouns and adjectives related to elettromagnetism:
ferromagnet,
magnetosphere,
magnetic,
magnetism,
electric,
electricity,
electromagnet,
electromagnetic,
electromagnetism. (Caforio and Ferilli 2014)

The task prompted by this visual/verbal input is worded as follows:

(5) Work with your classmates [pairs? groups?] and deduce the linguistic and physical implications of the links between each term in the spidergram. Some of the words are created by word formation [affixation?], others are compounds. (Caforio and Ferilli 2014)

A further task is set, which consists in matching definitions with the terms in the spidergram, as in the following example:

(5) ___________ (n, U sing.): a form of energy from charged elementary particles, usually supplied as electric current through cables, wires, etc. for lighting, heating, driving machines, etc. (Caforio and Ferilli 2014)

There is little or no teaching of terms in the other materials examined. The CLIL module attached to *Fenomeni, leggi, esperimenti. Meccanica. Termodinamica* (textbook 2) published by Mondadori Education consists entirely of a number of excerpts from "Works of eminent physicists", preceded by a brief

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introduction – in Italian – cursorily summarising content, and accompanied by no further help, no glosses, no teaching of vocabulary, no language scaffolding and, more importantly, no tasks to check students' comprehension.

Classroom language is introduced – and regularly accompanied by translation – before the teaching units attached to the physics coursebook published by Zanichelli (textbook 1) – also printed separately as independent booklets. Classroom language is meant to scaffold BICS for the students, but seems to offer input that is already known to 2nd level students of English, as shown in the following examples:

(6) May I have your attention?

(7) Today we are going to talk about…

(8) Does everyone have a copy?

(9) Please read in silence.

(10) Please leave a line after each answer.

(11) Please put up your hand.

(12) Revise chapter… (Anzola and Borracci 2012)

Far from scaffolding the students' BICS, this classroom language appears to be designed to furnish the content teacher with the essential tools for oral interaction in a CLIL class. These lists of probable fragments of teacher talk are followed by true/false, multiple-choice, gap-filling and find-the-mistake activities which are meant to check comprehension of audio-aural material presented through videos. Here is an excerpt from one of the multiple-choice activities:

(13) *Select the correct answer.*
To sign up for the extra activities [sic] should go to the a. administration
b. bar
c. presidency [sic]
(Anzola and Borracci 2012)

Of greater use may be the "Maths" and "Physics talk" sections, which precede the block of teaching units called "chapters". These sections consist of a number of mixed materials, ranging from instructions as to how numbers and symbols should be written and read to details about scientific notation, grouping, functions and graphs. Unexpectedly, an isolated definition appears for the term "expression", followed by a brief list of verbs which collocate with the noun:

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(14) In mathematics, an expression is a finite combination of symbols and numbers.
Mathematical expressions are calculated, solved or evaluated. (Anzola and Borracci 2012)

The "Physics talk" consists entirely of formulae, which are given a label – under the heading "Subject" – followed by an enunciation "In symbols" and finally spelt out "In words":

(15) Energy of a photon
$E = hv$
The energy of a photon is equal to the product of the Planck constant h and the frequency v of its associated electromagnetic wave. (Borracci and Carbone 2014)

Rather surprisingly, the South African coursebook (textbook 5), too, provides simple instructions on how to write "Units as Words or Symbols":

(16) Unit names are always written with a lowercase first letter, for example, we write metre and litre. The symbols or abbreviations of units are also written with lowercase initials, for example m for metre and l for litre. The exception to this rule is if the unit is named after a person, then the symbol is a capital letter. For example, the kelvin was named after Lord Kelvin and its symbol is K. If the abbreviation of the unit that is named after a person has two letters, the second letter is lowercase, for example Hz for hertz. (FHSST Authors 2008)

The instructions are supplemented by an 'exercise':

(17) *Exercise: Naming of units*
For the following symbols of units that you will come across later in this book, write whether you think the unit is named after a person or not.
1. J (joule)
2. l (litre)
3. N (newton)
4. mol (mole)
5. C (coulomb)
6. lm (lumen)
7. m (metre)
8. bar (bar) (FHSST Authors 2008)

Allegedly aiming to scaffold students' language skills, the physics textbook published by Zanichelli (textbook 1) provides further material after a "Slides and notes" section, followed by a 'concept map', sample questions and model answers. This 'language practice' does not appear to have a clear focus on language, as shown by the gloss detailing its function on the book blurb:

(18) Language practice: esercizi di fisica in inglese per mettere alla prova le conoscenze linguistiche e disciplinari [physics exercises in English to test pupils' linguistic and disciplinary knowledge]. (Anzola and Borracci 2012; Borracci and Carbone 2013, 2014)

There is some confusion as to whether the section should further linguistic or disciplinary competence, and there is no indication that an integration of the two is being aimed at through the activities labelled as 'language practice'. Here follow some sample tasks:

(19) 1. Match the terms in column two to the hints in column one [matching terms with definitions].
2. Find and correct the mistakes [identifying content mistakes].
3. Complete the sentences in the first column using the chunks in the second column [matching information].
4. Complete the passage [gap-filling activity with focus both on content and on language].
5. True or false [focus on content]. (Borracci and Carbone 2013)

Two further sections complete each unit:

(20) *Reading comprehension: letture in lingua con esercizi di comprensione* [exercises using passages downloaded from the web].
Multiple choice and problems: con prove d'esame A-level assegnate in Inghilterra [using the texts of A-level exams in England]. (Anzola and Borracci 2012; Borracci and Carbone 2013, 2014)

As to the need to support students' metacognition, *Pearson for CLIL Physics* (textbook 3) opens each module with a detailed list of the skills which will – hopefully – be acquired through the didactic tools deployed in the teaching units making up the module. Here follows an example:

(21) In this module you will develop the following competences:
- explaining phenomena of everyday life in light of the principles of dynamics;
- forming questions and adopting strategies for solving problems of dynamics, and evaluating their solutions;
- mastering the linguistic tools for handling communication and learning in English;
- reading, understanding and interpreting various types of written texts relating to Newton's laws;
- producing various types of text suitable for interpreting and reporting what you have learnt about Newton's laws. (Bianco et al. 2012)

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While the first two 'competences' focus on the acquisition of content and disciplinary skills, the other three objectives are language-oriented, as they put emphasis on reading and writing skills in L2 and on a rather vaguely worded mastery of "linguistic tools for handling communication and learning in English". Students are thus made aware of the fact that thanks to the CLIL physics classes they will acquire both disciplinary and linguistic competence.

Similarly, the South African coursebook (textbook 5) opens teaching units or 'chapters' with an 'introduction' detailing skill acquisition and objectives:

(23) You will [...] learn how to use position, displacement, speed, velocity and acceleration to describe the motion of simple objects. You will learn how to read and draw graphs that summarise the motion of a moving object. You will also learn about the equations that can be used to describe motion and how to apply these equations to objects moving in one dimension. (FHSST Authors 2008)

Also the *Cambridge IGCSE Physics Coursebook* (textbook 6) opens each teaching unit with a list of objectives:

(24) *Core:* Interpreting distance against time and speed against time graphs.
Core: Calculating speed and distance.
Extension: Calculating acceleration. (Sang 2010)

Another strategy adopted by *Pearson for CLIL Physics* (textbook 3) with a view to furthering students' metacognition is a section rounding up the unit on Newton's Second Law of Motion:

(25) *Dynamics:* General strategy for solving problems.
Model: Make a simplified assumption, if necessary.
Visualise: – Translate the words into symbols. – Draw a sketch to visualise the situation. – Draw a motion diagram or a few sketches representing different moments on the object's path. – Identify the forces involved. – Draw a free-body diagram.
Solve: Use Newton's second law of motion. Take the vectors from the free-body diagram and use kinematics to find the velocity and positions.
Assess: Is the result reasonable? (Bianco et al. 2012)

By contrast, in other CLIL materials no metacognitive mention of either learning strategies or learning objectives can be traced. The reason why some teaching units are also offered in English is never hinted at, and the outcome of the rather laborious process of working in physics through a

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foreign language is shrouded in mystery. True, CLIL materials are not methodological treatises, nor are they meant to work out theoretical models while exploring the process of acquiring language competence and disciplinary content at the same time. Yet, a modest effort to detail objectives, methods and targeted competence would be beneficial to both students and teachers, who are definitely facing a challenge when setting out to engage in Content and Language Integrated Learning – or Teaching.

Also beneficial to BICS and CALP acquisition would be a consistent adoption of 'scaffolding' strategies, especially in the form of context-embedded tasks. The opencourseware *Physics* (textbook 5) regularly adopts context-embedding strategies in the introduction to each 'chapter':

(26) Imagine you had to make curtains and needed to buy fabric. The shop assistant would need to know how much fabric you needed. Telling her you need fabric 2 wide and 6 long would be insufficient – you have to specify the unit (i.e. 2 metres wide and 6 metres long). Without the unit the information is incomplete and the shop assistant would have to guess. If you were making curtains for a doll's house the dimensions might be 2 centimetres wide and 6 centimetres long! (FHSST Authors 2008)

Again, of all the CLIL materials examined, *Pearson for CLIL Physics* (textbook 3) is the only textbook to provide a "Lead-in" section at the beginning of each unit consisting in true/false context-embedded questions such as the following:

(27) If you move a magnet towards a compass and then away from it, the needle deflects in one direction and then in the other. T/F
(Bianco et al. 2012)

By choosing to tick either T (for true) or F (for false), students are required to rely on their everyday experience so that they can build up new knowledge and competence on the basis of what they already implicitly know. This opening task is followed by an activity meant to teach terminology, which requires students to match terms and definitions before they have been taught anything on the relevant topic. Rather than teach technical lexis, this activity appears to test untaught vocabulary. It may therefore either function as a guessing game, or it may open the unit on the strength of the assumption that the content has already been covered in L1. The latter hypothesis, however, runs counter to the didactic purposes of CLIL, which is meant to integrate content and language teaching and learning and is grounded on the belief that language acquisition works best when

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the students' focus is on content rather than language (Krashen 1982). By anticipating knowledge of the content in L1, the didactic focus inevitably shifts from content to linguistic form, thus neutralising the benefits of the CLIL approach, in that its function is reduced to the status of language practice superimposed on the staple L1 teaching of physics. What would be of great use for purposes of language scaffolding is, rather, a regular attempt to contextualise tasks, which, however, rarely occurs in the Italian materials, even when questions are posed and problem-solving tasks are set. 'Authentic' materials consequently appear to be better suited than any of the ad hoc CLIL materials to boosting students' disciplinary competence and to fostering their acquisition of both Content Obligatory and Content Compatible language.

3. The discourse of CLIL instruction

The reason why among non-linguistic subjects the sciences are strongly recommended as suitable disciplines for CLIL projects in Italy is probably that scientific discourse is felt to be an LSP with firmly built-in lexical, morpho-syntactic and textual conventions whose acquisition performs a fundamental gate-keeping function, making it highly desirable to equip 2nd level students with Cognitive Academic Language Proficiency in this discourse area. This essential didactic need provides powerful motivation for the considerable effort involved in teaching and learning disciplinary content in a foreign language and therefore represents a strong rationale underlying the methodological approach of Content and Language Integrated Learning. However, are the existing CLIL materials suitable to fulfil this need? In other words, do the Italian CLIL materials adequately incorporate the discursive features of scientific instruction, or should materials originating in English-speaking countries be preferred as 'authentic' samples of this discourse field? To find out, I will analyse three crucial levels of the meaning-making process: lexis, syntax and textual construction.

3.1. *Terminological issues*

Specialised lexis or terminology is undeniably a key factor in scientific communication. It is therefore extremely revealing of the specialised nature of the discourse of science, both in expert-to-expert and in expert-to-learner

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communication. That is why the model discourse provided to learners of science in the form of course books should ideally deploy accurate terminology of the relevant disciplinary area, thus facilitating students' acquisition of CALP.

Specialised lexis is essentially monosemic within each specific field (Gotti 2003; Garzone 2006; Gotti 2008). Yet the CLIL materials examined do not always appear to adopt terms endowed with the quality of monoreferentiality. For example, *Pearson for CLIL Physics* (textbook 3) makes no distinction between the concepts of 'scalar speed' and 'vectorial velocity', tending to privilege the adoption of the noun 'velocity', which consequently functions as a polysemic lexical item. Underlying this choice, which is common to all CLIL materials, may be the false assumption that 'speed' is a general English noun while 'velocity' is a specialised term pertaining to the field of physics. This, however, is a form of popular rationalisation of what appears to be an inaccurate selection of lexis as, in actual fact, both 'speed' and 'velocity' were originally general English words which were endorsed as terms by the discourse of physics through a process of semantic redetermination (Garzone 2006). In the same way, *Physics* by Zanichelli (textbook 1) fails to clarify the concepts of scalar speed and vectorial velocity, using 'speed' and 'velocity' as synonyms in a formula on Beta velocity, which is included in the "Physics talk" section:

(28) *Beta velocity*
$\beta = v/c$
Beta is the ratio of the velocity of an object (or an inertial reference frame) v to the speed of light. (Borracci and Carbone 2014)

Differently, the opencourseware *Physics* (textbook 5) provides a concise simple definition of 'velocity' and clear explicatory text on the difference between 'speed' and 'velocity':

(29) *Velocity* is the rate of change of position.
Average velocity (symbol v) is the displacement for the whole motion divided by the time taken for the whole motion. Instantaneous velocity is the velocity at a specific instant in time.
(Average) speed (symbol s) is the distance travelled (d) divided by the time taken (_t) for the journey. Distance and time are scalars and therefore speed will also be a scalar […].
Instantaneous speed is the magnitude of instantaneous velocity. It has the same value, but no direction. (FHSST Authors 2008)

To further clarify the two concepts, a table schematising relevant features is added:

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(30)

Speed	Velocity
1. depends on the path taken	1. independent of path taken
2. always positive	2. can be positive or negative
3. is a scalar	3. is a vector
4. no dependence on direction and so is only positive	4. direction can be guessed from the sign (i.e. positive or negative)

(FHSST Authors 2008)

The *Cambridge IGCSE Physics Coursebook* (textbook 6), too, explains the difference between scalar 'speed' and vectorial 'velocity':

(31) In physics, the words *speed* and *velocity* have different meanings, although they are closely related. *Velocity* is an object's speed in a particular direction. [...] Velocity is an example of a *vector quantity*. Vectors have both magnitude (size) and direction. Another example of a vector is weight – your weight is a force that acts downwards, towards the centre of the Earth. Speed is an example of a *scalar quantity*. Scalars only have magnitude. Temperature is an example of another scalar quantity. (Sang 2010)

Clear, explicatory text of this kind would be extremely beneficial to learners' acquisition of CALP (Cognitive Academic Language Proficiency), but unfortunately no explanation of conceptual differences between scalar speed and vectorial velocity can be traced in the CLIL materials. More importantly, no monosemy is attached to the term 'velocity', whose polysemic use appears to be rather confusing in texts designed for scientific instruction.

3.2. *Nominalisation and passivisation*

Another crucial level of meaning construction is morpho-syntax. Specialised discourse is not modelled on any 'special grammar', but rather has wider recourse to certain structures – common to the general language – which meet special discursive needs, such as the needs for thematisation and depersonalisation, typically attributed to the discourse of science (Gotti 2003; Garzone 2006; Gotti 2008).

Surprisingly, teaching materials originating in English-speaking countries scarcely adopt these structures at all. Here follow examples of nomi-

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nalisation, which are much rarer than in the discourse of Italian CLIL physics:

(32) Balancing is the clue to finding an object's centre of mass. (Sang 2010)

(33) This was the motivation for adopting a set of internationally agreed upon units. (FHSST Authors 2008)

In the cases where nominalisation is adopted, no depersonalisation is being aimed at. Rather, the nominal forms traceable in the excerpts above represent largely consolidated options commonly in use in general English. Examples of passivisation are even scarcer and the few occurrences of passive structures do not seem to mark any specialised use of the language:

(34) The acceleration is the gradient of the *v* vs. *t* graph and can be calculated as follows: [...]. (FHSST Authors 2008)

In scientific discourse the adoption of nominalisation and of the passive voice enables the authors to conceal agency, thus making scientific discourse sound more impersonal, apparently originating with the community of scientists rather than with individual researchers. This depersonalising effect is coupled with a convenient semantic loading of noun phrases in subject position and a consequent unloading of verbs – often reduced to the mere function of copulae. This choice often serves the purpose of thematising information, shifting it from its status as 'new' or rheme to the status of 'given' or theme, thus functioning as a strongly cohesive device (Halliday and Matthiessen 2004).

Very little use of these syntactic strategies can be traced in the texts originating in English-speaking countries, which testifies to a consistent effort to avoid overspecialised language in 2nd level didactic materials. Differently, CLIL texts often make recourse to nominalisation and passivisation, as can be seen in the following examples:

(35) No process that works on a cycle is possible whose result is the absorption of heat from a reservoir and the conversion of this heat into an equivalent amount of work. (Borracci and Carbone 2013)

(36) Conduction may be seen as the transfer of energy from the more energetic particles of a substance to its less energetic particles, and is caused by interactions between the particles. (Bianco et al. 2012)

(37) Isothermal expansion (C → D): the gas is brought into contact with a heat reservoir at temperature Tc. Work is done on the gas as it is com-

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pressed (Wcd < 0) and heat Qc is transferred to the heat reservoir. (Borracci and Carbone 2013)

(38) Electromagnetic waves are generated by the accelerated motion of electric charges. (Caforio and Ferilli 2014)

CLIL materials appear to be striving hard to conform to the discursive standards of English for science. Yet in this way, a golden opportunity to model the language of CLIL physics on the didactic requirements of 2nd level scientific instruction is missed.

3.3. *Text type profile*

Physics textbooks originating in English-speaking countries show a clear prevalence of expository text, with frequent recourse to instruction whenever tasks – often of the problem-solving kind – are set.

This pattern can be traced also in the CLIL materials, which, however, are rich in narrative text reporting on scientific discoveries and providing information about eminent researchers of the near and distant past. For example, the reading comprehension passages included in the teaching units of *Physics* by Zanichelli (textbook 1) are narrative in nature. Further examples are the sections interspersed in *Pearson for CLIL Physics* (textbook 3) detailing the history of leisure activities like skydiving or throwing the javelin, which feature as short narratives, told either in the past or in the present simple. They are visually set apart from the rest of the text in that they are framed, usually with an accompanying photograph. Also *Physics* published by Mondadori (textbook 4) features various framed narratives on the life of the great physicists of the past, accompanied by photos or pictures of the relevant famous researcher. Such narratives are absent in coursebooks originating in English-speaking countries, with occasional exceptions, such as the account – labelled 'case study' – provided by opencourseware *Physics* (textbook 5) on how Galileo hypothesised and Newton later demonstrated that objects fall at the same rate regardless of their mass.

Another clear difference emerging from a comparison of the two corpora is the quality of exposition characterising the texts in each corpus. Undoubtedly prevalent in both corpus and control-corpus, exposition generally combines the features of synthetic and analytic exposition in the English and South African materials, while in the CLIL texts it tends to favour the synthetic approach. The following are examples of texts featur-

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ing sentences functioning as "thematic text bases" (Werlich 1983) in the two corpora:

(39) *The Law of Conservation of Energy:* Energy cannot be created or destroyed, but is merely changed from one form into another [thematic text base of synthetic exposition]. So far we have looked at two types of energy: gravitational potential energy and kinetic energy. The sum of the gravitational potential energy and kinetic energy is called the mechanical energy. In a closed system, one where there are no external forces acting, the mechanical energy will remain constant. In other words, it will not change (become more or less). This is called the Law of Conservation of Mechanical Energy [analytic expansion of thematic text base]. (FHSST Authors 2008)

(40) Heat is energy transferred from one body to another (or from a body to the environment) that are in thermal contact with each other, due to a temperature difference between them. (Borracci and Carbone 2013)

(41) A heat engine is a thermodynamic system, operating in a cycle, that converts heat or thermal energy into mechanical work. (Borracci and Carbone 2013)

(42) The electromagnetic spectrum is the distribution of electromagnetic radiations according to their different wavelengths (or frequencies). (Caforio and Ferilli 2014)

Differently from all other materials in both corpora, the *Cambridge IGCSE Physics Coursebook* (textbook 6) regularly avoids the typical synthetic or synthetic/analytical structure of exposition, showing a clear preference for contextualised exposition starting with information on sample situations in which the learner can experience a given law of physics in action. In other words, exposition is usually preceded by a circumstantial introduction which makes the thematic text base difficult to identify, as in the following example:

(43) A car driver uses the accelerator pedal to control the car's acceleration. This alters the force provided by the engine. The bigger the force acting on the car, the bigger the acceleration it gives to the car. Doubling the force produces twice the acceleration, three times the force produces three times the acceleration, and so on. (Sang 2010)

Thus exposition, which serves the fundamental purpose of explaining and is therefore an essential text type in the discourse of instruction, is relied on to favour comprehension by embedding explanation in a context that

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is familiar to the learner. Similar context-embedding strategies would be extremely useful in CLIL materials as they would further students' understanding of disciplinary content in L2.

4. Conclusions

A close reading of materials developed in Italy for CLIL physics and coursebooks published in English-speaking countries has shown that CLIL materials do not consistently adopt strategies for integrating acquisition of language and disciplinary content and for scaffolding students' BICS (Basic Interpersonal Communication Skills) and CALP (Cognitive Academic Language Proficiency). As a matter of fact, only some of the materials teach terminology, and they often fail to embed tasks in sufficient context. As to taking measures that may favour meta-cognition, only *Pearson for CLIL Physics* includes sections detailing teaching objectives and learning strategies. By contrast, context-embedding and meta-cognition play a vital role in the textbooks in use in English-speaking countries.

A comparison of the discursive features characterising the two corpora reveals a more accurate use of specialised lexis in the English and South African materials, as well as a strenuous effort to make the discourse of scientific instruction – in terms of both syntactic features and overall cognitive-textual organisation – more accessible to learners, while CLIL materials appear to be striving hard to conform to the grammatical and textual standards of specialised discourse. This difference in the handling of the discourse of instruction may be symptomatic of differing approaches to the teaching of science, which affect learning objectives and consequently teaching strategies. In particular, didactic practice in English-speaking countries tends to privilege comprehension and acquisition of disciplinary content through a consistent choice of context-embedded presentation techniques and consolidation tasks, whereas the didactic approach underlying the teaching of physics in Italian schools appears to be grounded on the belief that 2nd level instruction should ideally mould learners into experts thanks to a process of appropriation of the discourse of science into the discourse of scientific instruction. The question remains open whether learners at secondary school level would better profit from a popularising rather than technical handling of the discourse of scientific instruction.

In conclusion, I suggest that CLIL physics materials be designed to facilitate teachers in their effort to scaffold students' acquisition of both

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disciplinary content and language with a special focus on terminology. More technical aspects of scientific discourse, notably those features of English for science which prioritise syntax aimed at optimising depersonalisation and thematisation, should be discarded in favour of a less specialised variety of the language, better suited to learners' cognitive and expressive needs. I also suggest that CLIL teachers of physics make use of a number of presentation and practice techniques and activities conceived to scaffold students' understanding of content and use of L2 in situations close to their everyday experience, though relevant to disciplinary objectives.

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Corpus

Textbook 1:

Anzola, Eleonora, and Silvia Borracci. 2012. *Physics. Mechanics*. Bologna: Zanichelli.

Borracci, Silvia, and Angelo Carbone. 2013. *Physics. Thermal Physics, Waves*. Bologna: Zanichelli.

Borracci, Silvia, and Angelo Carbone. 2014. *Physics. Electromagnetism, Relativity and Quantum Physics*. Bologna: Zanichelli.

Textbook 2:

Bergamaschini, Elisa, Paolantonio Marazzini, e Lorenzo Mazzoni. 2012. *Fenomeni, leggi, esperimenti. Meccanica. Termodinamica*. Milano: Mondadori Education.

Textbook 3:

Bianco, Camilla, Alessandro Biondi, James Pearson-Jadwat, and Vittoria Armato. 2012. *Pearson for CLIL Physics*. Milano - Torino: Pearson - Longman.

Textbook 4:

Caforio, Antonio, and Aldo Ferilli. 2014. *Physics. CLIL Tools for Physics Learning – Electromagnetic Waves, Astrophysics and Cosmology*. Milano: Mondadori Education.

Control-corpus

Textbook 5:

FHSST Authors. 2008. *The Free High School Science Texts: Textbooks for High School Students Studying the Sciences Physics Grades 10-12*. http://www.fhsst.org.

Textbook 6:

Sang, David. 2010. *Cambridge IGCSE Physics Coursebook*. Cambridge: Cambridge University Press.

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