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Teaching and Learning Mathematics in a Non-native Language: Introduction of the CLIL Methodology in Italy

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The recent reform act for the Italian upper secondary school has ruled the gradual introduction, from the 2012-2013 school year onwards, of the CLIL (content and language integrated learning) methodology in the *Licei* and technical schools. While CLIL clearly offers students great opportunities for developing their skills and abilities in a foreign language, used as the medium of instruction, the impact of CLIL on the teaching/learning process, for the non-language subject contents, still needs to be investigated. The paper focuses on the training of mathematics CLIL teachers. Then, we try to identify the areas of competence that are necessary for CLIL teachers in general and mathematics CLIL teachers in particular. Our analysis is supported by the outcomes from a questionnaire. In the analysis, we make mainly use of the text linguistic perspective.

Keywords: CLIL, mathematics, language, teacher training

Introduction

The CLIL (content and language integrated learning) methodology aims at making students acquire both "language skills" and the "content" at the same time (Marsh, 2002).

In Europe, the issues related to the language teaching/learning are inspired by the CEFR (Common European Framework of Reference), which are consistent with teaching/learning contexts which integrate "language" and "content". In Italy, the recent Upper Secondary School Reform has introduced the introduction of the CLIL methodology in a large number of schools (the *Licei* and *Istituti Tecnici*). Moreover, the new Initial Teacher Training Act provides for a module on CLIL for future teachers, whichever subject they will teach.

Until now, a theoretical reflection on issues concerning the introduction of the CLIL methodology in Italian schools has not been carried out. As a consequence, pilot experiments which have been implemented in a few schools can be only exploited firstly to identify critical points which might arise, and secondly to define a suitable theoretical framework to address them.

In this paper, we suggest a theoretical framework compatible with the perspective of text linguistics which seems to be effective to analyze different ways of using "language" when the "content" is mathematics.

Mathematics Taught in a L2 (Second Language)

In order to investigate issues to be taken into account in promoting the use of CLIL methodology as far as mathematics is concerned, we propose an analytical model suitable for the different ways the L2 (non-native

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language) is used in classroom. This contribution is focused on a linguistic approach, namely, a text linguistic approach which is exploited to analyze different types of discourse emerging in classroom.

As to mathematics being taught using CLIL methodology, apart from a few papers (e.g., Hofmannová, Novotná, & Pipalová, 2004), we can only refer to studies about peculiar teaching contexts, such as bilingual schools (Barton & Neville-Barton, 2003; Barwell, 2002; Clarkson, 1992) and multicultural classrooms (Barton, Barwell, & Setati, 2007; Setati & Adler, 2001). In these contexts, pupils are actually taught in a L2, but the educational aims differ, sometimes significantly, from CLIL teaching. In particular, in the majority of the above-mentioned studies, the ordinary classroom language is a L2 only for (sometimes just a few) students and it is used to teach all content subjects. Moreover, the language of the classroom is often either the teachers' mother tongue or fully mastered by them.

This is not the case for the Italian context where the CLIL methodology provides for only a single subject to be taught in a language that is a L2 for both the teacher and the students.

The Key Competences of CLIL Teachers

Once stating the lack of theoretical references, how can CLIL mathematics teachers be trained nowadays? How can we tackle this issue? We think that the theoretical framework of the CLIL across context project (Hansen-Pauly, 2009) can be used as a basis to investigate what critical issues are to be taken into account. In fact, the main project output is represented by the identification, definition, and description of the following "areas of education and competence" (see Figure 1) which are considered necessary to CLIL teachers, whichever the subject (mathematics included) to be taught.

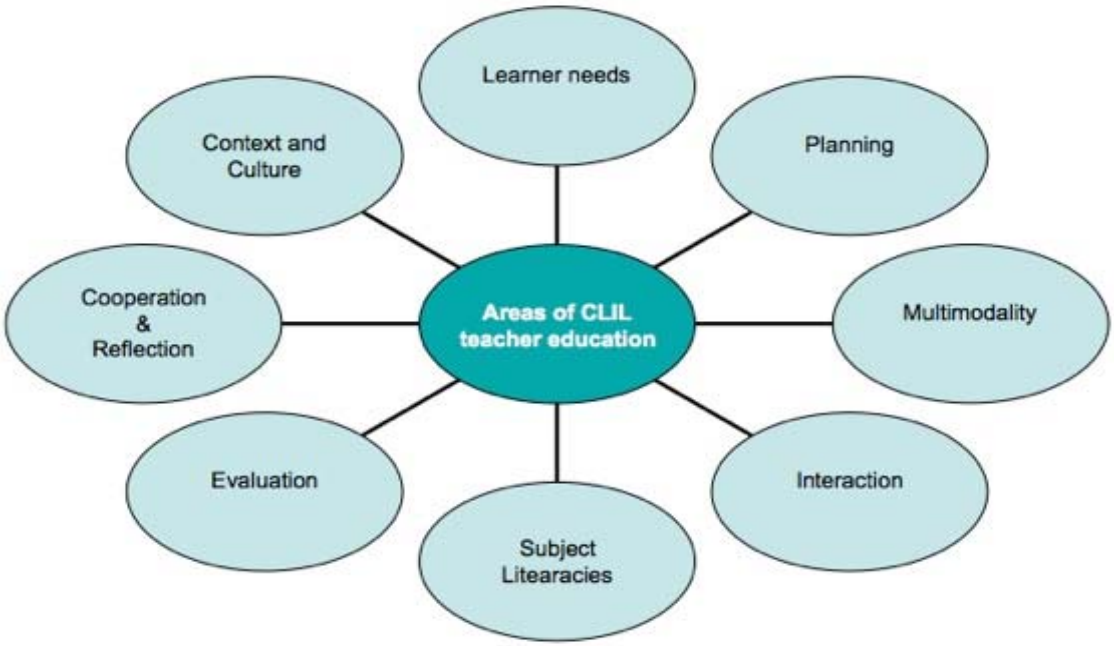

Figure 1. Key areas of CLIL teacher competence.

In fact:

(1) CLIL teaching always takes place in a social and cultural context where different languages may be used—context and culture;

(2) CLIL requires more planning, moving from less to more language demand in units, integrating content and language objectives—planning;

(3) CLIL teachers are learning academic and other content at the same time; it is important to pay attention to learners' experiences, language levels, and needs in learning the subject—learners' needs;

(4) CLIL teaching involves teaching the text types and typical language patterns and value in the subject areas—subject literacy;

(5) CLIL requires teachers to mediate both language and content through the use of talk in interaction in the classroom (the types of question we ask, getting students to elaborate, and widening types of interaction)—interaction;

(6) CLIL is a pedagogy which requires more cooperation between subject and language teachers, between teachers in preparing material—cooperation and reflection;

(7) CLIL teaching involves not only language but other ways of communicating meaning (pictures, tables, graphs, mathematical symbols, and use of tools)—multimodal teaching and learning;

(8) Assessment in CLIL raises important issues about the relationship between subject knowledge and language ability—evaluation/assessment.

The complexity and, at the same time, the interrelations of the above competences made it impossible to address, at least at an initial investigation of the introduction of the CLIL methodology, many areas of competence at the same time. For that reason, we focus our initial study on only three areas—learners' needs, subject literacy, and interaction—in which the teachers are more concerned about, as it will emerge from the analysis of the questionnaire.

As far as mathematics is concerned, a first study (Favilli, 2010) on possible modalities for training teachers to teach mathematics in a foreign language has been carried out, within another European project "Making Mathematics Teachers Mobile". As part of the activities in the project, a questionnaire has been introduced to secondary school mathematics teachers in Austria, Czech Republic, Denmark, France, and Italy. Outcomes from its analysis help, firstly, investigate mathematics teachers' attitudes about CLIL teaching; and secondly, plan their training.

Italian Mathematics Teachers' Attitudes About CLIL

The main aim of the questionnaire was to collect information about the respondents and their opinions about future teaching of mathematics in a foreign language. The questionnaire included 24 items which can be grouped as follows:

(1) Foreign languages spoken and levels of competence: Teachers are asked to say what languages they know and what are their levels of competence;

(2) Prior experiences: Teachers are asked to say if they have experienced teaching their subject in a foreign language, and to say if, when and how they interacted with a language teacher;

(3) Present opinions: Teachers are asked to evaluate the relevance of knowing a foreign language when teaching mathematics. Moreover, they are questioned about possible additional difficulties students could encounter when teacher and students do not use their mother tongue;

(4) Expectations: Teachers are asked about the possibility to teach mathematics in a foreign language and to figure out possible impacts on the subject learning;

(5) Professional development: Teachers are asked to consider their own needs if asked to teach in a foreign

language, and possible resulting changes in their teaching practice.

The eight areas of competence for CLIL teachers, which we have introduced in the previous section, have been somehow, implicitly or explicitly, also mentioned by more than 300 mathematics teachers, who answered the questionnaire.

In the next part of this section, our perspective on the areas of competence for mathematics CLIL teachers in Italy is presented.

The Impact of the L2 in Mathematics

While, as expected, learner's needs, interaction, and subject literacy are the competences most referred to by the respondents, it is surprising to see how evaluation/assessment is not such a worrying issue for them. On the contrary, the poor cooperation of mathematics and language teachers and the lack of prior CLIL teaching experience are the main reasons why planning, multimodal teaching and learning, cooperation and reflection, context and culture are not paid too much attention to.

We are now presenting some comments about the three areas which are mostly addressed by the teacher so as to identify a possible link among them. Not only these areas are the most addressed, but they also give evidence of the specific role played by L2 in the teaching/learning processes and how the language influence the content. For that very reason, we present in the next section a model to take into account possible changes in the use of the language in math lesson in L2 compared to math lesson in the native language.

Apart from the positive comment:

> CLIL teaching is challenging for pupils.

learner's needs are mostly characterized through two different points of views: considering L2 as an obstacle and considering the necessity to modify the way the language is used.

> It would be confusing for many students and learning requires concentration and most part of the concentration would be necessary to understand the language.

The two answers above can be clearly referred to the L2 as an obstacle, whereas here after a comment refers to the need for changing the way the language is used:

> A prerequisite is the ability to communicate using terms understandable by pupils.

This prerequisite is also connected to another area of competence: interaction. As to the interaction, teaching mathematics in a foreign language could represent a possible support for mathematics teaching/learning, as the L2 is recognized as a useful barrier to prevent misunderstandings:

> Teachers and students need to take greater care in the use of the language, also including a more rigorous and synthetic use of the mathematical language and teachers develop a deeper concern about the difficulty of mathematics and then about its teaching.

But it can also consider as an obstacle which is difficult to overcome, despite of the possibility to combine the use of language with symbols:

> The language would represent a barrier despite the universal symbolism of mathematics.

As to the prerequisites needed, interaction in a CLIL classroom requires great ability in using standard

mathematical terminology, but also non-formal language knowledge, to make it possible for teachers to give additional explanations and examples. Furthermore, positive interaction in CLIL teaching requires methodological changes by teachers as,

> they should pay more attention to language accuracy, and use more concise language.

Subject literacy is, certainly, the CLIL competence area of biggest interest for mathematics teachers, as clearly shown by their comments. The importance of knowing a foreign language and using it to teach mathematics could even make teachers reflect on,

> what teaching mathematics means.

In particular, the knowledge of the language,

> increases ability to teach and explain, using simple but rigorous words thanks to the particularly limited and specific mathematics vocabulary.

Subject literacy is also important for making it possible to teach mathematics in a foreign language,

> thanks to its rules that one can understand also without speaking and the specificity of its language, and the use of symbols.

CLIL teaching is a possible support for mathematics learning as it represents,

> a proof of the universality of mathematics and its independence from the language

and it requires,

> greater reflection on the concepts to be taught.

As to the prerequisites needed, teachers say that subject literacy includes both,

> good knowledge of the to-be-taught topic and the mastery of the language at least on a scientific level.

The Text Linguistic Approach

In order to investigate the role played by L2 in a math CLIL lesson, as outlined in the learners' needs, subject literacy, and interaction areas of competence, we move from a text linguistic approach, since as it will emerge in the following, it can also give the possibilities to address semiotic, psychological, and social issues, and as a consequence, to entail other areas of competence.

In the text linguistics perspective, four basic types of mathematical discourse in classroom can be distinguished: dialogic, descriptive, argumentative, and regulative-directive discourse (Benveniste, 1966; Weinrich, 2001; MacWhinney, 1995; Searle, 1969).

The first three types of mathematical discourse not only can be used to analyze the mathematical discourse in classroom, but also constitute the basic linguistic aspects of the communicative competence (dialogue, description, and narration).

In particular, argumentative language in mathematics appears to represent a sort of mathematical specificity in the large category of narrative language.

The regulative-directive discourse type is a particular kind of dialogical language related to definite (e.g., educational) contexts or hierarchical relationships between linguistic interlocutors.

According to Givón (1979; 1991), it is relevant to capture the logic of the linguistic complexity which moves from an informal linguistic pragmatic polarity to a more formal syntactic, lexical, and morphological counterparts. This is consistent with the importance of taking into account the dynamics of the classroom interaction.

Direct translation of the complexity scale into the above-quoted partition of types produces the following implicative formulation: “dialogue” (with a present speaker) → “description” (of referents in context) → “narrative” (where a world is re-created in absentia).

In this view, in order to analyze how L2 affects the use of mathematical language in classroom, we identify an analytical model for the mathematical classroom discourse. The model aims at taking into account both the mutual integration of complexity sequences of linguistic phenomena and the dynamics of verbal interaction in classroom by means of three different mathematical discursive types.

The dialogic (content non-specific) language is constituted by an informal discourse to speak about the content. It is characterized by the use of colloquial linguistic expressions which are common in everyday language and a very limited use of content specific expressions. Such a type of discourses mainly appears in direct discourses and dialogues.

It is intentionally used by the teacher so as to introduce a specific mathematical content going back to mathematical/non-mathematical situations that the teacher considers familiar to the students.

The descriptive (content semi-specific) language is characterized by a rich amount of descriptions and occurrences of common descriptive discourse. It is often supported by gestures either to indicate elements accessible in context or to stand for specific content objects (e.g., positioning an arm so as to indicate the slope of a line).

Such type of discourse is used by the teacher in order to pose a problem, also stimulated by means of (rhetoric) questions. It is also used by teacher so as to refer to a specific mathematical object by means of gestures aiming at representing it and as a consequence with the intention to give a visual interpretation to support students to understand the discourse.

Students usually make great use of semi-specific language, since they often use such type of discourse in argumentation, when a formal language should be required.

The argumentative (content-specific) language is a type of argumentative language which is characterized by the formal language used mainly in an argumentative style, also by the support of specific mathematical symbols and formulas. Symbols and formulas are often used to synthesize the discourses they stand for.

The content-specific language is the target language which should be mastered by students learning mathematics.

It is used by the teacher mainly in proving statements and students should make use of this in formal situation, i.e., oral and written tests.

The Research Study

The different types of discourse emerging in classroom can be exploited to firstly plan and secondly to analyze a math CLIL lesson. In fact, the analytical model detailed above should not only allow identifying the types of language any part of the CLIL math lesson refers to, but also provide a frame in which making a priori analysis, suggesting to the teacher in which specific teaching/learning situation using a specific type can be more effective than another. In addition, it could provide a frame to design specific tasks aiming at making a

specific type of language emerging in students' production.

Some of the answers given by teachers, which we have already classified previously according to the three areas of competence, can be generally referred to the three types of discourse, even though not specifically to only one of them.

> A prerequisite is the ability to communicate using terms understandable by pupils.
>
> Teachers and students need to take greater care in the use of the language, also including a more rigorous and synthetic use of the mathematical language should pay more attention to language accuracy, and use more concise language increases ability to teach and explain, using simple but rigorous words thanks to the particularly limited and specific mathematics vocabulary.

> Thanks to its rules that one can understand also without speaking and the specificity of its language, and the use of symbols.

In the comments reported above, it is not clear whether,

> A prerequisite is the ability to communicate using terms understandable by pupils.
>
> It can be classified as belonging to "content non-specific" or to "content specific".

Continuous shifting from a type of discourse to a different one, even though it is not always identifiable, surely impacts the effectiveness of the use of the L2 in math classroom. Therefore, further research is necessary on the impact of this shifting on the teaching/learning process, thus, making teacher aware of their impact and management during the classroom activities.

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