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Diploma Thesis

# Teaching Mathematics through English

## Mathematics as a CLIL subject

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## **Prohlášení:**

Prohlašuji, že jsem diplomovou práci “Výuka matematiky v angličtině – matematika jako předmět CLIL“ vypracoval sám, s využitím zdrojů uvedených v seznamu literatury.

V Olomouci 20.6.2012

.....

## **Poděkování:**

Rád bych poděkoval vedoucímu diplomové práce Simonu Gillovi, M.A. za veškerou pomoc, poskytnuté rady, jak z teoretické, tak i praktické oblasti, čas věnovaný mé práci a konzultacím, které vedly k zpracování této diplomové práce.

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**Abstrakt:** Diplomová práce je zaměřena na výuku matematiky v anglickém jazyce formou CLIL. Práce se zabývá metodou CLIL samotnou, jejími základními principy a postupy, stejně jako možnými problémy, které mohou vzniknout při výuce předmětů touto metodou. Práce se také zabývá aplikací metody CLIL na výuku matematiky, a přináší návrhy tematických plánů pro 6. – 9. třídu s řešenými úlohami.

**Klíčová slova:** CLIL, jazykově a obsahově integrované vyučování, vyučování v cizím jazyce, matematika, anglický jazyk, výuka matematiky, výuka matematiky v angličtině

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Abstract: The diploma thesis is focused on teaching Mathematics through English language as a CLIL subject. The thesis deals with the CLIL method itself, its principles and approaches, as well as possible problems that might occur when teaching according to this method. The thesis also deals with the application of CLIL method on Math teaching and brings drafts of thematical plans for 6<sup>th</sup> – 9<sup>th</sup> grade.

Keywords: CLIL, Content and Language in Learning, Teaching in Foreign Languages, Mathematics, teaching mathematics, teaching Mathematics through English

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## **APPENDIX**



## **Introduction**

This diploma thesis presents how Mathematics is taught through English language with the CLIL approach.

The aim of this thesis is to describe what the CLIL teaching method is, what the goals of a CLIL lesson are, what problems may occur when preparing for or teaching a CLIL subject, to find out how to apply CLIL method to teaching Mathematics and how to do that effectively and to come up with possible thematic and lesson plans.

The thesis is divided into three parts.

The main objective of the first part is to present a brief history of CLIL, to define what CLIL actually is and who CLIL teachers are, what the characteristics and basic principles of CLIL are, whether CLIL has any drawbacks, and what the current situation of CLIL is in the Czech Republic.

The second part of the thesis describes some necessities for applying CLIL to Maths including the language and challenges the teaching Maths as a CLIL subject brings.

The third part presents possible drafts of 5 thematical plans for 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> grade plus one lesson focused on spoken mathematical language.

# 1 CLIL

## 1.1 Brief history of Content and Language Integrated Learning

The acronym CLIL stands for the term Content and Language Integrated Learning. Darn (2006) describes that it involves not only learning and teaching a curricular (content) subject, such as arts, biology, physics, geography, history, physical education, or, in the case of this thesis, mathematics, through a medium of a foreign language, but also the other way around - learning a foreign language by studying these content-based subjects.

Although Content and Language Integrated Learning is a rather new term (as written on CLIL Consortium webpage (2009) it was first launched by David March of the University of Jyväskylä, Finland, in 1994), the idea of teaching a curricular subject in a different language (I used the term “different”, because this does not only include foreign languages, but minority or regional forms or dialects of one language as well) has been well-known for a few hundred years. Pupils all over the world were taught bilingual for many reasons – their parents had different mother tongues and this enabled them to communicate fluently in both their mother’s and father’s homeland, or living near country borders or changing political or social establishments. The Czech Republic can stand as an example of this, either because of changes that were made to border lines in the western region during World War II that caused the migration of Czech and German citizens, and thus many people spoke both Czech and German language there, or teaching Russian as a compulsory language during Communist Era. And even nowadays many people in the Czech Republic understand Slovaks and vice versa. In Eurydice’s survey on Content and Language integrated Learning at School in Europe (2005) is written that one of the first steps towards the CLIL as we know it nowadays took place during the ‘70s and ‘80s of the 20<sup>th</sup> century in Quebec (French-speaking province of Canada) in an experiment. English-speaking parents wanted their children to learn French rather than English, simply because the first mentioned language was vital there, whereas the second one was not. These kind of experiment took place not only in Canada, but in many other countries, such as United States (implementing for original inhabitants, such as Mohawk), China, or Australia

(where immersion programs are offered in German, French, Japanese, etc.) and their successful outcome (and the active contribution of parents was one of the most crucial factors) evoked many studies and researches (Bostwick, 2012). Since then, this Canadian model has been known as an immersion, although the term itself is an umbrella term covering various types of immersion. The starting age of the learner or time spent in immersion are just few of them. In 2003, the European Commission launched the Action Plan 2004 – 2006, where they suggest launching some educational experiments through Europe, and these models follow the Canadian one, but although there are many similarities, there are also several differences. Kovács (2007) states that the most important ones are that the target language is taught as a separate subject before it becomes the medium of teaching, and after this the language is still taught separately.

## **1.2 CLIL Definition**

As stated in 1.1, the abbreviation CLIL stands for Content and Language Integrated Learning. This means it is a teaching method or approach that integrates both non-native language (English in many cases, but also French, German, Japanese, and so on) and the content subject. Therefore, learners acquire knowledge of a subject that is part of the curriculum and learn, use and improve their knowledge of the foreign language at the same time. This is sometimes mistaken with other two interpretations of a content-language teaching. The first one is a bilingual teaching of a non-language subject, where the suggested purpose is to teach a non-language subject in a target language, but the true aim is the knowledge of the non-language subject presented through a target language. The second one is a teaching a target language through topics of vocational subjects or curricular links. However, the real objective is only to gain new knowledge of the subject in the target language. As Pinkley (2011) describes, CLIL Compendium contributors identified five dimensions related to the idea of this modern educational approach within Europe. She also noted that the age range of students, students' degree of contact with CLIL and sociolinguistic environment are three leading factors that need to be considered in relation to these dimensions.

### **1.2.1 The Cultural Dimension**

The first of the dimensions describes the importance of intercultural understanding and knowledge and explains how vital it is to build up awareness of different habits, culture, languages and communication among the pupils. This starts in lessons of Geography, where children learn about neighbouring countries and History lessons, where they learn about the development of political and cultural systems in the past, or Civics.

### **1.2.2 The Environmental Dimension**

This dimension prepares students for internationalization. This can be done by international bonds between schools and various learning programmes, such as Comenius (for pupils and teachers from primary and secondary schools) and Erasmus (for University students and teachers) in Europe. (European Commission, 2011)

### **1.2.3 The Language Dimension**

The language dimension improves the overall language proficiency of learners, develops their communication skills, both oral and written. It also informs a student about the history and evolution of the mother tongue (in classes of that language, eg. Czech, German, Russian, and in History or Civics classes) and of the target foreign language (in foreign language classes).

### **1.2.4 The Content Dimension**

The aim of this dimension is to offer different perspectives for studying content. Great example of this could be the different approach of describing atoms and molecules in classes of Physics and Chemistry. It also presents the specific language terminology for these content subjects. Additionally, it prepares learners for their future job or future studies.

### **1.2.5 The Learning Dimension**

The fifth dimension, as the title prompts, sets the learning methods and strategies, both generally (thematic plans, lesson plans, and so on) and individually (it tries to create the best and the most efficient plans for learners according to their own skills, needs, abilities, etc.). This dimension also carries out one of the most important things in learning process – the motivation. It deals with motivating individuals due to their learning strategies, ways to increase and sustain it, and what to do in case of lack or loss of motivation.

## **1.3 CLIL Teacher**

A question of a great importance - “Who is a CILL teacher?” It is logical that he or she cannot be just anyone who wants to teach a curricular subject in a foreign language. Schools are responsible for every single employee and therefore it is absolutely indisputable that fully qualified and certified teachers are a crucial part of the successful educational process. There are two types of teachers that can potentially become future CLIL teachers.

First, these are the subject teachers. As I have already mentioned previously, they are teachers specialized in one or more subjects such as Biology, Physics, Chemistry, Mathematics, Arts, PE, Geography, History, and many other subjects, including those at specialized secondary schools. But in general, all of these are non-language subjects. To perform as CLIL teachers, they need a professional qualification in a foreign language, which is at least level B2 due to Colabianchi on the British Council website (2010).

The second possibility is the language teachers. They are qualified for linguistic education on various levels (kindergartens, primary or secondary schools, etc.), and for delivering CLIL teaching, they need knowledge of a non-language subject.

In Europe as the Eurydice’s survey shows (2005), most of the teachers have a certified qualification in at least one non-language subjects, or they have exactly two – one language and one non-language subject. But there is no certificate or qualification that relates

specifically to CLIL type teaching, and thus the only certifications required by European countries are those related to language proficiency as such. From the map on Figure 1.1 in the Appendix it is clearly visible that most of the European countries require only the basic qualification (any diploma or similar evidence that proves the owner had received training in a specialized institution of educational character) of a fully qualified teacher.

On the other hand as the Eurydice's survey shows (2005), some countries like Germany or Norway, where teachers study two subjects (a foreign language and a non-language subject), they are regarded as competent for performing CLIL teaching methods. Hungary is the only European country that requires certification of both specialisations (Eurydice, 2005). The low requirements of further forms of training is mainly caused by the fact the CLIL type education exists only as a project form in those countries or is in the early stage of development. Luckily, modern trends and research into more efficient ways of education favors CLIL more and more. France started to run a new form of receiving evidence in order to teach a non-language subject through a foreign language in 2003 (Eurydice, 2005). A similar idea is performed in Germany, where students can obtain a special qualification for so-called *Bilinguales Lernen* (or *Euregio-Lehrer*, meaning bilingual or Euro teacher) that allows them to teach a curricular subject in the target language (Eurydice, 2005).

### **1.3.1 CLIL Teacher's Competencies**

Now it is crystal clear that teachers should have some sort of qualification, because a piece of paper proving you are qualified teacher does not often mean you are eligible for CLIL teaching. Bertaux, Coonan, Frigols-Martín and Mehisto (2009) summarize in their study that CLIL teacher should have both skills that help laying basics for starting and keeping CLIL programme working and skills that allow the very realisation of CLIL.

On the following pages, I am going to describe some of the most crucial competences a true CLIL teacher should have to be able to prepare, deliver and assess a CLIL teaching. This includes some general competences, language competences, competences for preparing a course, competences for dealing with pupils or students (including problems that may occur when pupils or students get in touch with different culture or similar ones) and for organizing and arranging a class, and competences a teacher may find useful when working with

classroom equipment (ICT, IWB, etc.). I was inspired by the study of researchers mentioned in the previous paragraph.

### **1.3.1.1 CLIL Knowledge in General**

First of all, they suggest CLIL teachers should know what CLIL actually is and how it is different from other learning programmes and concepts of teaching, including the main characteristics. This also includes stating the key features of CLIL teaching and the benefits that this type of provision brings. Providing a description of some regional or national rules connected with CLIL or depicting other's experience with this type of teaching is always a great benefit.

It is also very important for teacher to be capable of connecting involved people with it (mainly students and their parents, other teachers, public), and of linking CLIL methods with not only the school curriculum, but also the national curriculum, and thus meet all the requirements needed. Furthermore, the teachers must know how to implement CLIL into school plans without disturbing its running or ruining its visions. Affirmative attitude towards CLIL policies and methods and positive representation of this system is necessary, regardless to whom the teacher speaks to – students, parents, teacher colleagues and so on. He or she should be also able to prepare and assess suitable tools, such as tasks & tests, surveys, survey outcomes and similar.

### **1.3.1.2 Language Competences**

As already mentioned in 1.3 there are also language competences that are vital for being a CLIL teacher. In this paragraph, I am going to sketch out some. Communication in appropriate register and successful swithing between various register types (for instance academic, formal, informal) according to the desired context is one of the basic competences that CLIL teachers need. They should be able to read and compose texts within their subject specialization, including terminology, phrases and sentence structures that come with the knowledge of these subjects. Teachers have to master classroom management language under numerous circumstances, such as individual/pair/group work, place (placement of students' tables or chairs during classes, also arranging panels, posters and pictures, plants, etc.) and time organisation, coping with noise, inadequate behaviour

or discipline problems, effective supporting motivation and communication. They must also know how to use that language properly – apart from the already mentioned registers, it is mainly the volume of one's voice, tone or speed in which teacher is speaking that is important. Bertaux, Coonan, Frigols-Martín and Mehisto (2009) also recommend to train personal voice abilities to minimize humming, pause-fillers, stammering or unnecessary repetition. This is often a difficult task that cannot be learned on day-to-day basis, but needs a lot of hard work and comes only with experience.

In addition to this, the teacher is supposed to be able to use the target language crystal clearly to explain students what are their lesson (week, month, thematical or other) plans, individual goals and steps they will follow for achieving them, also presenting new pieces of information, both language and subject, giving understandable instructions (what book to open, which exercise to fill in, what tool to use, when to hand in the homework, and so on). Speaking about presenting new stuff and doing exercises, it is obvious teachers must be able to check if students understand these instructions or not (and in case they do not understand, he or she shall choose alternative or different approach to make them understand).

### **1.3.1.3 Course Planning**

In this point, I will present some of the competences CLIL teachers should have to create a CLIL course. In relation to language competences described in the previous paragraph, it is an important ability to adjust the language level to subject curriculum, and naturally, the other way round, adapt the subject difficulty to language curriculum. I stated few times before, CLIL lessons cover content and language, and therefore teachers must plan a course including both parts. Moreover, the course must include all the learning skills – listening, reading (these are receptive skills), writing and speaking (productive skills). There must be some sort of evaluation as well that reflects the development of learners and the course in general, and thus we need to apply summative assessment. The word summative indicates that it is some kind of summarization, often in form of test, which comes after a certain period (such as after finishing a unit or content or term exam). Tests are marked and scored afterwards. The outcome is either in points or percentage, or in grades, and provides information about learner's performance. Sometimes, it is called the assessment *of* learning, because it describes the performance. (Harlen, 2007)



However, we also have the assessment *for* learning that provides qualitative feedback of students' performance called formative assessment. (Brown, 2004) Good CLIL educator must not only create and use both summative and formative evaluation, but needs to balance them in content and language. Planning the course also requires the teacher to constantly develop learners' content and language skills, to approach to learners as individuals with their needs and thoughts and to stimulate their creativity as well as critical thinking, and use the assessment wisely to raise their learning abilities. It is also a good thing to help and combine learners' knowledge from other curricular subjects from time to time, just to enrich them and provide an approach from different perspective.

#### **1.3.1.4 Students First**

Although all teachers were once learners as well and although they keep learning throughout their life, they often forget how things are working “on the other side of the barricade.” And thus, all the education methods can sometimes fail just because of lack of cooperation with students. In 1.3.1.1, I mentioned positive representation, and it is necessary to highlight it again. Bertaux, Coonan, Frigols-Martín and Mehisto (2009) recommend positive attitude towards students is the essential quality every teacher must have and creating working relationships with them is first step to make education successful. This includes the belief in every single learner and his abilities and knowledge (sometimes it can be tricky to find these abilities, but everyone surely has them, and teachers must not give up), respect their opinions and beliefs, and their diversity as well (such as origin, faith, sexual orientation).

When a learner is in need of help, teacher is supposed to reserve some time (generally after the regular classes) and aid as much as he or she can. And not only in this time, but in every lesson teacher must support individual learning methods, especially when working in class where students with special educational needs (also referred as SEN students, diagnosed with some kind of mental or physical challenge, various disabilities, etc.) are present.

### **1.3.1.5 CLIL Integration and Implementation**

Through sections 1.3.1.1 to 1.3.1.4 I have described competences and skills that are needed to establish and maintain a CLIL course. From this point and further, Bertaux, Coonan, Frigols-Martín and Mephisto (2009) suggest more CLIL teachers' competences that are necessary for successful realization. Starting with the integration, it is vital for a teacher to be able to keep the triple focus of the CLIL course (this triple focus is that language part, content part and learning skills part I described in 1.3.1.3) and merging content and language subjects together (and knowledge from different subjects as well), which means he or she should support both content learning in language classes and language learning in content classes.

When teachers are about to plan a lesson, it is advisable to create tasks that combine various learning styles or skills. Hošek (2001) describes that the monotonous and repetitive work, either physical or mental, is exhausting and may cause frustration or even states of stress or anxiety.

To raise students' interest in a topic, Bertaux, Coonan, Frigols-Martín and Mephisto (2009) propose choosing an authentic material and adapting or modifying it for actual purposes can do most of the work, e.g. a short extract or paragraph about a recent archeological discovery with all articles blanked out, a matching exercise with a picture of a space shuttle and its parts or a Pythagorean Theorem with scrambled word order. This is where teachers' imagination comes handy and attacking learners' hobbies, interests or personal involvement is a good way to success. This involves not only exercises and tasks, but any visual (things to see), auditory (things to hear) and tactile (things to touch or play with) materials and real life items (such as newspaper, radio broadcast record, workshops with an expert, and so on). On the other hand, it is very important for the teacher to decide how to use these materials, when to use them, how time-consuming or how difficult these activities can be, and thus wise implementation depends only on the teacher himself. And of course, the main criterium for choosing these materials is language and content suitability. However, cross-curricular bonds and relations can provide some help and motivation.

Teachers should be able to guide learners through the curriculum and explain the connections between the old knowledge (things that learners know from previous lessons/units/years or even subjects) and the new knowledge (things that learners are actually learning

or are about to learn in the near future) and provide information that can create various opinions on the same topic, but both the language and the content must remain accessible for all students within the class and must not create any kind of disadvantages among them. (Bertaux, Coonan, Frigols-Martín, Mehisto, 2009)

### **1.3.1.6 Second Language Acquisition**

Within the Europe, Common European Framework for Languages is valid, and every CLIL teacher must know what is written in it and know how to work with it. It is a good deal to use it as a self-assessment tool, to assess learners' level of knowledge, and to define language targets. When outlining the course plan there are several things teachers should know.

Firstly, it is the difference between second language learning and second language acquisition and which one to choose when giving a lecture. Shütz (2007) wrote that due to Krashen's theory, the first mentioned, L2 acquisition, is a process of adapting a foreign language that is similar to way how small children learn L1 (however the term SLA – Second Language Acquisition is an umbrella term for both acquisition and learning). They are acquiring it subconsciously, unaware of any grammar. The acquisition is made through the communication, and children themselves are building up the knowledge of what is correct and what is not. In L2 acquisition, it is not important *how* the form of the communication looks like, but *what* the actual information is. In contrast, due to Krashen's (1981) theory the second mentioned, L2 learning, is not communicative. It is all about learning the language rules. Learners are presented the new language with all the grammar, vocabulary and rules, they are able to talk about them and follow them when completing tasks, such as gap filling, word formation, transforming active sentences into passive or vice versa, etc. These students might be successful in a standartized test, although their speech or writing often comes with many mistakes or does not make any sense at all, simply because of lack of experience in communicative layer of a language.

After that, teachers must be able to identify words, phrases, grammar rules, idioms, etc. within a supplied material (texts, records, videos, ...) that are new for learners. It is necessary to provide additional support materials (vocabularies, meanings, example phrases or sentences, etc.) that will help learners to understand and make sure they all understand. In addition to that, it is always a good move to identify possible problematic parts of the plan

(for instance reading ordinal numbers or years) and prepare an additional exercise to refresh learners' knowledge. Furthermore, teachers should be always prepared for code-switching and language switching. Although CLIL is about educating through L2, we cannot avoid using L1 completely, therefore it is up to the teacher to decide whether to switch to a mother tongue or not. Often, it is complicated to decide, and one shall not use it more than necessary (it had been quite usual when I was at secondary grammar school that a teacher in a language class overused L1 instead of L2, because it was easier for both him and learners to understand). Bertaux, Coonan, Frigols-Martín and Mehisto (2009) explain that teachers must choose wisely appropriate error correction strategies as well and take into account abilities and skills of every single student in the class. To choose wrongly may cause demotivation and that is highly undesirable. Nevertheless, teacher must choose appropriate strategies to support language production and communication in general.

#### **1.3.1.7 All Cultures Welcome**

Unlike the previous centuries, when having a foreigner in a class was rather a curiosity, during the 20<sup>th</sup> century this changed a lot and, on the contrary, it is quite curious to not have at least one student, whose cultural background differs from the background of the rest of the class. Turner (2005) suggests that it is teachers' duty to create friendly class environment, where all members are equal regardless their origin, faith or culture, promote cultural awareness and raise students' interest in these differences. This can be fulfilled by creating games or tasks that are typical for various cultures, adapting authentic materials from other regions or countries. Children sometimes tend to point out peculiarities or differences, and it is very important to avert any kind of improper behavior or abuse based on such things and help them to overcome cultural stereotypes that are often the source of such abuse. Visiting students and schools abroad via various exchange programmes, such as those mentioned in 1.2.2, are just one of many possible ways how to raise the cultural awareness of learners and improve global attitude towards cultural varieties.

#### **1.3.1.8 Classroom Environment**

Everyone has surely experienced a class, where a teacher was in bad mood, walls were empty, air was stuffy, chairs and tables were old and uncomfortable, and a class with walls decorated with interesting posters and educational panels, fresh air

inside, comfy chairs for every student, and teacher, who is positive and helpful. And we all can agree that learning something new was a lot easier and enjoyable in the second case than in the first one. Young (2012) explains that not only the equipment of the class, but the teacher himself too, participate on generating pleasant classroom climate, and then the education process is more pleasant for the learner as well as the teacher. Both the teacher and the room where the learning process takes place should encourage all students to work efficiently and experiment with the language they use, stuff they are learning about and skills they are applying. A pleasure atmosphere and all the equipment one can utilize help a teacher to manage pair/group work, instruct students, improve communication and interaction.

#### **1.3.1.9 Innovation in Education**

As time goes by, even education systems evolve, presenting different approaches to teaching, new methods and techniques that are more effective or comprehensible (for both learners and teachers) than the previous ones. It is up to teachers whether to keep their methods “up-to-date” or not, but in this modern time it is not difficult to exchange an outdated one for a cutting-edge one. To keep up with the latest developments, Bertaux, Coonan, Frigols-Martín and Mehisto, (2009) suggest teachers should improve their teaching strategies systematically, try to use popular media and materials (that supports learners’ motivation, mostly among the younger generations). Self-assessment on a regular basis is a good way how to improve own education skills as well as studying latest researches, articles and other sources focused on pedagogy and CLIL. It is important to help learners with adapting to these new strategies, motivate them to prefer the new one before the old one and support them systematically. Not only in the Czech Republic, but all over the world schools support their teachers in self-improvement and fund professional courses that help with their continuous development. Furthermore, regional, national or international conference takes place from time to time, focused on exact subject or theme, and every teacher is free to visit it. And every teacher should not only improve himself, but also support his colleagues in their development.

This also includes modern information and communication technologies (ICT). As Böhmová (2009) describes, Czech schools experienced the boom of interactive white-boards and other modern ICT equipment lately, supported mainly by ESF ČR project called *EU peníze školám* that brought more than 4.5 billion CZK (approx. 158 million €) to schools. To use full

potential of these technologies, good CLIL teacher should be able to search and use proper materials with the ICT equipment, help students with using various media and ICT equipment and enhance their learning abilities as well as general ICT understanding. It is also advisable to balance the usage of “new” sources (electronic stuff, such as computers, the Internet, IWB, etc.) and “old” sources (studentbooks, newspaper articles, books and so on). It is teachers’ duty to instruct students about how to manipulate with the ICT equipment (this is generally done at the beginning of the year/semester) and students should do so only under the supervision of the authority. It is worth mentioning that ICT equipment and the Internet are a great way how to perform the international communication mentioned in 1.3.1.7 (via using audio-visual communication software such as Skype, etc.).

#### **1.4 CLIL Variants**

As Colabianchi (2010) describes, there are three slightly different ways how to create a CLIL lesson. In so-called *Soft CLIL* topics from the curriculum are taught as a part of a language course. This variant is eligible for younger learners or pupils that are starting with a foreign language and CLIL. On the other hand, we have *Hard CLIL* where about a half (or even more) of the curriculum is taught in a non-native language. This is suitable for experienced or older learners, due to the fact that it is often very demanding. Great example of school where *Hard CLIL* is taught is Gymnázium Olomouc – Hejčín and its bilingual six-year study programme. As informed on the school’s webpage (2012), in first two years, English is taught intensively (9 hours per week in the 1<sup>st</sup> year and 10 hours per week during the 2<sup>nd</sup> year) and then, since 3<sup>rd</sup> to 6<sup>th</sup> year, 6 subjects are taught through English only – Maths, Physics, Chemistry, Biology, Geography and History. Apart from *Soft* and *Hard CLIL*, we also have *mid CLIL* and its difficulty is between the first and the second variant. Some schools teach a limited amount of hours of some subjects.

We also have another view on different forms of CLIL approach, as described by Baladová and Sladovská (2009). The first form is suitable for young learners on lower elementary schools. The content of a target language is focused on vocabulary connected with the non-language subject. Learning and formulating tasks of that non-language subject is performed in the native language (in this case in Czech) and instructions during classes are

both in Czech and the target language. The second form is suitable for higher elementary or secondary schools. Formulating tasks and achievements of the curriculum are guided in Czech language, learners gather information from target language texts and books and formulate their answers in Czech. Instructions during lessons are in the target language only, but grammar, phrases, etc. of the target language teacher explains in Czech. The third form, suitable for secondary schools, has its achievements of the curriculum and formulating tasks in the target language, but students can answer either in Czech or the target language, as well as searching for information in materials in both Czech and the target language. Grammar is explained by the teacher in Czech and the target language, phrases, verbal expressions and text formations are presented in the target language (in mother tongue only if necessary). According to Baladová and Sladovská, the ideal outcome of these CLIL variant is mastering the knowledge and the terminology in both the target and the native language.

## 1.5 CLIL Principles

When speaking about CLIL, many teachers often refer to *4Cs Framework* or *4Cs Principles*. This term was established by Do Coyle in 1999, and as he describes, classroom-based evidence shows that there are four building blocks for effective CLIL practice, and we can find these blocks through many research projects. Teachers and learners are exploring interconnections between the *content* (subject matter), the *communication* (language of learning – analysis of a content and syllabus demands, and language for learning – builds up learner's repertoire and cognitive skills), the *cognition* (the thinking integral to high quality learning) and the *culture* (sometimes referred as community or citizenship, the global citizenship agenda). These are the 4Cs and the 4Cs Framework consider both integrated learning (content and cognition) and language learning (communication and culture).

The purpose of this is to grow in these four Cs at the same time. Content means not only progression in knowledge and skills related to specific elements of a curriculum, but it also supports learners in creating their own knowledge, understanding and developing skills. This content is related to cognition, where the aim is to develop thinking skills that link concept formation, understanding and language, and allows learners to create their

own interpretation of content, according to their language demands. Communication offers using a target language to create new knowledge and skills, it is an opportunity to learn through language and to interact via new communication technologies, such as the ones described in 1.3.1.9. Culture expose learners to various perspectives and shared understandings, offers them links lying between cultural identity and language and strengthens intercultural understanding and global citizenship. (Hawkes, 2011)

## **1.6 CLIL Characteristics**

We can say from what we learnt from the previous text that CLIL models depend on many various factors, such as outcomes, aim or context and this may vary at all levels throughout the education system, starting with kindergartens up to universities. As Marsh (2005) points out, these CLIL models differ according to the age of the learners, target language, exposure time and overall objectives. Generally, we differentiate two CLIL models. First one is the *modular model*. That means that CLIL is used in short thematic units (or modules, therefore modular model). The second one, used during long time periods in special programmes, is called *programme based model*.

In the following sections, I will describe some important aspects connected with CLIL teaching – age that is appropriate for starting with CLIL teaching, subjects that can be taught as CLIL subjects, languages we can use for CLIL teaching and time we need for CLIL.

### **1.6.1 CLIL Characteristics - Age**

There have been so many scientific researches on how people learn language throughout their life, as Marsh (1999) explains, and thus we know that the way how we learn it changes as we grow older. Moreover, these researches give us answers how *acquiring language* relates to *learning language*. Acquiring is the way how small children get a language, when it is used by their parents in the environment around them, and that is why some people think that the younger we are, the better we are able to learn a new language. Older children get the language in language learning classroom or, as Marsh points out, through computer-aided



programmes, which popularity increased over past few years. According to his point of view, we can achieve the successful language learning through the opportunity of receiving instructions and experiencing real-life situations in the target language.

Marsh (1999) emphasizes the difference between the acquisition of language at the early age and learning in classes, simply because meanwhile there is some kind of a natural use of language at the early stage, language learning classroom lacks it. And he insists that this naturalness plays a major role in CLIL based teaching, and its relations to the non-language subject teaching as well as to the language itself. He also points out that CLIL approach can offer this naturalness to any learner of any age, and it also motivates and increases the “hunger” for knowledge. Contrastly, he mentions that many people that leave school are able to use just very little of the foreign language they learnt for so many hours. Of course, some of them have the appropriate knowledge and will be able to use the language actively for the rest of their lives, mainly because they enjoyed learning it, but most will find it difficult. The key success factor lies in using the language and learning by doing, and it is not so much what we know about the language, but how we use it.

As Marsh (2002) also emphasizes, it is necessary for a learner from Europe to have multilingual skills, as the countries have different official languages. But there are no findings suggesting that CLIL method is not suitable for a specific age or abilities (such as weak or below average learners). There will always be some students that will find learning according to CLIL difficult, but there is little evidence about this. On contrary, we can find good results within CLIL method among mixed ability learners in Europe. In one case, not researched, but reported locally, a school catering for adolescents with severe behavioural problems has used CLIL/EMILE for some years because it reportedly enhances the learning environment.

Marsh (2002) also explains that it had been argued if there is some kind of critical period in which second language acquisition best occurs, but the research didn't bring any conclusion yet. This period is basically described as “the younger the learner starts, the better”. Some researchers with the naturalistic approach suggest that an early exposure to CLIL method, even in low exposure, may be advantageous. However, non-naturalistic learning environments may offer no recognizable advantage.

As you can see, there is no optimal age to start with CLIL, as the learning depends mainly on the situation. Introduction of low-exposure CLIL at the early stage of learning can become an advantage as well as later beginning with high language exposure. The important thing is that any experience of language learning should be gained in highly naturalistic environment.

### **1.6.2 CLIL Characteristics - Subjects**

We have a wide variety of subjects that can be taught in a foreign language, and CLIL method is mostly connected with social studies such as Geography, History, Civil or Social Education and sometimes Physical Education. But what matters more than the choice of a subject is keeping the dual focus of CLIL lesson, therefore any of the languages as well as the non-language subjects should be linked to some genuine context.

Marsh (2005) says that from the very beginning of CLIL teaching the choice and parameters of subjects were discussed a lot. Traditionally, they were mainly from a field of Humanities and Social Studies. In some countries, natural Science subjects such as Mathematics, Physics, Chemistry or Biology are taught experimentally in a target language. The main discussed problem is the suitability of the subject or its content fields according to teaching it in another language, and yet there is no clear conclusion. On the other hand it is certain that subjects that belong to the Humanities are more suitable than the others, because of the promotion of intellectuality and culture-specific features which help learners to be conscious about characteristics and habits of the target language culture. That is why Humanities are commonly the natural choice for CLIL teaching method, yet other subjects (Natural Sciences field) are taught as well, even as a part of an experimental teaching.

There are also some differences between subjects on primary and secondary schools, when they are taught as CLIL subjects. As Eurydice survey (2006) informs, at the primary level it depends mainly on the teacher, his specialisation and certain amount of time he can devote to CLIL method. At the secondary level, there is a possibility to select one or more subjects (or its content fields) from a wide range of subjects through the curriculum. It is necessary to note that the range may vary from one school or region to the next in the majority of European countries.

Eurydice document (2006) also sums up CLIL provision is often focused on specific activities or subjects. This implies all the secondary education where teaching in the target language concerns science or social science subjects. In some countries teaching artistic subjects and PE may be part of CLIL provision as well.

As CLIL does not focus on specific age of learner, it does not focus on a specific subject as well. However, it is highly important to balance the dual focus of CLIL provision and pay as much attention to languages as to the subject content. But generally, all subjects, either in primary or secondary level, may become the target of CLIL. Subjects such as mathematics, natural or physical sciences, history, geography and recently economics are often mentioned in official recommendations on CLIL provision. (Eurydice, 2006)

### **1.6.3 CLIL Characteristics - Languages**

Marsh (2005) writes that CLIL approach as a language learning method is mainly regarded as a new and innovative form of standart language teaching and thus the potential of teaching content subject is not fully taken into account. It is assumed that if we apply CLIL method the overall language knowledge of a learner is improved. According to this interpretation, the teaching is influenced by target language teaching methods, and thus it is not real CLIL approach, but only a traget language teaching using other contents that the standart target language teaching contents.

According to Eurydice survey (2006) English language is the main target language in the European CLIL. This is also the case of CLIL type provision in all the countries in which it is possible to offer English as a target language. The teaching of English language has often led to many innovations for various reasons, and this influenced the way of teaching other languages. However, this has not prevented teaching in other target languages such as Italian, French, German or Spanish.

Although English language is one of the most important languages in Europe, it does not have the monopoly in the European CLIL. It is widely spread in higher education, mostly in economic or business areas, but in the mainstream education (on primaries and secondaries) other languages such as French or German have the same importance as English itself.

#### 1.6.4 CLIL Characteristics – Exposure Time

Eurydice survey (2006) informs that exposure time is the most random characteristic. The official requirement for CLIL provision in mainstream school education is not set and it varies not only from one project to another, but it depends on the subjects and years concerned. If we take into account combinations of all subjects and levels, the official minimum time varies between 1 and 11 hours per week. It is mainly because primary schools in the most of the European countries have big freedom when creating a CLIL programme and this contains the style and scale of CLIL-based activities as well, therefore the official minimum differs so much. Not only the reserved time for CLIL activities and subjects varies, there is also different amount of lesson time per week depending on the type of CLIL provision. You can see the official minimum amount of time in different countries within Europe on Figure 1.2a, 1.2b and 1.2c in the Appendix.

Marsh (2005) follows this and states that in European conditions the time span is between few week and 7 years (maximum). He also adds that up to three different content subjects are taught in one target language. On the other hand, it is quite common that teachers and learners are used to use both the target and the native language in the classroom, for example a certain amount of a content is taught in the target language and the rest is taught in the native language of the learner.

Marsh (2002) also explains that high exposure time does not necessarily lead to high competence. There are several factors that are more important this, such as the form, intensity and timing. He agrees that CLIL method is a good way how to learn both language and content, but no research proves that the more is always the better. On contrary, there is a widespread opinion that low exposure over a longer period of time may be more beneficial than high exposure over a short period. In terms of exact timing, exposure for about 20 minutes per day, 1.5 hour a week in total, is considered to be the right amount that comes up with positive outcomes.

To sum up, it seems that the matter of exposure time follows the rule *quality over quantity* – the timing and intensity of exposure (quality) may be more important than total time of exposure (quantity).

## **1.7 Challenges in CLIL**

In the previous sections we learned that CLIL teaching method that gave us advantages and creates many innovative approaches to content and language learning. In the following sections I am going to discover some of the drawbacks that CLIL method brings.

Marsh (2005) states that the negative aspects are caused by the position of learner's L1, the need of specialized teachers (combination of non-language subject and target language subject), the knowledge of content subject, problems with creating or finding suitable materials, and as well some kind of general certification. In fact, students that undergo a CLIL course are not given any special certificate or diploma. Only thing the future teachers get after leaving university is the leaving certificate (or diploma), but the fact that they went through a part of their studies in a target language is mentioned only by a short statement in that certificate. Marsh suggests it would be good move to establish a European or even world-wide agency that would officially distribute such certificates.

### **1.7.1 The Position of Learner's Mother Tongue**

In Marsh's (2005) view there are several issues related to learners in connection with CLIL learning method. One of the most important is the learners' mother tongue competence. Basically, learners that go through a content subject that is taught in a language different from their native one, are exposed to the academic registers of their mother tongue for a shorter period than students that study the same content subject in their native language. Therefore some experts argue that this may have a negative influence on the development of the learner's L1. However, this limitation of the mother tongue is rather an exception. It is because in CLIL there is usually about two or three content subjects taught in the target language. The negative influence idea comes mostly from various immersion programmes where all the content subjects are taught in the same target language and the native language is not trained in the academic field.

According to Eurydice (2006) the usage of the mother tongue may be stated in the legislative of a country. Laws regarding languages to be used in education can make it difficult to use

other languages than the language of instruction. The legislative may sometimes state that there is only one language of instruction and thus the use of any other language may be considered as not completely legal. But as the survey states, some countries issued some decrees that make the legislative more flexible in terms of language teaching framework.

### **1.7.2 Specialized Teachers**

I have already written about CLIL teachers and their competences in section 1.3, but this section will focus on problems that might occur when school needs one.

Eurydice (2006) states that the basic requirements for CLIL teaching are far more demanding than conventional language teaching. There is a need of specialised teachers as well as suitable teaching materials to a distinctly greater extent than in the standard language teaching. Number of countries suffer from lack of teachers qualified for some kind of CLIL teaching. And moreover, the survey points out that teachers themselves complain about an absence of training programmes focused on teaching methods for subjects that are taught in other than the native language. We still have many teachers trained in teaching the target language, but still they have not been trained in special skills that are essential for CLIL teaching method itself. In some countries, schools are able to cover this problem by a requirement saying suitable teachers for CLIL teaching should be native speakers of the target language, ensuring they have the necessary language and practical skills.

Problem of specialized teachers is mentioned by Marsh (2005) as well. He argues that there is world-wide lack of teachers that are able to perform CLIL teaching professionally. His point is that not only in Europe, but all over the world, teachers are mostly qualified in one subject only. For these teachers, an additional training in the language or content subject may be really expensive. And even if the teacher has the dual qualification of both content and language subject, Marsh (2005) points out that they still need some type of additional training to be able to teach in an integrated context.

### **1.7.3 Knowledge of a Content Subject**

Another thing that Marsh (2005) argues about is the danger of limitation of the content subject, when it is taught in the target language only. This problem must be taken seriously, particularly when school authorities demand the learner's knowledge in the content subject should be as big as that of the standard native language learner. This problem is one of definition. If we understand by historical knowledge merely the historical facts listed in a text book (declarative knowledge) it is easily possible to define it. If, however, we also include procedural knowledge, e.g.. knowledge on how to deal with historical content, it will be much more difficult for us to define it. Now you see that it is really difficult in modern content subject to define the content itself quantitatively and thus define learner's subject knowledge equally.

### **1.7.4 Suitable Materials**

Even if the school is able to find a suitable teacher, problems are not solved at all. As Eurydice (2006) continues, creating or finding materials appropriate for CLIL teaching might be really tough task. These materials need to be available not only in the target language, but in the native language as well and they need to cover subjects in a national curriculum. Therefore searching for these materials or creating them from the very beginning is difficult and time consuming mission (especially when creating materials for new target languages), and when we add the time needed for preparing lessons for other classes, we can see how challenging it might be, and mostly for teachers – beginners.

Marsh (2005) takes this problem into account as well and he states that only in few countries these materials exist in a form of exclusively developed booklets for CLIL. The booklets usually contain text collections relating to the content subject. Marsh also praises the idea of exchanging materials, developed by teachers themselves, with other teachers all around the world (with the same target language) or using native-language textbooks for the content subjects in their own classes. In general, these materials always need some kind of adapting (adjusting it for particular level, abilities, activities, etc.), although some teachers still use them without any adaptation at all. In some European countries teachers started to establish

associations recently, in which they can cooperate, and these associations create databases where any teacher can share his own materials or find similar made by other teachers. For example, I would like to mention Czech database called *Metodický portál RVP.cz*, which originates from 2009 project of Czech Ministry of Education, Youth and Sports (RVP.CZ, 2012).

### **1.7.5 Society**

It is important to say that society is an important part of education system. Many teachers surely experienced a pupil or a student who came from a different country. The phenomenon of migrating people, as Marsh (2005) describes, is one of the central problems of CLIL teaching. It is typical for many industrialized countries all over the world, especially for large western countries of European Union – larger groups of immigrants settle down and start a family and their children learn two languages in their early years. The first language is the language of the family and the second one is the language of the country they are living in. But the children mostly know how to speak in the family language, but the reading or writing abilities are rare (simply because it is spoken at home, but there is almost no need to write or read in that language), and they have often problems with the second language as well. This is because they learn both languages inadequately, mainly because there is no specific promotion in school for them (with respect to writing and reading skills).

As written in Eurydice (2006), some countries (Poland, Spain, Austria, and the Czech Republic as well) tend to emphasize the expenses the introduction of CLIL into education system bring as well. Training teachers, preparation and distribution of appropriate materials or official certification, all of these exceed the financial pool of the national, regional or local authorities. The survey informs that in the Czech Republic there are still some restrictions for budget limiting further spread of CLIL teaching method on schools, although there is an education law from 2004 that clarifies the preconditions for this type of provision. If schools decide to introduce CLIL method as a part of the curriculum for secondary education, they are not entitled to extra financial support. (MŠMT, 2004)



## 1.8 CLIL in the Czech Republic

Now we will briefly look at how Content and Language Integrated Learning is practiced in the Czech Republic. In the document by Ministry of Education, Youth and Sports (2005) it is written that in December 2005 the Czech government approved the National Plan for Target Language Teaching (originally Národní plán výuky cizích jazyků) with an action plan for season from 2005 until 2008 and the objective of this document was to improve the language competences of both children and adults in our country. The plan was based on the Action Plan of the European Union on Promoting Language Learning and Linguistic Diversity for years 2004 – 2006.

Among the National Plan objectives of Ministry of Education, Youth and Sports document (2005) it is said it is necessary to create suitable conditions for advancement of target language knowledge and competences of our population. The outcome of this should be that everyone is able to understand and communicate in target languages. These objectives should be achieved through various strategies, and one of them is to teach some subjects in a target language. Moreover it is introducing brand new specialisation at universities to prepare CLIL teachers.

In document by NÚOV (2005) it is pointed out that children began to learn a target language in 4<sup>th</sup> grade of primary school before 2005 (this was my case as well), and a second target language was not compulsory. Generally, Czech children learnt fewer languages at primary school compared to the European average. The Ministry of Education, Youth and Sports (2005) emphasized children should begin with familiarising with English language around the final year of kindergarten in the form of propaedeutics (it is a course providing an introduction to advanced study of language) and this familiarization should proceed in the 1<sup>st</sup> grade of primary school.

As the Ministry of Education, Youth and Sports (2005) informs, CLIL teaching method was announced officially in the Czech legislation in 1995. CLIL in the Czech Republic refers to any type of learning context in which both language and content are integrated to implement specified teaching aims. This means that the term CLIL could be used for a class where a foreign language teacher instructs his/her pupils or students on a non-language subject in

that foreign language or vice versa, where a subject teacher uses any additional language as a medium of instruction.

## **1.9 Summary of Chapter One**

In the first chapter of my diploma thesis I tried to provide a description of CLIL teaching method. At first, I wrote about forming of the idea of CLIL through time and other historical milestones of this method, then I depicted its definition and basic dimensions. The next subchapter described teachers using CLIL and their competences from various fields and points of view. Afterwards I wrote about different CLIL variants as well as about basic CLIL principles. Then, I characterized some of the parameters that CLIL method has, such as age, exposure time or languages. The last subsection of chapter one described some of the main problems one can encounter when establishing or applying CLIL.

## 2 Mathematics as a CLIL Subject

In the Chapter Two, I am going to describe some of the significant points that are necessary for successful teaching Mathematics through the CLIL teaching method. I will make use of many pieces of information I have described in the Chapter One in the following sections.

### 2.1 Basics of Teaching Maths through CLIL

First of all, it is vital to mention the meaning of the abbreviation CLIL. As written in section 1.2 it is Content and Language Integrated Learning. Notice please that the *Content* comes in the first place and it really indicates “content first”, because the curricular content leads language learning. As stated in Cambridge document (2010), teaching Mathematics through English often involves learners in making hypothesis and then proving if it is correct or wrong.. Teachers of Mathematics should be aware of the language the learners need to think during this process, create the hypothesis and then provide appropriate proof. For example:

**HYPOTHESIS:** If the **sum** of all digits of a whole number is **divisible** by **3**, **then** we can **divide it by 3** (it is **divisible by 3**).

**PROOF:** The **sum** of all digits of number **237** is **12** and **12** is divisible by **3**, **which implies** that we can divide it by **3** (**which implies** that it **is divisible by 3**).

Teachers are supposed to teach this language and help the learners to notice it, so the learners can use it afterwards correctly as well. It is an advisable thing in CLIL to repeat the language model many times before the learners can produce their own language accurately.

In 1.5 I have described Coyle’s CLIL principles often referred as 4Cs Principles or 4Cs of CLIL. They are **Content**, **Communication**, **Cognition** and **Culture** (the 4<sup>th</sup> one is sometimes switched for **Community** or **Citizenship**). They have their rightful place in Maths CLIL as well.

The first one, *content*, simply shows what the math topic is. It can be either a whole math field (algebra, geometry, etc.) or one of its parts (linear graphs, equations, right-angled triangles and so on).

*Communication* stands for the maths language that learners communicate during their lessons. It can be language of comparison for comparing and contrasting graphs (increasing, decreasing, curve), terms used in a hypothesis or in a proof, or even the text of a task itself (A line is drawn through the points (0,0) and (1,1). What acute angle does it make?).

*Cognition* indicates all the thinking skills that are demanded of learners when dealing with a task in a math lesson, e.g. identifying, generalising, reasoning or classifying.

*Culture* (or community) might be a little tricky, but we can always think about whether there is some kind of cultural focus in the lessons. In maths, we can talk about its history, for example how Pythagoras “discovered” his theorem, conversion between Greek and Arabic numerals, or differences between mathematical symbols around the world, such as the usage of decimal point (United States, United Kingdom, Canada) and decimal comma (Czech Republic, Switzerland, Austria). As the Cambridge documents (2010) advises, in multilingual contexts it is important to take time and talk about different methods that are used in various cultures represented by learners in the classroom.

## **2.2 Mathematical Language in CLIL Lessons**

It is clear that in CLIL lessons of Mathematics, both teachers and learners should use almost only the target language. The use of the mother tongue is not completely forbidden, but this option should be taken as the very last choice and only when it is really necessary. The Cambridge book (2005) continues that learners are supposed to produce two types of the target language. They are *content-obligatory* and *content-compatible* language.

In Vollmer (2006) we can read that the content-obligatory language, or, as some linguists describe, subject-specific language, is the characteristic language that every subject has. It includes subject-specific vocabulary, grammatical structures and functional expressions. All

these things are necessary for learners to learn about the curricular subject, take part in interactive classroom tasks and communicate subject knowledge.

On the other hand, as the Cambridge Glossary (2009) explains, content-compatible or so-called non-subject-specific language is the language that learners might have already learned in their previous English classes and which they can use in CLIL classes for much wider communication in the subject. Let me depict a table as an example of both content-obligatory and content-compatible language that maths teachers could identify for learning about linear graphs.

<b>CONTENT-COMPATIBLE LANGUAGE</b>	<b>CONTENT-OBLIGATORY LANGUAGE</b>
the same, similar, different point, line numbers, digits letters of the alphabet (both Greek and Latin) (explaining) This means, this shows, what is...	linear / non-linear graph straight-line graph, curved graph $x$ -axis, $x$ coordinate $y$ -axis, $y$ coordinate, the $x$ and $y$ axes (explaining) I'll plot the coordinates on the graph.

### 2.3 Challenges of Maths CLIL Lessons

I have already come across several problems or drawbacks that might occur in relation to CLIL in section 1.7, such as position of the mother tongue in CLIL lessons, finding specialized teachers and suitable materials for these lessons or general opinion of society on innovative methods like CLIL. Teaching Mathematics as a CLIL subject brings some challenges as well, and in this section, I will describe some of them, including possible solutions or advices that may help to deal with them.

In 1.7.2., I described the problem with specialised teachers and mentioned that the conductor of a CLIL lesson is mostly either a target language teacher or a subject teacher. Not knowing

the second part of the CLIL (target language field for a subject teacher and vice versa) is the challenge they may encounter.

Maths teachers might be a bit unsure about the target language, mainly when they have not used it for some time. It is important for them to be able to present and explain concepts accurately and clearly, check subject-specific language of himself as well as of learners, use suitable language for asking questions, paraphrasing, clarifying and generally managing the lesson in the target language. To improve their performance, teachers can use various dictionaries that include maths vocabulary (especially those with audio function for pronunciation are advisable). They can use grammar reference books as well to practise building complex sentences (e.g. sentences with conditionals and so on). It is also crucial to make sure that learners know the functional language that is required for the subject area (describing data on graphs, etc.).

Language teachers, on the other hand, have the confidence of the target language, but they might be unsure about the subject knowledge and related skills. They need, for example, to know how to explain mathematical ideas or procedures in an understandable way and to be able to answer learners' questions about the subject topic. It is also necessary to be able to widen their maths vocabulary knowledge, including the pronunciation. To cope with that, it is suggested to read something about the mathematical concepts and skills in L1 books (or on the Internet), to identify and highlight the subject-specific language and record it in the topic areas, and so on. It is also a good move to prepare answers for possible questions learners might have during the lesson beforehand.

Cambridge guide (2005) suggests that every teacher, when preparing a CLIL lesson, should always consider all the learning outcomes of each lesson, unit and course. These learning outcomes are learner-centered, which means that they are focused on what the learners can learn and achieve rather than on what teachers are teaching. To manage that, teachers should ask themselves questions like "What will learners know about maths?", "What will they be able to do at the end of the lesson / unit / course they didn't know at the beginning?" or "What skills will they practise, what will they learn about co-operation?" When learning about the circle, the possible preparation can look similar to this table.

<b>Learners should know:</b>	<b>Learners should be able to:</b>	<b>Learners should be aware of:</b>
<p>the length of the radius is half the length of the diameter</p> <p>the formulae for the area and circumference of a circle</p>	<p>calculate the area and circumference of different circles</p> <p>label different parts of circles</p>	<p>The application of the formulae in everyday life, e.g. calculating the distance a bicycle can travel</p>

## **2.4 Summary of Chapter Two**

In the second chapter of the thesis I have tried to outline some necessities for successful teaching of Mathematics as a CLIL subject. I have described a few possible ways how to apply the Maths teaching on CLIL principles and methods, then I have characterized two types of language that is used during Maths CLIL lessons – the content-compatible language and the content-obligatory language – with examples of each. In the last section of Chapter Two I have described some of the challenges teachers might encounter when preparing and delivering a Maths CLIL lesson, providing some tips and advices.

### 3 Maths CLIL Lessons

In Chapter Three, I am going to provide several thematical and lesson plans for CLIL lessons of Mathematics for second level of primary schools (from 6<sup>th</sup> to 9<sup>th</sup> grade) according to everything I have learnt when studying sources and materials listed in the refferences section and described in the previous two chapters of this thesis as well as according to things I have learnt during my studies of English language and Mathematics and their methodology on Palacký University and my teaching practice.

#### 3.1 Spoken Mathematics

Pupils are taught basic numerals in the beginning of their English lessons. Therefore revision of these basics should be one of the very first lessons in Maths CLIL. Moreover, the same lesson should widen their knowledge in reading larger integers, decimal numbers as well as reading math symbols.

##### **What should learners know before the lesson:**

###### Reading basic numbers and symbols

<i>Numerals</i>	1,2,3,4,5,6,7,8,9,0	one, two, three, four, ...
<i>“Tens”</i>	10,20,30,40, ...	ten, twenty, thirty, forty, ...
<i>Hundreds</i>	100,200,300, ...	one hundred, two hundred, ...
<i>Combined</i>	23,99,356, ...	twenty-three, ninety-nite, three hundred and fifty-six, ...
<i>Math symbols</i>	+, -, =, ×, ÷	plus, minus, equal to (equals) multiplied by, divided by



## What should learners be able to do after the lesson:

### Reading larger numbers

<i>Thousands</i>	1 000, 2 000, 3 000, ...	one thousand, two thousand, three thousand, ...
	1 100, 1 200, 1 900, ...	eleven hundred, twelve hundred, nineteen hundred, ...
	1 234, 5 678, ...	twelve hundred and thirty-four, five thousand six hundred and seventy-eight, ...
	10 000, 30 000, ...	ten thousand, thirty thousand, ...
	100 000, 500 000, ...	one hundred thousand, five hundred thousand, ...
<i>Millions</i>	1 000 000, $10^6$	one million
<i>Billions</i>	1 000 000 000, $10^9$	one billion

### Reading decimal numbers

1.0, 1.01	one point oh, one point oh one
-5.76, -9	minus five point seven six, minus nine
5.76	five and seventy-six hundredths

### Reading math symbols

$<, >, \pm, \neq$	less than, more than, plus or minus, not equal to
$() , [] , \{ \}$	parentheses, brackets, braces
$\infty$	the symbol for infinity
$a^2, 5^2$	a squared, five squared
$\sqrt{2}$	root two, the square root of two

There are at least two methods for reading numbers aloud. The choice is decided for each number. It is easier to say twelve hundred than one thousand two hundred. One of the general rules of mathematics is simplicity, so fewer words improve communication. In British English numbers like 2 259 are read as two thousand two hundred and fifty-nine, whereas in American English it is read as two thousand two hundred fifty-nine.

## Activities to practise

### I. Reading aloud

*Teacher writes various sets of numbers on the board, reads them aloud, students repeat. Afterwards teacher points to the numbers one after another, then randomly, pupils are supposed to pronounce them aloud (together or alone).*

Aims: to be able to differentiate different numbers

to be able to read different numbers correctly

to be able to pronounce different numbers correctly

Skills: reading (pupils read numbers on the board)

speaking (pronouncing numbers correctly)

listening (listening to the teacher, listening to classmates if they pronounce numbers correctly)

a) 19, 28, 37, 46, 55, 64, 73, 82, 91, 10

b) 101, 204, 301, 409, 506, 603, 708, 802, 907

c) 12, 20, 13, 30, 14, 40, 15, 50, 16, 60, 17, 70, 18, 80, 19, 90

d) 123, 272, 356, 418, 599, 674, 770, 810, 915, 414

e) 18, 880, 16, 660, 50, 515, 11, 110, 13, 330, 313, 19, 919, 990

f) -5, -17, -25, -44, -71, -105, -674, -708, -19, -90

g) 2.5, 7.1, 8.6, 15.9, 71.3, 22.12, 47.74

etc.

Model sentences teacher can use:

Repeat after me..., Read these numbers aloud. What number is this, Susan?,

Peter, what number is this?, Pronounce these numbers carefully., ...

### II. Odd one out

*Teacher writes various sets of numbers on the board or on handouts, pupils are supposed to decide, which number does not fit to the set and explain why.*

Aims: to be able to distinguish different numbers

to be able to read and pronounce different numbers

to be able to explain differences between numbers

Skills: reading (pupils read numbers on the board or in the handout)

speaking (pronouncing numbers, explaining differences between numbers)

listening (listening to the teacher, listening to classmates if they pronounce numbers correctly or if they chose the right odd one out)

writing (writing down the odd one out)

- |    |                                   |   |
|----|-----------------------------------|---|
| a) | 11, 17, 14, 23, 19, 10, 18, 13    | (23 – the only number over twenty)                        |
| b) | 65, 174, 12, 33, 99, 45, 71, 29   | (174 – the only 3-digit number)                           |
| c) | 12, 8, 46, 36, 4, 11, 54, 10      | (11 – it is not divisible by 2 / it is odd number)        |
| d) | 11, 31, 55, 23, 47, 99, 64        | (64 – the only number divisible by 2 / it is even number) |
| e) | 715, 4 562, 599, 343, -79, 81     | (-79 – the only negative number)                          |
| f) | -25, 26, -13, 55, 115, -479, 3.14 | (3.14 – the only decimal number)                          |
| g) | 33, 55, 999, 77, 4 444, 45, 11    | (45 – the only number made of two different digits)       |

### III. Which number should replace the X?

*Teacher writes various sets of numbers on the board or on handouts, pupils are supposed to find out, which number was replaced by X.*

Aims: to be able to read and pronounce different numbers

to be able to fill in the missing number according to some rule

Skills: reading (pupils read numbers on the board or in the handout)

speaking (pronouncing numbers, explaining which number is missing)

writing (filling the missing number on the board or into the handout)

listening (listening to the teacher, listening to classmates if they pronounce numbers correctly or if their missing number is correct)

- |    |                               |   |
|----|-------------------------------|---|
| a) | 2, 4, 6, X, 10, X, X, 16      | (8, 12, 14 – completing the sequence of even numbers) |
| b) | -3, -2, -1, X, 1, 2, 3        | (0 – comes after -1 and is before 1)                  |
| c) | 2, 3, 5, 7, 11, 13, X, 19, 21 | (17 – sequence of prime numbers)                      |
| d) | 1, 3, 5, 7, X, 11, 13, 15, X  | (9, 17 – sequence of odd numbers)                     |

#### IV. Crossword

*Teacher prepares a crossword, students are supposed to cross out numbers. Can serve as relaxing activity at the end or at the beginning of the lesson.*

Aims: to be able to recognize names of numbers

to stimulate brain at the beginning of a lesson or relax the brain after a lesson

Skills: reading (finding numbers in the crossword)

writing (writing down the solution of the puzzle)

speaking (saying the solution aloud)

There are many ways how to create a crossword or a puzzle. I used Free Puzzlemaker by Discovery Education website (2012).

```
Z Y M N N A Y T E
E T H I E E T M L
R N A N E T F T E
O E T E T W I T V
Y W H T N E F H E
T T I E E L O G N
R N R E V V U I I
O E T N E E R E C
F T Y S S E V I F
```

After crossing out all of the numbers, remaining solution is *mathematics*.

### **3.2 Divisibility**

VÚP document (2005) is the main curricular framework document. It states that after completing the primary school a pupil should have the knowledge of divisibility. This includes primes (or prime numbers), composite numbers, multiples, divisors, the greatest common divisor, the least common multiple and basic divisibility rules. According to Odvárko and Kadleček (1998) and many other mathematical textbooks, it is included in the curriculum of the 6<sup>th</sup> grade on Czech schools.

### 3.2.1 Divisor

<b>What should learners know:</b> how to divide natural numbers how to divide natural numbers with remainders	<b>What should learners be able to:</b> decide if a given number A is a divisor of another given number B decide if a given number A is divisible by another given number B identify all divisors of a given number
<b>Content-compatible language</b> numbers, digits	<b>Content-obligatory language</b> plus, minus, multiplied by, divided by, equals divisor, is (not) divisible by natural numbers, prime numbers

**Aims:** to be able to find out which numbers are divisible by a given number

to be able to find out which numbers are divisors of a given number

**Skills:** reading (comprehension of the opening problem, reading given tasks)

speaking (reading the opening problem aloud, answering questions, describing the process of counting, asking for advice)

writing (writing down answers, writing tasks into exercise books)

listening (listening to the teacher and classmates)

#### **Opening problem**

27 pupils went on a school trip. When they returned, they realised they have extra 556 crowns. Peter is going to give the money back to his classmates. If he gives 20 crowns back to every pupil, 16 crowns will remain. But he can't give 21 crowns back, because they don't have enough money. Is that correct?

*Answer:* Yes, that is correct. 20 crowns multiplied by 27 pupils equals 540 crowns, 16 crowns remain.

$$20 \times 27 = 540, 16 \text{ remains}$$

He would need 567 crowns to give every pupil 21 crowns.

Afterwards, Peter and his classmates decided to buy flowers for their teacher. They paid 70 crowns for it. He thinks that he can give the rest of the money back to everyone with no remain. Is he right? How much will every pupil get?

*Answer:* Yes, he is right again. 556 crowns minus 70 crowns equals 486 crowns.  
 486 crowns divided by 27 pupils equals 18 crowns each.  
 $556 - 70 = 486$        $486 \div 27 = 18, 0$  remains

$96 \div 8 = 15$ 16 0 Remainder is 0. <i>We say:</i> <b>Number 96 IS DIVISIBLE BY number 8.</b> <b>Number 8 IS THE DIVISOR OF number 96.</b>	$91 \div 8 = 11$ 11 3 Remainder is not 0. <i>We say:</i> <b>Number 91 IS NOT DIVISIBLE BY 8.</b> <b>Number 8 IS NOT THE DIVISOR OF number 91.</b>
--	---

### Tasks and activities

#### I. Use the division and decide (yes – no):

- a) Number 48 is divisible by 9. (no)
- b) Number 415 is divisible by 5. (yes)
- c) Number 8 is the divisor of number 99. (no)
- d) Number 15 is the divisor of number 210. (yes)

#### II.

- a) Find out, which numbers [1, 2, 4, 8, 12, 35, 62, 140] is number 140 divisible by.  
(1, 2, 4, 35, 140)
- b) Find out, which numbers [1, 50, 9, 112, 8, 33, 3, 198] are divisors of number 198.  
(1, 9, 33, 3, 198)

#### III.

- It is said that every natural number larger than 1 has at least two divisors. Do you think it is true? (it is true)
- Which two divisors does number 7 have? (1 and 7)
- Which two divisors does number 3 477 surely have? (1 and 3 477)

IV. You have 10 seconds to find two divisors of number 1 144 among these numbers. Now!

49, 437, 10, 186, 1 144, 946, 14, 76, 1

### 3.2.2 Divisibility Rules

<b>What should learners know:</b>	<b>What should learners be able to:</b>
how to divide natural numbers	decide if a given number A is a divisor of another given number B
how to multiply natural numbers	identify all divisors of a given number
<b>Content-compatible language</b>	<b>Content-obligatory language</b>
numbers, digits	plus, minus, multiplied by, divided by, equals multiple, divisor, is (not) divisible by natural numbers, prime numbers even numbers, odd numbers

**Aims:** to be able to find out which numbers are divisible by a given number

**Skills:** reading (comprehension of the opening problem, reading given tasks)

speaking (reading the opening problem aloud, answering questions, describing the process of counting, asking for advice)

writing (writing down answers, writing tasks into exercise books)

listening (listening to the teacher and classmates)

#### **Opening problem**

Ten thieves were arguing in a pub how to divide 1991 golden coins. Little John heard them and offered them his help. They agreed, so little John took 991 golden coins and divided the rest on ten equal portions.

How many golden coins did each thief get?

Did little John fool those thieves?

*Answer:* Each thief got 100 golden coins.  $1\ 991 - 991 = 1\ 000$        $1\ 000 \div 10 = 100$

He fooled them, indeed. He should took 1 golden coin and divide 1 990 coins in ten equal parts of 199 coins.  $1\ 991 - 1 = 1\ 990$        $1\ 990 \div 10 = 199$

**DIVISION BY 10**

**Every natural number that ends in a 0 is therefore always divisible by 10.**

**DIVISION BY 5**

**Every natural number that ends in a 0 or a 5 is therefore always divisible by 5.**

I. From numbers 180, 748, 832, 895, 10 000, 10 005 write down those that are:

- |  |                            |
|--|----------------------------|
| a) divisible by 10                         | (180, 10 000)              |
| b) divisible by 5                          | (180, 895, 10 000, 10 005) |
| c) divisible by 5, but not divisible by 10 | (895, 10 005)              |
| d) not divisible by 10 and by 5            | (748, 832)                 |

II.

Write down all natural numbers bigger than 184 and smaller than 197 and are not divisible by

5. (186, 187, 188, 189, 191,  
192, 193, 194, 196)

***Opening problem***

A school magazine costs 2 crowns. Pupils are buying it and they put money into the moneybox. Jane, as the cash-keeper, is counting the taking. She counted 113 crowns. How does she know that someone made a mistake?

*Answer:* The magazine costs 2 crowns, but 113 is not divisible by 2.

**DIVISION BY 2**

**All natural numbers that end in 0, 2, 4, 6 or 8 are always divisible by 2.**

**All even numbers are always divisible by 2.**

**All odd numbers are always not divisible by 2.**

III.

Write down all 3 digit numbers bigger than 979 that are divisible by 2.

(980, 982, 984, 986, 988, 990, 992,  
994, 996, 998)



IV.

Write down all natural numbers that are bigger than 105 and smaller than 120. How many odd numbers and even numbers are among them?

(odd numbers: 107, 109, 111, 113, 115, 117, 119)

even numbers: 106, 108, 110, 112, 114, 116, 118)

V. Mr. Wiley withdraws 870 crowns in a bank. He wants the whole sum in the same type of coins. Decide, if the cashier can give him the money in:

- |                   |                                  |
|-------------------|----------------------------------|
| a) 20-crown coins | (no, 870 is not divisible by 20) |
| b) 2-crown coins  | (yes, 435 coins)                 |
| c) 5-crown coins  | (yes, 174 coins)                 |
| d) 10-crown coins | (yes, 87 coins)                  |

***Opening problem***

Now we know that a natural number is divisible by 10 if it ends in a 0, divisible by 5 if it ends in a 0 or a 5, and divisible by 2 if it is even number. But when is the number divisible by 3?

**The sum of all digits of a number is called the DIGIT SUM.**

For example, the digit sum of the number 356 is  $3 + 5 + 6 = 14$ .

**DIVISION BY 3**

**All natural numbers whose digit sum is divisible by 3 are therefore divisible by 3.**

VI.

Write down all natural numbers that are bigger than 88 and smaller than 105. Circle all the numbers that are divisible by two. Then decide, which of the circled numbers are divisible by 3.

89	90	91	92	93	94	95	96
97	98	99	100	101	102	103	104

### 3.2.3 Greatest Common Factor (GCF)

<b>What should learners know:</b>	<b>What should learners be able to:</b>
identify all divisors of a given number decide if a given number A is a divisor of another given number B decide if a given number A is divisible by another given number B	distinguish prime numbers from composite numbers do a prime factorisation find greatest common factor of given numbers (GCF)
<b>Content-compatible language</b>	<b>Content-obligatory language</b>
numbers, digits	plus, minus, multiplied by, divided by, equals multiple, divisor, is (not) divisible by natural numbers, prime numbers, composite numbers even numbers, odd numbers product, integer

**Aims:** to be able to distinguish prime numbers from compound numbers

to be to find the greatest common factor of given numbers

**Skills:** reading (comprehension of the opening problem, reading given tasks)

speaking (reading the opening problem aloud, answering questions, describing the process of counting, asking for advice)

writing (writing down answers, writing tasks into exercise books)

listening (listening to the teacher and classmates)

#### *What we already know*

Every natural number larger than 1 has at least two divisors – number one and the number itself.

**Numbers that have exactly two different divisors (number 1 and the number itself) are called PRIME NUMBERS.**

**2, 3, 5, 7, 11, 13, 17, 19, 23, ...**

**Numbers that have more than two divisors are called COMPOSITE NUMBERS.**

**4, 6, 8, 9, 10, 12, 14, 15, 16, 18, 20, 21, ...**

I.

Decide whether number 1 is a prime number, a composite number or none of them.

Explain your opinion.

(number 1 is neither prime or composite number, because it has only one divisor – itself)

II.

Number 105 is divisible by 3. We say that number 105 is a product of two lesser integers.  $105 = 3 \times 35$

Find the smallest prime number that is a divisor of number 35.

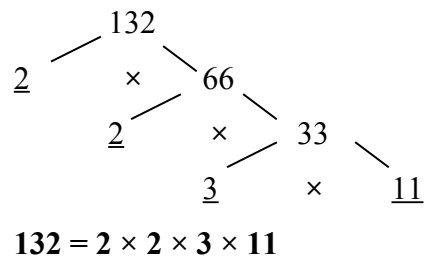
$$105 = 3 \times 5 \times 7$$

**We expressed the number 105 is a product of three prime numbers.**

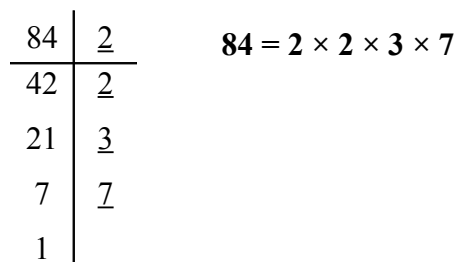
**Every composite number can be decomposed into a multiple of prime numbers.**

We have several ways how to find the prime integers of a given number. This method is called **prime factorisation**.

The first one is called a *waterfall*.



Or we can use a *ladder*.



III. Decide if these numbers are decomposed into a multiple of prime numbers. Correct any mistakes and justify them.

- a)  $81 = 3 \times 3 \times 3 \times 3$  (correct)
- b)  $27 = 3 \times 9$  ( $3 \times 3 \times 3$ )
- c)  $154 = 2 \times 7 \times 13$  ( $2 \times 7 \times 11$ )
- d)  $104 = 2 \times 2 \times 26$  ( $2 \times 2 \times 2 \times 13$ )
- e)  $72 = 2 \times 2 \times 3 \times 3$  ( $2 \times 2 \times 2 \times 3 \times 3$ )
- f)  $765 = 3 \times 3 \times 5 \times 17$  (correct)

IV. Decompose given numbers into a multiple of prime numbers and write down all the divisors of that given number.

- a) 68 ( $2 \times 2 \times 17$ ; divisors: 1, 2, 4, 17, 34, 68)
- b) 42 ( $2 \times 3 \times 7$ ; divisors: 1, 2, 3, 6, 7, 14, 21, 42)
- c) 100 ( $2 \times 2 \times 5 \times 5$ ;  
divisors: 1, 2, 4, 10, 20, 25, 50, 100)

### ***Opening problem***

Kate has two pieces of cloth. One is 90 cm wide and the other piece is 72 cm wide. She wants to cut both pieces into strips of equal width that are as wide as possible. How would she cut the strips?

First of all, Kate will find all numbers that are divisors of number 90 and of number 72 as well. Check her progress.

#### Common Prime Factors Method

$$90 = \underline{2} \times \underline{3} \times \underline{3} \times 5$$

$$72 = \underline{2} \times 2 \times 2 \times \underline{3} \times \underline{3}$$

#### List Method

divisors: 1, 2, 3, 5, 6, 9, 10, 15, 18, 30, 45, 90

divisors: 1, 2, 3, 4, 6, 8, 9, 12, 18, 24, 36, 72

We can see from Common Prime Factors Method that numbers 90 and 72 have these primes in common: 2, 3, 3. Now we just multiply them and we get the maximum width of strips, that is 18.  $2 \times 3 \times 3 = 18$

From List Method we can see that the greatest common divisor is 18.

**Numbers 1, 2, 3, 6, 9, 18 are divisors (factors) of number 90 and number 72 as well.**

**They are called common factors.**

**Number 18 is THE GREATEST COMMON FACTOR (GCF) of numbers 90 and 72.**

**The greatest common factor of these two numbers is written as GCF(72, 90):**

$$\text{GCF}(72, 90) = 18$$

**The greatest common factor (GCF) is divisible by all of the other common factors.**

V. Divisors, common divisors, GCF

- a) Write down all divisors of number 8. (1, 2, 4, 8)  
b) Write down all divisors of number 12. (1, 2, 3, 4, 6, 12)  
c) Write down all common divisors of both numbers. (1, 2, 4)  
d) Write down the greatest common factor of both numbers. (GCF(8, 12) = 4)

VI.

Queen Sylvia gave 42 sapphires and 45 rubies to her daughters. How many daughters does the queen have? How many sapphires and how many rubies did each daughter received?

*Solution:*

We are going to find the greatest common factor of numbers 42 and 45.

$$42 = 2 \times \underline{3} \times 7 \quad \text{divisors: } 1, 2, \underline{3}, 6, 14, 21, 42$$

$$45 = \underline{3} \times 3 \times 5 \quad \text{divisors: } 1, \underline{3}, 9, 15, 45$$

$$\text{GCF}(42, 45) = 3$$

Queen Sylvia had 3 daughters. Each daughter received 14 sapphires and 15 rubies.

VII. Find the GCF of these numbers:

- a) 12 and 45

$$12 = 2 \times 2 \times \underline{3}$$

$$45 = 3 \times \underline{3} \times 5$$

$$\text{GCF}(12, 45) = 3$$

b) 100 and 330

$$100 = 2 \times \underline{2} \times \underline{5} \times 5$$

$$330 = \underline{2} \times 3 \times \underline{5} \times 11$$

$$\text{GCF}(100, 330) = 10$$

c) 182 and 55

$$55 = 5 \times 11$$

$$182 = 2 \times 7 \times 13$$

$$\text{GCF}(55, 182) = 1$$

### 3.3 Percentages

According to VÚP document (2005) every pupil of the higher primary should have the basic knowledge of percentages including easy calculations. This area is usually taught in 7<sup>th</sup> grade, and so do Odvárko and Kadleček (1998) in their textbook for 7<sup>th</sup> graders.

<b>What should learners know:</b> multiplying, dividing of numbers counting with decimal numbers counting with fractions	<b>What should learners be able to:</b> calculate percentage of a whole calculate the whole when they know the percentage
<b>Content-compatible language</b> numbers, digits	<b>Content-obligatory language</b> plus, minus, multiplied by, divided by, equals multiple, divisor, is (not) divisible by natural numbers, prime numbers, composite numbers even numbers, odd numbers percentage, a whole

**Aims:** to be able to count a percentage from a whole

to be to find the original whole, when they know the percentage and the current whole


- Skills:** reading (comprehension of the opening problem, reading given tasks)  
speaking (reading the opening problem aloud, answering questions, describing the process of counting, asking for advice)  
writing (writing down answers, writing tasks into exercise books)  
listening (listening to the teacher and classmates)

**Opening problem**

Larry saw an advertisement saying that there will be a sale 15% on skis from tomorrow. He has 450 crowns and his parents promised him another 2 000 crowns. The ski he wants costs 2 800 crowns. Does he have enough money to buy them in the sale?

We read 15% as fifteen per cent.  
To reduce the price by 15% means to reduce it by 15 / 100 (or 0.15).

This is 100% (2 800 crowns).



This is 15%

Now count with Larry:

$$\frac{15}{100} \times 2800 = 15 \times 28 = 280 + 100 + 40 = 420$$

This is 15 per cent of today's price, the price reduction will be 420 crowns.

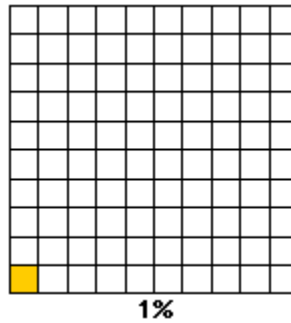
$$2800 - 420 = 2380$$

The price after sale will be 2 380 crowns. Can Larry buy the ski with the money he has?

*Answer:* Yes, he can, he has 2 450 crowns including his parents' money.

**One per cent of a whole is one hundredth of that whole.**

1% of a whole is  $\frac{1}{100}$  of the whole or 0.01 of a whole.

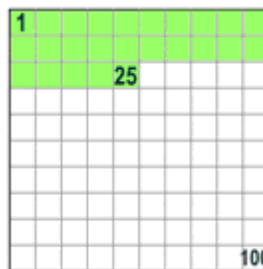


Because *percent* means *per 100*, we should always think:  
This should always be divided by 100.

I. Count 1% of:

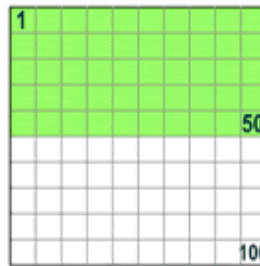
- |                  |                          |
|------------------|--------------------------|
| a) \$100         | (\$1)                    |
| b) 8 000 crowns  | (80 crowns)              |
| c) 360 €         | (3 € 60 cents or 3.60 €) |
| d) 18 cm         | (0.18 cm)                |
| e) 425 inches    | (4.25 inches)            |
| f) 183 litres    | (1.83 litres)            |
| g) 40 kilometers | (0.4 kilometers)         |
| h) 65 miles      | (0.65 miles)             |

25% of a whole means  $\frac{25}{100}$  or 0.25 of a whole.



50% of a whole means half or  $\frac{50}{100}$  or 0.5 of a whole.





II. The whole is 860. Count these percentages:

- a) 1% (8.6)    b) 10% (86)    c) 20% (172)  
 d) 70% (602)    e) 85% (731)    f) 46% (395,6)

III. Decide whether these statements are true or false. Correct the mistakes.

- a) 26% of 1 000 is 26. (wrong, 260)  
 b) 71% of 2 000 is 1 420. (correct)  
 c) 39% of 3 900 is 390. (wrong, 1 521)  
 d) 100% of 10 is 100. (wrong, 10)

IV.

There are 36 pupils in the classroom. 75% of them learn English language, 50% of them learn German language.

- a) How many pupils learn English? (27 pupils)  
 b) How many pupils learn German? (18 pupils)

V.

Car factory produced 152 000 cars, 35% of them were exported abroad. How many cars did the car factory exported abroad?

100% ..... 152 000 cars  
 35% ..... ? cars

$$\frac{35}{100} \times 152\,000 = \frac{35 \times 152\,000}{100} = \frac{35 \times 1\,520}{1} = 53\,200 \text{ cars}$$

The car factory exported 53 200 cars abroad.

VI. Rewrite these fractions as percentages and decimals:

- a)  $\frac{1}{4}$  (25%, 0.25)    b)  $\frac{1}{2}$  (50%, 0.5)    c)  $\frac{3}{4}$  (75%, 0.75)  
 d)  $\frac{2}{5}$  (40%, 0.4)    e)  $\frac{1}{8}$  (12.5%, 0.125)  
 f)  $\frac{7}{8}$  (87.5%, 0.875)

***Historical background***

The word *percent* comes from the latin *Per Centum*. The latin word *Centum* means 100, therefore a century is 100 years or a centurion was a officer of Roman army commanding 100 soldiers.

VII. Find the whole, if you know that

- a) 50% of a whole is 350

$$\begin{array}{r} \uparrow 50\% \dots\dots\dots 350 \uparrow \\ 100\% \dots\dots\dots x \end{array}$$

$$\frac{x}{350} = \frac{100}{50}$$

X over 350 equals 100 over 50.

$$x = \frac{100 \times 350}{50}$$

X equals 100 multiplied by 350 over 50

$$x = 700$$

X equals 700.

- b) 20% of a whole is 100

$$\begin{array}{r} \uparrow 20\% \dots\dots\dots 100 \uparrow \\ 100\% \dots\dots\dots x \end{array}$$

$$\frac{x}{100} = \frac{100}{20}$$

$$x = \frac{100 \times 100}{20}$$

$$x = 500$$

- c) 5% of a whole is 20

<p>↑ 5% .....</p> <p>100% .....</p> $\frac{x}{20} = \frac{100}{5}$ $x = \frac{20 \times 100}{5}$ $x = 400$	<p>20 ↑</p> <p>x ↑</p>
--	------------------------

d) 32% of a whole is 224

<p>↑ 32% .....</p> <p>100% .....</p> $\frac{x}{224} = \frac{100}{32}$ $x = \frac{224 \times 100}{32}$ $x = 700$	<p>224 ↑</p> <p>x ↑</p>
---	-------------------------

e) 68% of a whole is 952

<p>↑ 68% .....</p> <p>100% .....</p> $\frac{x}{952} = \frac{100}{68}$ $x = \frac{952 \times 100}{68}$ $x = 1\,400$	<p>952 ↑</p> <p>x ↑</p>
--	-------------------------

f) 66% of a whole is 1 056

<p>↑ 66% .....</p> <p>100% .....</p> $\frac{x}{1056} = \frac{100}{66}$ $x = \frac{1056 \times 100}{66}$ $x = 1\,600$	<p>1056 ↑</p> <p>x ↑</p>
--	--------------------------

VIII.

A computer costs \$300 in an IT shop. They are planning 10% sale on everything. Unfortunately, Jack missed the sale, and they raised the prices by another 10%. What was the price of the computer after the sale and after the prices risen?

$$\begin{array}{l} \uparrow 100\% \dots\dots\dots \$300 \uparrow \\ \uparrow 10\% \dots\dots\dots \$ x \uparrow \\ \frac{x}{300} = \frac{10}{100} \rightarrow x = \frac{300 \times 10}{100} \rightarrow x = 30 \end{array}$$

$$\$300 - \$30 = \$270$$

The price after the sale was \$270.

$$\begin{array}{l} \uparrow 100\% \dots\dots\dots \$270 \uparrow \\ \uparrow 110\% (100\%+10\% \text{ risen price}) \dots\dots \$ x \uparrow \\ \frac{x}{270} = \frac{110}{100} \rightarrow x = \frac{270 \times 110}{100} \rightarrow x = 297 \end{array}$$

The price of the computer was \$297 when all prices have risen again.

### 3.4 Pythagoras' Theorem

Pythagoras' Theorem is an important part of geometrical knowledge a pupil learns on primary school and it is mentioned in VÚŠ document (2005) as well. This mathematical field is mostly taught during the 8<sup>th</sup> grade and it is described in Odvárko and Kadleček (1999) as well. However, this field is taught on secondary schools as well, and thus it is important for learners to do their best, so they will not have problems with it during their further studies.

<b>What should learners know:</b>	<b>What should learners be able to:</b>
what is a triangle, types of triangles, square formulae for circumference and area of triangles and squares	calculate sides of a right triangle apply this knowledge on real life situations
<b>Content-compatible language</b>	<b>Content-obligatory language</b>
numbers, digits side, legs, rule	plus, minus, multiplied by, divided by, equals, sum of

	multiple, divisor, is (not) divisible by line, line segment, angle, hypotenuse triangle, right triangle, square squared
--	--

**Aims:** to be able to find the length of the hypotenuse and the length of other two sides of a right triangle

To be able to apply the knowledge for real life problems and situations

**Skills:** reading (comprehension of the opening problem, reading given tasks)

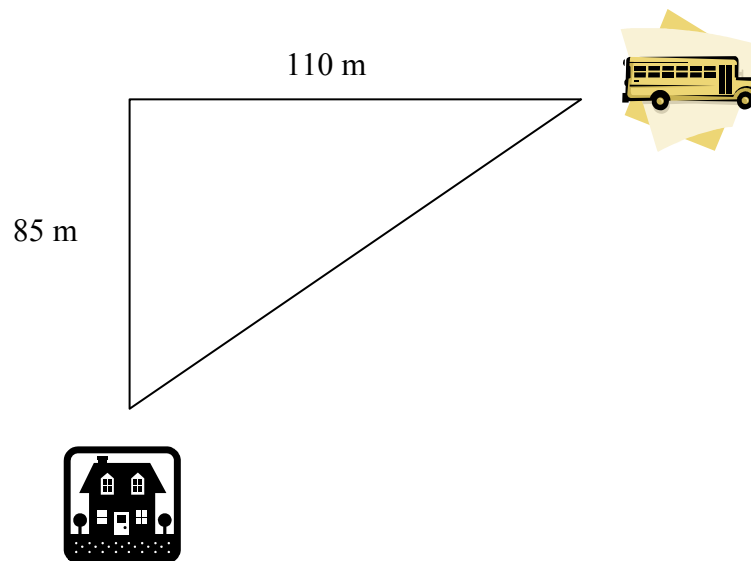
speaking (reading the opening problem aloud, answering questions, describing the process of counting, asking for advice)

writing (writing down answers, writing tasks into exercise books)

listening (listening to the teacher and classmates)

### ***Opening problem***

Residents of a house are too lazy to walk home from the bus station all the way on the sidewalk, so they shorten the way across the lawn as shown on the picture. How much is the way across the lawn shorter than the length of the sidewalk?



A **right angled triangle** is a triangle which has a right angle as one of its angles. The side opposite the right angle is called the **hypotenuse** and is the **longest side** of the triangle. The other two sides are called **legs** of the triangle.

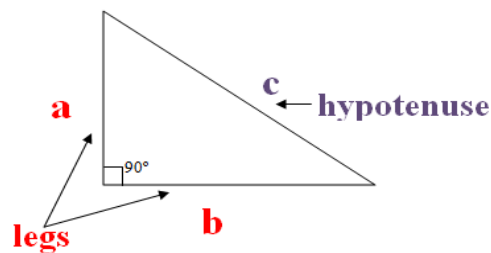
### ***Historical background***

The ancient Egyptians used a rope with 12 equally spaced knots to form a triangle with sides in ratio 3 : 4 : 5. This triangle has a right angle between the sides of length of 3 and 4 units, and is the simplest right angled triangle.

Around 500 BC Pythagoras, the Greek mathematician and philosopher, formulated a rule which connects the lengths of the sides of all right angled triangles.

The theorem basically says that in a right angled triangle, with hypotenuse  $c$  and legs  $a$  and  $b$ ,  $c^2 = a^2 + b^2$ , according to the picture.

We read that as a squared plus b squared equals c squared. In geometrical form, the Theorem



$$a^2 + b^2 = c^2$$

is – in any right angled triangle, the area of the square on the hypotenuse is equal to the sum of the areas of the squares on the other two sides, as shown on the following picture.

Back to the opening problem. We have two legs of lengths 85 m and 110 m. What is the length of the hypotenuse?

$$a = 85 \text{ m}$$

$$b = 110$$

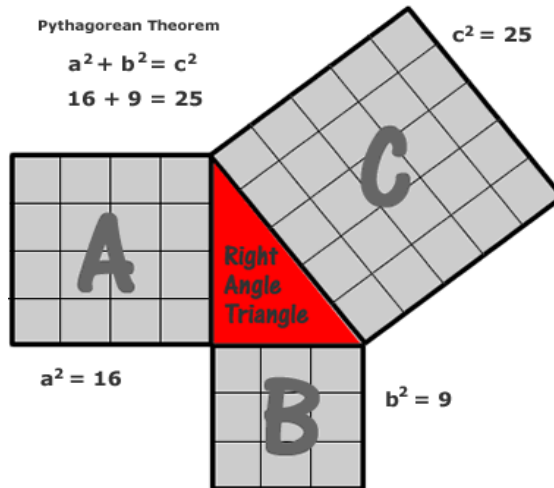
$$\underline{mc = x \text{ m}}$$

$$c^2 = a^2 + b^2$$

$$x^2 = 85^2 + 110^2$$

$$x^2 = 7225 + 12100$$

$$x = \sqrt{19325} = 139.01$$



The length of the hypotenuse is 139 metres.

I. Calculate the length of the hypotenuse of a right angled triangle  $DEF$  with legs lengths:

- |                               |          |
|-------------------------------|----------|
| a) $d = 12$ cm, $e = 16$ cm   | (20 cm)  |
| b) $d = 4.3$ cm, $e = 8.9$ cm | (9.9 cm) |
| c) $d = 9$ cm, $e = 12$ cm    | (15 cm)  |
| d) $d = 0.6$ dm, $e = 1.8$ dm | (1.9 dm) |

II. Calculate the length of a leg in a right angled triangle, if the lengths of hypotenuse  $c$  and the other leg are given:

- |                                 |           |
|---------------------------------|-----------|
| a) $a = 24.5$ cm, $c = 35.7$ cm | (26 cm)   |
| b) $b = 138$ dm, $c = 317$ dm   | (285 dm)  |
| c) $c = 4.81$ mm, $a = 1.46$ mm | (4.58 mm) |

III. Decide, whether triangles with given lengths are right angled or not and explain why.

- |                       |       |
|-----------------------|-------|
| a) 8 cm, 8 cm, 8 cm   | (no)  |
| b) 20 m, 21 m, 29 m   | (yes) |
| c) 17 mm, 8 mm, 15 mm | (yes) |
| d) 13 mm, 12mm, 5 mm  | (yes) |
| e) 6 dm, 7 dm, 8 dm   | (no)  |
| f) 84 m, 13 m, 85 m   | (yes) |

### 3.5 Similarity of Triangles

At the end of the primary school, a pupil should know and be able to construct basic geometrical object in a plane and in a space, as VÚP (2005) informs. This includes the knowledge of congruence and similarity of basic objects, and mainly the similarity of triangles that is taught in 9<sup>th</sup> grade, according to Odvárko and Kadleček (2001). However, this field is revised on most secondary schools, with more geometrical objects.

<b>What should learners know:</b>	<b>What should learners be able to:</b>
what is a triangle, types of triangles different parts of triangles (sides, angles, ...)	decide if given triangles are similar or not cite the criteria for similarity of triangles apply this knowledge on real life situations
<b>Content-compatible language</b>	<b>Content-obligatory language</b>
numbers, digits side, leg, angle, rule	equilateral triangle, isosceles triangle, scalene triangle, acute triangle, obtuse triangle, right triangle ratio, proportion

**Aims:** to be able to find decide if triangles are similar or not

to be able to apply the knowledge for real life problems and situations

**Skills:** reading (comprehension of the opening problem, reading given tasks)

speaking (reading the opening problem aloud, answering questions, describing the process of construction, asking for advice)

writing (writing down answers, writing tasks into exercise books, constructing triangles)

listening (listening to the teacher and classmates)

**Two figures are SIMILAR if one figure is an enlargement of the other, regardless of orientation.**

**Two figures are CONGRUENT if they are identical in every respect, apart from position.**



### ***Opening problem***

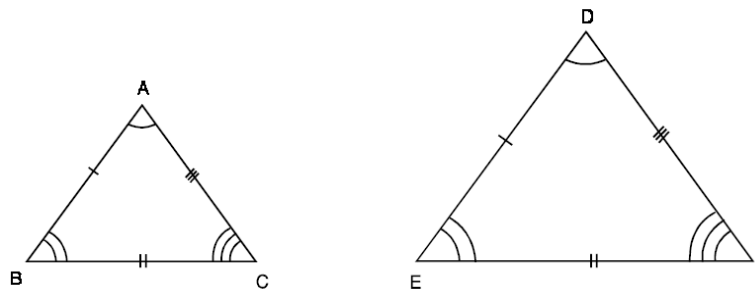
Many objects around us seem to have the same shape, but they often have different sizes. For example, photographs of different sizes, but developed from the same negative or a plastic model of a car and the car itself are of the same shape, but they have different sizes. How can we prove that they are similar? Look at the following picture.



These are two so-called equilateral triangles. That means that the triangle has all three sides of equal length and all three angles of the triangle measure 60 degrees. For all types of triangles, including equilateral triangles, there are special conditions of similarity.

**Two triangles are SIMILAR, if their corresponding angles are equal, and their corresponding sides are proportional.**

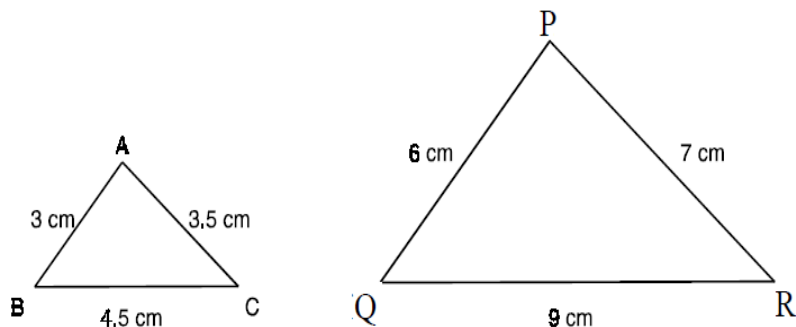
According to this basic rule, we can adjust our two triangles like this.



We can see now that every pair of angles is equal and every pair of sides is proportional. We say that  $\triangle ABC$  (triangle ABC) is similar to  $\triangle DEF$ . We write  $\triangle ABC \sim \triangle DEF$ .

### **I.**

Draw a triangle ABC with  $|AB| = 3$  cm,  $|BC| = 4.5$  cm,  $|CA| = 3.5$  cm and triangle PQR with  $|PQ| = 6$  cm,  $|RP| = 7$  cm and  $|QR| = 9$  cm.



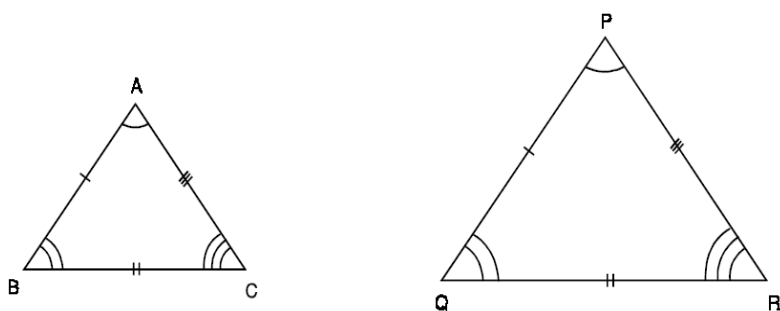
$$\frac{AB}{PQ} = \frac{BC}{QR} = \frac{CA}{RP}$$

We can see that  $\frac{AB}{PQ} = \frac{BC}{QR} = \frac{CA}{RP}$ . If you measure all the angles in both triangles, you would find that  $\angle A = \angle P$ ,  $\angle B = \angle Q$  and  $\angle C = \angle R$ . Repeat this with another two triangles having corresponding sides proportional, and you will come to the same result.

**SSS similarity criterion (side, side, side):**  
**Two triangles are similar if their corresponding sides are proportional.**

II.

Construct  $\triangle ABC$  and  $\triangle PQR$ , in which  $\angle P = \angle A$ ,  $\angle Q = \angle B$  and  $\angle R = \angle C$  as shown on the following figure.



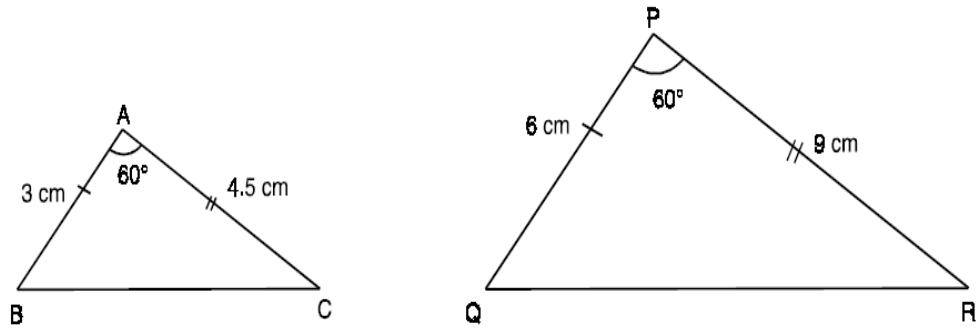
Measure sides AB, BC and CA of  $\triangle ABC$  and sides PQ, QR and RP of  $\triangle PQR$ . Now

find the ratio  $\frac{AB}{PQ}$ ,  $\frac{BC}{QR}$  and  $\frac{CA}{RP}$ . You will find out that all these ratios are equal and therefore these triangles are similar.

**AAA similarity criterion (angle, angle, angle):**  
**Two triangles are similar if their corresponding angles are similar.**

### III.

Take a line  $|AB| = 3$  cm, and at A construct an angle of  $60^\circ$ . Cut off  $|AC| = 4.5$  cm and then join BC. Now take  $|PQ| = 6$  cm, draw an angle of  $60^\circ$  at P and cut off  $|PR| = 9$  cm. Measure all the remaining angles and you should find that  $\angle B = \angle Q$ ,  $\angle C = \angle R$ , and therefore  $\triangle ABC \sim \triangle PQR$ .



**SAS similarity criterion (side, angle, side):**  
**Two triangles are similar if one angle of a triangle is equal to one angle of the other triangle and the sides containing these angles are proportional.**

### 3.6 Summary of Chapter Three

I have tried to come up with possible drafts for CLIL lessons of Mathematics for 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> grade of primary school. At the beginning, I have provided a lesson focused on spoken mathematics with several tasks. Then, I have created a possible plan for teaching basic divisibility rules for 6<sup>th</sup> grade and a plan for teaching percentages for 7<sup>th</sup> grade. For 8<sup>th</sup> grade I have prepared a combination of arithmetics and geometry on Pythagoras' Theorem with basic tasks. For 9<sup>th</sup> grade I prepared a geometry plan on criteria of similarity of triangles.

## Conclusion

To sum up, the aim of my diploma thesis was to investigate what the CLIL teaching method is, what its characteristics and principles, what possible drawback and problems connected with this method are, if there are any. Its aim was also to find out how to apply these principles on teaching Mathematics and come with drafts of plans on various mathematical fields focused on higher level of primary schools (6<sup>th</sup> to 9<sup>th</sup> grade).

In the Chapter One I provided a description of CLIL teaching method - forming of the idea of CLIL through time and some milestones, definition and basic dimensions, competences of teachers using CLIL, various CLIL variants and principles, basic characteristics of CLIL (age, exposure time, languages...), and main problems that may occur during teaching.

Chapter Two and Three were focused on theoretical and practical application of CLIL method described in Chapter One on Mathematics for higher level of primary schools. Chapter Two dealt with possible ways how to apply Maths on CLIL principles and methods, types of language used in Maths CLIL lessons and possible problems one can encounter when teaching Mathematics as a CLIL lesson. Following Chapter Three described possible plans for various mathematical areas that are taught on higher level of primary schools applied on CLIL teaching method.

At the end of my diploma thesis, I would want to say that its making gave me a lot of experience and helped me to form new opinionson English language, Mathematics and education in general, and although the research was often difficult, tiresome and even stressful, I had enjoyed it from the very first page up to the last one.

## LIST OF ABBREVIATIONS

BC	=	before Christ
CLIL	=	Content and Language Integrated Learning
ICT	=	Information and Communication Technology
L1	=	mother tongue, native language
L2	=	foreign language
MŠMT	=	Ministerstvo školství, mládeže a tělovýchovy (Ministry of Education, Youth and Sports)
NÚOV	=	Národní ústav odborného vzdělávání (National Institution of Technical and Vocational Education)
PE	=	Physical Education
RVP	=	Educational Programme – Frame of Reference
SLA	=	Second Language Acquisition

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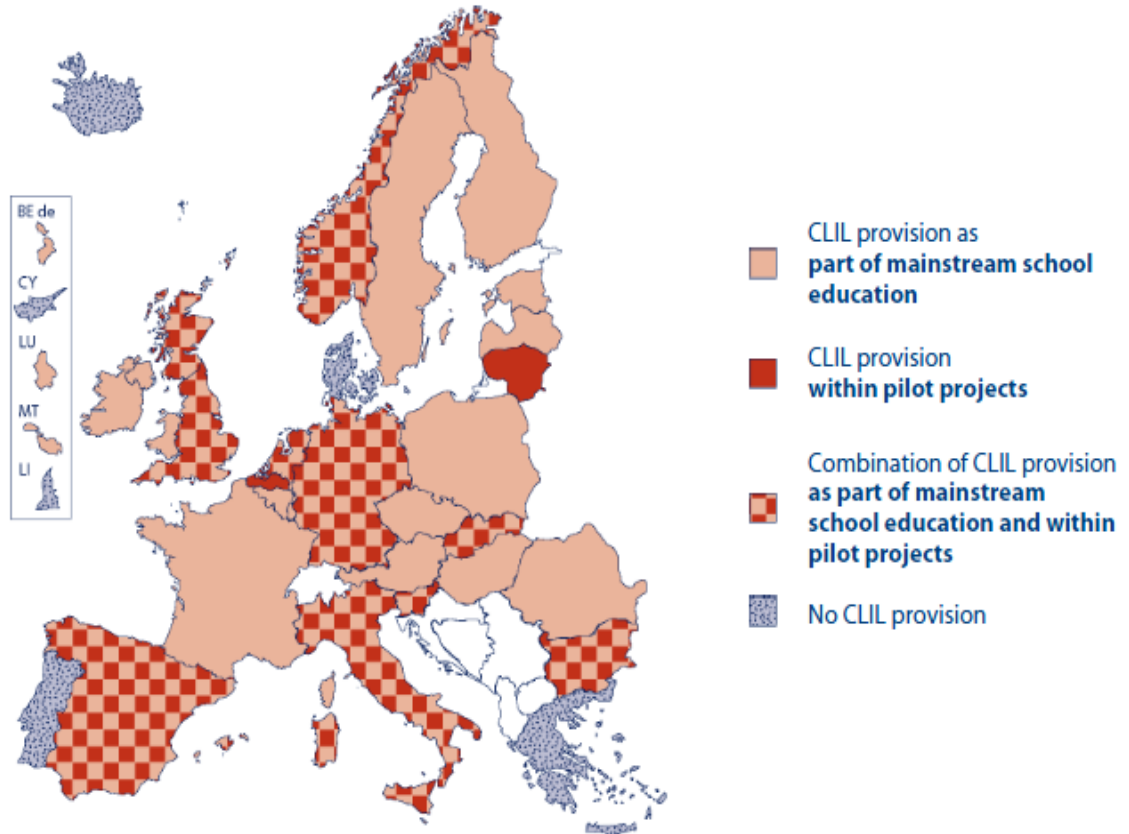
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## APPENDIX

**Figure 1.1: Status of CLIL provision in primary (ISCED 1) and general secondary education (ISCED 2 and 3), 2004/05**



Source: Eurydice.

Additional note

**Liechtenstein:** CLIL provision is available during the third year of primary education but on a very limited basis.

Explanatory note

Excluded from consideration here is any programme of support for children whose mother tongue is not the language of instruction, which offers educational provision in two languages primarily for the purpose of ensuring the more effective long-term integration of those children within mainstream education. International schools are also excluded. The Figure is limited to schools financed and administered by the public authorities. However, grant-aided private schools in Belgium, Ireland and the Netherlands are taken into account.

**CLIL provision as part of mainstream school education:** provision that is an integral part of one or more levels of the education system and not limited in time.

**Fig. 1.1**

**: Official minimum amount of time allocated to CLIL each week in pre-primary education (ISCED 0), primary education (ISCED 1) and general secondary education (ISCED 2 and 3), 2004/05**

<b>BE fr</b>	ISCED 0-1: CLIL must correspond to at least half (and no more than three-quarters) of weekly provision from the third year of pre-primary education to the second year of primary education. CLIL must correspond to at least one quarter (and no more than two-thirds) of weekly provision from the third year of primary education to the sixth year of primary education.  ISCED 2-3: CLIL may account for one quarter of weekly taught time
<b>BE de</b>	ISCED 0: between 50 and 200 minutes a week; ISCED 1-3: no recommendations
<b>CZ</b>	Varies depending on the institution and subjects concerned On average, 2 or 3 lessons per subject concerned per week
<b>DE</b>	Varies depending on the particular <i>Land</i> . On average 2 or 3 lessons per subject concerned per week.
<b>ES</b>	Varies depending on the particular Autonomous Community CLIL provision in English: ISCED 0: 7-9 hours a week ISCED 1: 9-12 hours a week (depending on the stage) ISCED 2 (first year): on average 11 hours a week

**Fig. 1.2a**

<b>FR</b>	ISCED 1: 2 hours a week of additional instruction in the target language ISCED 2 and 3: 4 hours a week of additional instruction in the target language + subject taught half in French and half in the target language
<b>IT</b>	Varies depending on the region
<b>LV</b>	Varies in the case of foreign languages (from 1 to 6 lessons per subject per week depending on the year concerned) Provision with minority languages is in a transitional stage
<b>LU</b>	ISCED 1: 24 hours a week (out of 30 in all). ISCED 2 and 3: 25 hours a week (out of 30 in all).
<b>HU</b>	Varies (must be equivalent to the minimum amount of time per subject in mainstream education)
<b>MT</b>	Around 50 % of teaching in the target language
<b>NL</b>	ISCED 1: (:) ISCED 2 (years 1-3): 50 % of teaching in the target language ISCED 2 (years 4-5/6): at least 1150 hours are recommended for this stage
<b>AT</b>	ISCED 1: 1-2 hours a week ISCED 2 and 3: no recommendation. Allocation at the discretion of the teachers.

**Fig. 1.2b**

<b>PL</b>	ISCED 1: (foreign languages) first year – intensive teaching of the target language (18 hours a week). ISCED 2 at <i>gymnasium</i> (foreign languages): 6 hours a week for 3 years. ISCED 3 (preparatory year for <i>lyceum</i> ): 18 hours a week of intensive teaching of the target language. ISCED 3 at <i>lyceum</i> (foreign languages): 6 to 8 hours a week ISCED 1 (minority languages): first year (4 hours a week)
<b>SI</b>	Varies (schools may fix the number of subjects a week)
<b>FI</b>	Varies depending on the school and the status of the language offered
<b>BG</b>	ISCED 1: first year – intensive teaching of the target language (21 lessons/week) Other years (+ ISCED 2 and 3): (:)
<b>RO</b>	ISCED 1, 2 and 3 (foreign languages): 4 lessons/week using the target language (irrespective of the year) + 1 lesson/week in a chosen language ISCED 1, 2 and 3 (minority/regional languages): varies because school types differ. The time for teaching using a minority language may be equivalent to that recommended in mainstream education in some schools; from 4 to 8 lessons/week depending on the year in others; from 1 to 4 lessons a week in yet others.

No CLIL provision: BE nl, DK, EL, CY, LT, PT, IS and LI

No recommendation: EE, IE, SK, SE, UK and NO

Source: Eurydice.

Additional notes

**Spain:** The information shown relates solely to the types of CLIL existing in Autonomous Communities that were able to take part in data collection.

**Liechtenstein:** CLIL provision is available during the third year of primary education but on a very limited basis.

**Norway:** The Norwegian National Centre for Foreign Language Instruction is to propose new requirements in the near future.

Explanatory note

A lesson generally lasts 50 minutes.

**Fig. 1.2c**