Content and Language Integrated Learning Approach: Learning Science through English

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Content and Language Integrated Learning (CLIL) describes educational methods where content subjects other than languages are taught through a foreign/second language with dual-focussed aims, namely the learning of a content, and the simultaneously learning of a foreign/second language. Although CLIL activities have only recently been defined as such (this approach has also been called Bilingual Content Teaching, Bilingual Subject Teaching or Content-Based Language Teaching), the experience of content-based language learning is not at all new. CLIL can be thought of as a generic "umbrella" term that covers a range of different approaches in diverse educational contexts.

As early as 1965 language immersion education was introduced in Canada in order to promote the French language at secondary level. Bilingual education projects have also produced good results in a number of other countries. In the United States, immersion programmes can be found in a number of languages, including French, German, Spanish, Japanese, and Chinese. In the 1980's, there has been a rapid growth in the number of English-language medium secondary schools, where traditional school subjects are taught through the medium of English and language skills are developed through the study of other subjects with a high degree of success.

At present the situation is that CLIL is getting increasing attention and this basically for two reasons. Firstly, because in most countries at the end of the XXth century, foreign language teaching and learning seem to be in a state of crisis. It is felt that the investment is far behind the results achieved. In Spain for instance, in the last decade, there has been considerable effort made in beginning to learn a foreign language (mainly English) in primary school at a very early age without envisaging apparent improvements. Secondly, multilingualism has become a political goal but also a political necessity in Europe (Treaty of Maastricht). Europe aspires to educate citizens that are capable of speaking, apart from their mother tongue, two other commu-

nity languages (White Paper, 1995). Although education administrators and language teaching specialists have understood that our present approach to learning and teaching foreign languages can hardly foster multilingualism in Europe, there is a disagreement about the best way to develop adequate linguistic proficiency in several languages. A number of post-communicative approaches that are learner-centred and focus on greater learner autonomy are under discussion: task-based and process-oriented language teaching and learning is among the most frequently discussed models. One of the models that are becoming popular all over Europe is CLIL.

In contrast to this interest, scientific research regarding CLIL is only starting. Experiences of CLIL programmes in many countries in Europe have proven to work, however, it cannot be said why they work and which parameters should be studied in order to actually see linguistic and metalinguistic processes at work. Most of the research available is on the Canadian and United States immersion programmes yet, it is not applicable to the European setting since the variables are different. On the whole, the research findings suggest that any educational programme in which content and language is integrated seems to offer a more challenging language learning environment than traditional language classes. CLIL seems to have a positive impact not only on the learning of content and the target language, but also on other factors, such as learner motivation, methodologies and autonomy.

Learning Languages in a "Content and Language Integrated Learning" environment

Integrating language with content instruction promotes effective language proficiency

When foreign/second language instruction is integrated with instruction in academic content, it is more effective than teaching the language in isolation. Proficiency in the target language is not a prerequisite to academic development; rather, language learning results from using language to perform authentic communicative functions. Recent trends in language teaching and learning have moved from teaching language in isolation to integrating language and content. The reason is that language is acquired most effectively when it is learned for communication in meaningful and significant social situations. The academic content of a curriculum can provide a meaningful basis for foreign/second language, given that the content is of interest value to the learners. Important and interesting content, academic or otherwise, gives students a meaningful basis for understanding and acquiring new language structures and patterns. In addition, authentic classroom communication provides a purposeful and motivating context for learning the communicative functions of a new language. Moreover, knowing how to use language in one social context or academic domain does not necessarily

mean knowing how to use it in others. For example, evidence indicates that the way language is used in particular academic subject area, such as science, is not the same in other academic domains, such as mathematics or social studies. The integration of second language instruction with subject content respects the specificity of language use.

Another reason for the shift toward language and content integration is the relationship between language and other aspects of human development. Language, cognition, and social awareness develop concurrently in young children. Integrated foreign/second language instruction seeks to keep these cognitive and personality components of development together so that foreign/second language learning is an integral part of social and cognitive development in school settings.

Integrating language with content instruction provides opportunities for extended meaningful language use

Research on CLIL activities have shown that approaches that provide opportunities for extended student discourse, especially discourse associated with activities selected by individual students, can be particularly beneficial for foreign/second language learning. At first, the increase in the time of exposure to the foreign/second language in CLIL approaches seemed to be the key element that explained why language learning was more successful than traditional language instruction. However, as research on French immersion programmes in Canada and other bilingual programmes in Europe, which have taken on a more traditional or conservative way of learning languages (even though based on communicative principles) and content, has highlighted, frequency of exposure to the target language is not the only factor to which success is attributed. Findings have shown that immersion students often perform successfully on reading and listening comprehension test but seldom achieve the same level competence in speaking and writing. The solution seems to lie in the use of methodologies that suggest activities and tasks that meet the same criteria as demanded of the communicative approach: purposefulness, interactivity, creativity, and unpredictability. Activity-centred learning programmes achieve high levels of foreign/second language proficiency even in productive skills. In sum, the use of instructional strategies and academic tasks that encourage increased interaction among learners and between learners and teachers is likely to be beneficial for foreign/second language learning.

Integrating language with content instruction provides simultaneous planning of language and subject content aims to maximise language learning

The integration of language and academic objectives should be carefully planned, providing for presentation, practice and, application of specific language forms that

are necessary for discussing academic content. If integrated instruction is not planned systematically, teachers may use strategies that are not optimal for promoting full foreign/second language development. In an effort to make content material as comprehensible as possible teachers may be using a restricted set of language functions, correct content more often than linguistic form and be inconsistent in their corrections of linguistic form. In order to develop the learner's language skills fully, teachers must progressively model more complex language and use instructional activities that demand more complex language skills from learners. Instructional strategies and tasks must be carefully selected so that the learner uses and learns targeted structural aspects of the language of a specific content area. Identifying the semantic and syntactic features and language functions and tasks that are part of academic language for a content area and incorporating them in the design of lesson plans provides for an effective language learning environment.

Research results are conclusive as to how CLIL benefits foreign/second language competence. Drawing from the same experiences, CLIL environment seems to also benefit the understanding of subject matter.

Learning in a "Content and Language Integrated Learning" Environment

Is there something such as CLIL methodology?

Content and language integrated learning or any form of multilingual education is a meaning-focused learning method where language knowledge is not the ultimate goal but rather a vehicle for instruction. The aim of CLIL is twofold: learning subject matter together with learning a language. But CLIL is first an educational approach embodying a range of different methodologies and not simply using an additional language for the purpose of instruction. In a way, the CLIL learning environment seems to enforce a new methodological approach in the content classroom, and this pressure on methodology seems to be higher on the content than on the language side. It can be observed that content teaching in CLIL classes is beginning to undergo major changes which have something to do with the different learning environment. Adherents of CLIL are starting to raise critical reflection of the pedagogical potential of CLIL and the issue concerning the development of a CLIL methodology. The advantages of the CLIL approach are clearly language-oriented since it provides for a higher degree of authenticity and a higher frequency of exposure to the target language. However, there are a number of additional features in CLIL which, if integrated more consistently into the classroom, will make this approach a more powerful instrument not only for the promotion of language competence. It is important to see that through CLIL a learning environment is created which makes it pos-

sible much more easily to put into effect modern pedagogical theories. The learning environment created through CLIL lends itself much better to the introduction and use of learning techniques and strategies. The learner will get to know the necessity of using strategies of hypothesis building and hypothesis testing in the content subject and will transfer them to his language learning. Learners will, for example, be introduced to analytic strategies in the interpretation of maps; observation of phenomena and will also use them in language learning. They will work with subject-specific vocabulary and thus increase their vocabulary learning potential. Subject learning is highly strategic and learners will much more easily transfer their strategic knowledge to their language learning. Learning techniques and strategies are the most important tools for the autonomous learner and a CLIL learning environment seems to provide for promoting these. A CLIL classroom then, offers an environment for explorative learning which cannot be found in a conventional classroom. Exploring the content subject, experimenting with specific aspects are natural activities in a CLIL classroom. Discovery learning and project work are much easier to embed into such learning environment than into a conventional classroom.

One of the most controversial issues when discussing CLIL is the question whether CLIL needs a methodology of its own. We do defend the necessity for such a methodology and we believe the methodological discussion should evolve around the two major concerns which are language on the one hand and subject content on the other. Both should go hand in hand.

Learning Science in School through English

Our concern is with the language of experimental science and in particular with the learning of physical science in English in Spanish primary schools. As a C.L.I.L activity we believe both, subject knowledge teaching pedagogy and linguistic framework of analysis and description are necessarily relevant on equal terms. As to language, this study is located within the theoretical tradition of systemic functional linguistics (S.F.L) as initially developed by M.A.K. Halliday and later followed by the more recent Australian line of research into language education.

The linguistic theoretical framework

S.F.L. makes four theoretical assumptions about language. That language is *functional,* in other words, a system for making meaning rather than expressing it. It attempts to describe and explain how meanings are made in everyday linguistic interactions. That language is *semantic* and *contextual* and thus, meanings are influenced by the social and cultural context in which they are exchanged. That using language is a *semiotic* process, a process of making meaning by making a choice from the resource avail-

able, the system (grammar). So, the conceptual framework of S.F.L. is based on a functional one rather than on a formal one. It is functional in three distinct but related senses: in its interpretation of texts (everything that is said or written unfolds in some context of use); of the system (the three meaning components in language are called metafunctions)[1]; of the elements of linguistic structures (explained by reference to its function in the total linguistic system)

Language then, in S.F.L. is described as a three-strata semiotic system. The level of meanings realised by discourse-semantics; the level of wordings realised by lexico-grammar and the level of sounds realised by phonology/graphology. Also organised into two planes: content (meanings and wordings) and expression (phonology /graphology).

Plane	Stratum	Realisation	Unit of Analysis
Content	Meanings	Discourse-semantics	Text
	Wordings	Lexico-grammar	Sentence / phrase / word
Expression	Sounds	Phonology-graphology	Phoneme / letters

The underlying common focus in all applications of S.F.L. is the analysis of authentic products of social interaction (texts) considered in relation to the culture and social context in which they are negotiated. So, alongside a theory of language (three-strata model), systemic linguistics claims a theory of contexts. The linguistic plane, then, is the expression plane of a more abstract register (context of situation) and genre (context of culture) planes of communication[2]. S.F.L. then, allows to approach texts from two perspectives – that of language (science as text) and that of social context (science as institution).

The language of science

In Halliday's social-functional approach to linguistics, he distinguishes scientific English as generalised functional variety, or register, of the modern English language.

1. Linguistic texts typically make not just one, but a number of meanings simultaneously. What S.F.L. refers to as the three macrofunctions of language: experiential, interpersonal and textual meaning. (Suzanne Eggins, 1994, p. 11)

2. J.R. Martin interprets context as three communicative planes: register (context of situation) and genre (context of culture), with register functioning as the expression form of genre, at the same time as language functions as the expression form of register. Clearly, meaning potential is not evenly distributed across a culture. Access to genre and language as semiotic resources is mediated through discourses of ethnicity, class, gender and generation, which discourses are in continual process of negotiation with each other. Not only is this process of negotiation manifest in all text, but it functions as well as the source of semogenesis, both contextual and linguistic. It is for this reason that a fourth communicative plane, ideology, will be articulated here, with genre, and hence register and language as its expression form. (1992, Martin, J.R., pp. 495-6)

Whenever we interpret a text as "scientific English" we are responding to a cluster of features identifiable as a recognisable category to any speaker of English for whom it is in their domain of experience. It is a form of English in which certain words, and more significantly certain grammatical constructions, stand out as more highly favoured, while others correspondingly recede and become less highly favoured, than in other varieties of the language. As a functionalist linguist, Halliday has been particularly concerned with semantic change (semogenesis analysis), and this is reflected in his description of the evolution of scientific English. For him, scientific English is conceived as a linguistic/semiotic practice which has evolved functionally to do specialised kinds of theoretical and practical work in social institutions. His interest in the language of science is "on how the grammar of the clause works in scientific English to reconstrue human experience as technical knowledge" (Martin & Veel 1998)[3].

Halliday considers grammar as a theory of experience. Through language then, we build up a mental picture of reality; we make sense of what is happening. At a semantic level, one dimension of this reality is how the clause is organised to realise experiential meaning[4].

> "Our most powerful impression of experience is that it consists of 'goings on' – happening, doing, sensing, meaning and being and becoming. All these goings-on are sorted out in the grammar of the clause."
>
> (Halliday, 1994: Chapter 5)

When first encountered with the language of science the difficulties lie apparently in lexical terms. The language of science is defined as consisting of a battery of field specific, technical words – a jargon. However, the problems with technical terminology usually arise rather than from specific terms themselves from the complex relationships they have with one another. Usually we understand a technical term when we understand its relationship with a larger framework of reference. Technical taxonomies in the language of science is not groupings of related terminology but reveals high ordered conceptual constructions in which each term has its definite functional value. On top of this, lexical items almost always occur inside one or more nominal groups that also contributes with another difficulty – nominalisation. The main source of syntactic ambiguity is caused by the fact that something that would typically be expressed by a clause is being expressed through a nominal group. A process of nominalisation has taken place causing a semantic loss. Halliday directed

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3. As Lemke put it, the language of science demonstrates how language does not simply describe or reflect human experience, rather it interprets or construes it. A scientific theory therefore, is a linguistic construal of experience. The evolution of science was, the evolution of scientific grammar, we mean the grammatical resources of the natural languages by which science came to be construed

4. The clause models experience through the grammatical system of transitivity which in turn manages process types, this implying the process (verbs) itself, the participants (nouns) in the process and the circumstances (prepositional complements) associated with the process.

he attention to the ways in which nominalisation evolved as a resource for contruing scientific reality as a world of logical relations among abstract entities. Nominalisation with the recursive modification of the nominal group becomes the salient features of scientific discourse enabling complex sequences of text to be "packaged" as to form a single element in a subsequent semantic configuration. It is this nominalisation that enables these wordings to function as an element in another clause. So when processes are being classified they are nominalised and organised as things. Aside from facilitating classification, technical terms for processes function as a kind of shorthand. It is quicker to refer to –leaching– encapsulating the processes by a single name than to run through all the processes to which each refers. But it has also another effect: it construes these phenomena as if they were things. Essentially what we are looking at is the relationship between semantics and grammar – between meaning and form.

The correspondence is outlined below:

Semantics	Grammar
Participant	Noun
Process	Verb
Quality	Adjective
Logical relation	Conjunction
Assessment	Modal verb

This nominalisation has served to create higher and higher order abstractions which provide conceptual objects that populate the intellectual landscape of scientific specialities. These nominal abstractions are increasingly removed from concrete experience, and at each stage of the abstracting nominalising process, concrete referential information is lost, so that the material meaning of higher order nominals becomes increasingly hard to follow and agree on. Overall the effect of abstraction in the grammar of a text is to foreground nominal groups at the expense of clause complexes. The text then itself decodes reality as a set of relationships between things.

In each text there is a similar process where concrete reference is compacted and abstracted in the unfolding of the article's argument, where events turn phenomena into conceptualised processes. As actions are increasingly embedded in abstracted nouns, verbs also increasingly express abstracted relations. So the basic semantics is of conceptual objects deployed in nominalised grammatical forms, put in relations of coexistence, revelation or causation. One thing is another, or reveals another or causes another. Similarly, conjunctions and prepositions elaborate, extend or enhance these relations.

Everyday language of commonsense knowledge constructs reality as a balanced tension between things and processes, however, the scientific register of scientific

knowledge reconstrues it as an edifice of things. A powerful discourse which has become the norm.

According to Halliday & Martin (1993) scientific texts needn't be "alienating"[5] and "anti-democratic", but can be deconstructed and made accessible to the lay audience.

A need for recontextualsation.

Of all possible applications of S.F.L., we are concerned with the educational dimension. Christie, F. (1998) suggests S.F.L. as the model of grammar to "explain how school appropriates the discourses of fields of knowledge outside and relocates it for pedagogical purposes". In the popularisation of science research, scientific discourse has had to evolve in specific contexts to meet specific needs of target groups. This reconfiguring and reordering of scientific meanings to the principles of the new contexts is what Bernstein (1977, 1990, 1996) named "recontextualisation". Also used to refer to the reformulation of meaning that occurs in educational context. Thus, the language of "school science" –its genres and lexicogrammatical patterns– is different from the language of "industry science", "university science"…

Christie who is concerned with the reformulation of scientific knowledge for pedagogical purpose explores the tension produced between the pressures for organising or framing scientific knowledge into pedagogical sequence on one hand, and the desire to produce students who are independent producers of scientific knowledge on the other. To be literate in science means to be able to understand the technical language that is used. To understand this, we have to look more closely at what scientists are trying to do. So we have to be very clear about the kind of knowledge science is trying to construct and also about the ways in which scientists package this knowledge into text. In this process, of course, an important resource of technology is used by scientists –language– which is often overlooked. According to Christie, literacy in science has to be considered both from the point of view of field (knowledge that is being constructed) and genre (the global patterns of text organisation that packages this knowledge). Teachers have to understand the grammar of the language of technicality (order, classify, decompose and explain) together with the structure of the major scientific genres (report, explanation and experiment) to tackle the problem of science literacy. The linguistic technology is the key to understanding and practising science. In the same line Lemke (1990) agrees that discourse of upper primary school science is much more than the learning of a scientific content and points out limitations in traditional research into classroom language and processes. Mainly, that re-

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5. "If children get put off by the language of science (although they have no problem in recognising it) we call it 'alienation'" (Lemke, 1990[a], p. 3).

search has not addressed the manner in which contents of different school subjects are constructed in talk and the relationship of talk to the literacy students must learn to use in different subjects.

Natural language embodies, in its grammar, a theory of human experience. A scientific theory (physical science) reconstrues certain aspects or components of human experience in a different way, in the course of opening them up to be observed, investigated and explained. The problems addressed by modern physical sciences among others often involve phenomena that are far removed from the experiences of everyday. Schools have a crucial role to induct students into the alternative scientific worldviews – bridging across common sense and science. But this common sense interpretation of the world surrounding us is certainly a useful start for learning science.

Young children's world of meaning is organised congruently. That is, in young children's speech, meaning and lexical class are congruent with one another. When children first move from their infant protolanguage into mother tongue, they build up their picture of the world according to the same principles on which grammar, itself evolved. Children first construe experience in the clausal form, in the grammar of daily life. As they approach adolescence, and as a condition of entry into the world of adult knowledge, children have to construe their clausal grammar in a different nominalised form. In this ontogenetic process, only when cross-coupling begins is when we cannot avoid theorising both semantic and lexicogrammatical patterns and keeping them terminologically apart.

This is in no way to imply, of course that young children do not engage in logical reasoning of course they do. Commonsense knowledge is no less dependent on rationality but scientific knowledge in fact, evolved as a metaphoric reconstrual of experience; and it is this that has determined how it is pursued by those who are "doing science" and how it is transmitted to those who are learning.

In physics, just like in commonsense knowledge of the world, scientific processes are understood by building up experience through a congruent reference. Necessarily then, in learning science through a foreign/second language students should learn science concepts by developing cognitive structures through interactions with the environment. Students learn science constructively, i.e. students build or construct meaning by using their own experience and previous knowledge as a guide and, construct new scientific concepts through experiences that involve exploring, investigating and solving problems related to "tentative constructs" that students modify during the learning process. In learning science, as well as in acquiring and developing language, students assimilate experiences into a construct that is available to them through subjective representation. However, the meaning of the representation must be consistent with experience, with meaning of related constructs and with conventional meanings constructed by others.

We suggest then, that a staged lesson plan in which this first stage of establishing a congruent relationship with the actions that are performed is absolutely essential for later more abstract reformulation of these actions as is done in language of science.

The preliminary lesson stage needs to tackle the problem of bridging the gap between background and commonsense knowledge leading into scientific knowledge. Ogborn, Kress and McGillicuddy in an initial report on the research project "Explanation in the Science Classroom"[6], come to say that when a teacher "explains" science in school it is an act of communication – of reworking knowledge. From commonsense knowledge held by students from the experiences of everyday life into school science knowledge. So, language and science are often indistinguishable because we see them as deeply interdependent: talking science as remaking knowledge, science as reshaping language.

The next are experimenting stages in which at first level, students are involved in making direct observations of experiences and record data. This is intrinsically related with the performing of the actions/procedures and the congruent expression of these. Once the reference has been established, it is the moment for making generalisations about the phenomena (graphic representations...) and expressing them. At second level, the degree of abstraction goes further to making predictions about the relationships between the variables involved in the phenomena and again expressing them.

Finally, the ultimate level of abstraction is the "institutionalisation" of scientific knowledge or when scientific knowledge is "encapsulated" into a formula/model. By applying this physical law (a theory of world experience) to similar problems we are enabling discourse to move on providing the audience share the same referents.

Final Remark

It can only be hoped that the increasing popularity of C.L.I.L. practices will lead to greater insights into the ways content and language are integrated in learning. With only few exceptions, research has not yet addressed the manner in which contents of subject matter is constructed in talk and only a more subtle analysis of language will bring out the differences between the subject contents.

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Abstract:

CLIL (Content and Language Integrated Learning) has only recently become a popular and extended practice in mainstream education in our country in the hope of improving second/foreign language competence. However, CLIL has a two-fold aim: developing second/foreign language competence and subject matter knowledge.

These projects are starting to raise awareness as to which are the methodological issues concerning the integration of both second/foreign language and content instruction. Questions as to how subject discipline and language interrelate and what are the educational implications.

Resumen:

Recientemente, un número cada vez mayor de centros de educación primaria están considerando proponer experiencias en el ámbito de la enseñanza de contenidos curriculares a través de segundas lenguas o lenguas extranjeras (CLIL). Aunque en un principio, el objetivo a perseguir es el de mejorar la competencia en la lengua, sin embargo, es preciso aclarar que la enseñanza a través de contenidos tiene una finalidad doble: el desarrollo de la competencia lingüística junto con el desarrollo del conocimiento en una materia disciplinar.

Las experiencias piloto existentes hasta la fecha han puesto de relieve ciertas cuestiones metodológicas concernientes a la enseñanza integrada de lengua y contenidos. Interrogantes referentes a cómo la lengua y las materias disciplinares se relacionan y cuales son las implicaciones didácticas.