

CLIL and mathematics education

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Abstract Content and language integrated learning (CLIL) refers to teaching of non-linguistic subjects (e.g. mathematics) through an additional language (L2). When using L2 to understand and learn a non-linguistic subject, a wide range of cognitive processes are activated. In our paper we will concentrate on two items related to CLIL in mathematics education: 1. The interaction of three “languages” when teaching mathematics in L2, i.e. mother tongue (L1), L2 and the language of mathematics (L2) - advantages, disadvantages, possible obstacles related to CLIL in mathematics lessons. 2. Differences in L3 discourse when teaching mathematics in L1 and/or in L2. Concrete examples from CLIL used in secondary schools and from pre-service teacher training courses at Charles University in Prague will be used during the presentation.

Introduction

All over the world the past decades are associated with two very important changes: establishment of global network of communication and globalisation of all social, political, economic and ecological processes. These as well as other changes have had strong impact on various aspects of our everyday lives. In Europe, the 1990s in education can be characterised by the renewed and increased interest in foreign language teaching methodologies due to European socio-economic integration and globalisation. The new trends that have drawn from both European and overseas tradition lead towards using a foreign or a second language as a means of instruction.

Bilingualism constitutes the presence of at least two languages within one and the same speaker. *Primary bilingualism* describes situations where a child picks up the two languages at the same time whereas *secondary bilingualism* refers to cases where the mother tongue is acquired first and the second language later. Within secondary bilingualism there are many subtypes with regard to the degree of competence, ability or level of proficiency.

In 1990 *Lingua* (DG XXII) was launched and the following years were marked by increasing frequency of articles published on research and practice. In 1995 the European Commission adopted a document on education named „Teaching and learning. Towards the learning society.“ It declares proficiency in three Community languages as a prior objective, and suggests, in a list of methods, teaching content in a foreign language as a way to contribute to achieving this objective called *plurilingualism*.

Content and language integrated learning (CLIL) is a broad expression used to refer to any teaching of a non-language subject through the medium of a second or foreign language (L2). CLIL suggests an equilibrium between content and language learning. The non-language content is developed through the L2 and the L2 is developed through the non-language content.

Events concerning CLIL are innumerable, e.g. the Council of Europe Workshop 12 B entitled „Learning and Teaching Non-language Subjects through a Foreign Language“, the publication of three books: „Aspects of Implementing CLIL“, „Future Scenarios in Content and Language Integrated Learning“ and „CLIL Initiatives for the Millenium“. CLIL Consortium was founded in 1999. Growing interest in CLIL is envisaged as the year 2001 was declared European Year of Languages.

CLIL can be seen as an educational approach to support linguistic diversity and a powerful tool that can have a strong impact on language learning. CLIL is an innovative approach to learning, a dynamic and motivating force with holistic features. It constitutes an attempt to overcome the restraints of traditional school curricula, i.e. the teaching of individual subjects, and represents a shift towards curricular integration.

Researchers encourage experimentation with different content subjects, languages, methodological approaches and with learners of different ages. CLIL implementation varies also depending on the different school systems.

Language Learning or Second Language Acquisition?

Language learning is surrounded by myths, many of which give a very false impression of what best helps achieve success. There is much scientific research on how we learn languages, which now gives us greater understanding of the role of ‘acquiring a language’ in relation to ‘learning a language’. Language learning is supposed to be a conscious process whereas second language acquisition (SLA) is unintentional. Language learning happens at school, SLA occurs in a native speaking background.

What CLIL can offer to youngsters of any age, is a natural situation for language development which builds on other forms of learning. This use of language can boost a youngster’s motivation and hunger towards learning languages. It is this naturalness which appears to be one of the major platforms for CLIL’s importance and success in relation to both language and other subject learning. CLIL offers opportunities to allow youngsters to use another language naturally, in such a way that they soon forget about the language and only focus on the learning topic. That is why CLIL is sometimes called *dual-focussed education*.

The learning of mathematics can be seen as a process parallel to the way children acquire language skills, developing structure in oral ability prior to the more symbolic abilities with writing and reading (Gardella & Tong, 1999).

Learning/teaching process

Language serves as a means of communication. In relation to cognitive processes it is above all the instrument of information processing and storing. The development of speech interacts with the development of cognitive processes in such way that the reality in people's consciousness is represented by verbal signs, which can be organised, processed, developed and interconnected by an individual.

Mother tongue has a strong impact on the way the reality, perceived by the learner, is processed. It is an agent with a semantic and grammatical structure, a highly developed means of communication used in the social environment. The reality is structured by language categories, individual notions are linked together and added to the meanings of mental schemata describing the reality and enabling the learner's orientation in the world.

To study the influences of teaching a subject in a foreign language on the development of cognitive processes we selected the combination of mathematics and English. The advantages of this choice can be found in the fact that mathematics to a large extent excludes the possibilities of various interpretation/misinterpretation of particular problems. On the other hand, its exact character does not allow for the „holistic“ approach to the English language – it cannot show the wealth of idioms and ambiguity of its vocabulary (regardless of its sources).

Three languages

The paper deals with the interaction of three languages and its impact on the formation of cognitive processes: *Czech as the mother tongue* (L1), *English as a foreign language* (L2) and the *language of mathematics* (L3).

The structure of English and Czech language shows basic differences as Czech is an inflected language whereas English is mostly analytical. That is why it has other means for expressing syntactic relations. When comparing the sentence structure in both languages, we can, for instance, notice the important role of the subject in the English sentence. The functions of the subject in both languages differ. Moreover, the word order in Czech is relatively free whereas in English it is fixed. Passive voice has different characteristics as well as the category of countability.

Mathematics is a discipline where non-verbal communication, visual and graphic materials are used in a considerable extent. Its language has a typical grammatical structure and is rich in words that are only found in this specific field. The mathematical vocabulary is similar across many languages.

Although language factors influencing mathematics education have been investigated for more than forty years, the first important contribution to this topic probably being that of Brune (1953), their systematic research only began after 1980. The term “language factors in mathematics learning” has recently been used in many areas – ranging from psycholinguistics and sociolinguistics to the discourse during the school instruction and teaching mathematics in bilingual classes.

Hejný (Hejný, 1990, p. 26) defines the *language of mathematics* as an arbitrary system of signs by means of which thinking and communication is realised. For the teaching of mathematics, it is important to investigate the relationship

images and thoughts -> their linguistic representations (1)

from the standpoint of both their genesis (the processes of abstraction, specification, systematisation, and formalisation), and their possible deficiencies and information noise. The relationship (1) can be impaired in three ways:

- a wrong conception is assigned to words and/or signs
- no conception is assigned to words and/or signs
- there is no linguistic representation of ideas and conceptions

The heading of the ‘language of mathematics’ can be interpreted in a number of senses (Pimm & Keynes, 1994). It can have a variety of meanings:

1. The spoken language of the mathematical classroom (including both teacher and student talk).
2. The use of particular words for mathematical ends (often referred to as the mathematics register).
3. The language of texts (conventional word problems or textbooks as a whole, including graphic materials and other modes of representation).
4. The language of written symbolic forms.

The language of mathematics can also refer to language used in aid of an individual doing mathematics alone (and therefore include, e.g., “inner speech”), as well as language employed with the intent of communicating with others. Language can be used both to conjure and control mental images in the service of mathematics.

When children start attending school, they must learn new uses of language. The educational rituals of mathematics differ from those of ordinary communication (Glaserfeld, 1995). This typical feature is emphasized when teaching mathematics in a foreign language.

The teaching and learning of mathematics does not only include oral language (listening and discussing), but also involves the written form of the language, i.e. activities of reading and writing.

Language development considerations in the analysis of mathematical learning introduces a view of how oral language can facilitate the initial learning and communication of concepts and skills by having children create their understanding of mathematics using language they understand. With this as a base, they then can move on to mathematical symbolism, the most sophisticated level of communication (Gardella & Tong, 1999).

Differences in L3 discourse when teaching mathematics in L1 and/or in L2

This part focuses on the interaction in one lesson and uses it to consider the ways in which one teacher uses the talk of the classroom as a vehicle to develop the pupils' expression of their mathematical ideas and so to embark upon participation in a form of mathematical discourse (Back, 1999).

The *accuracy* of mathematical language is only relative. The statement for which a secondary student is criticised, is considered excellent when used by an eleven-year-old pupil.

In mathematics the difference between the language of the teacher and student is apparent. The level of challenge in teacher talk should be appropriate to the age and level of learners. If the accuracy of a teacher's language gets ahead of a student's level of thought too much, it becomes unintelligible to the student and usually leads to formalism and verbalism. If the accuracy in question is below the pupil's level of thinking, it has a deforming influence not only on the cultivation of his/her mathematical language, but also on his/her cognitive structure in general.

Using a foreign language for subject teaching makes the teacher adapt his/her teaching style towards the use of *interactive strategies*, the stress being put on the learners comprehension and feedback. The result is dual benefit: the development of both L2 and L3 receptive and productive skills. In practice the teacher uses the variety of verbal and non-verbal means to illustrate the meaning, such as repetition, rephrasing, gestures, body language, exemplification, analogies, representation and visualisation. The use of L1 is usually the last resort.

Younger children experience *difficulties* (Kratohvílová, 1999) when they encounter long instructions for a new mathematical element. When using a foreign language as a means of instruction the tendency is to use shorter and simpler sentences.

When implementing CLIL, many teachers often use textbooks and teaching materials obtained abroad. This might cause difficulties in understanding because of the usage of country specific realia. This applies to all stages of the lesson: introducing the concepts, practising them as well as in the problem solving.

Even though the language of mathematics is universal, it is necessary to be aware of certain conceptual differences. Some terms are known only in particular language (e.g. in English the Czech term „central symmetry“ is not used, the English mathematical term „barrel“ is not used in Czech for a special type of a solid). When preparing teaching it is necessary to make the concept analysis of the corresponding mathematical area.

Concluding remarks

In practice CLIL is implemented in a variety of ways. It makes use of various forms of instruction. One of the variables is the age of students. In some countries CLIL starts already in kindergartens. Usually it takes a form of short game-like activities performed in a foreign language (“language showers”) for which certain time of the daily schedule is set aside. In primary and lower secondary school, CLIL is used in topics, projects and integrated subjects. CLIL in secondary schools usually means the teaching of several selected subjects in a foreign language.

In some countries teacher-training is already available for teachers who want to become involved in CLIL. In other countries, however, specialised teacher-training courses for CLIL need to be developed. Teacher-training for CLIL can be organised in both pre-and in-service courses or can take the form of a joint course for foreign language teachers and content teachers. Experiences in this field are gained e.g. in the project SOCRATES - LINGUA A, Trans-language in Europe: Content and language integrated learning (countries involved Austria, Czech Republic, Finland, France, Italy, Spain, United Kingdom).

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