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USING COMPUTERS IN RELATION TO LEARNING CLIMATE IN CLIL METHOD

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Abstract: The main purpose of the work is to present a successful implementation of CLIL method in Mathematics lessons in elementary schools. Nowadays at all types of schools (elementary schools, high schools and universities) all over the world every school subject tends to be taught in a foreign language. In 2003, a document called Action plan for Language learning and linguistic diversity was approved by the European Union. Its purpose was to enable the acquisition of at least two foreign languages for all European citizens. The integration of content and language skills is a part of the plan. Within the school educational programs it is possible to choose CLIL (Content and language integrated learning) method. This method is an upward trend in contemporary education system. Teaching Maths in a foreign language requires some changes in current teaching methods, so the importance of the IT technologies is also mentioned. The work studies the impact of the CLIL method in teaching Mathematics and possible changes of the classroom climate and shows the results of the research focused on this method.

Key words: learning climate, CLIL method, dynamic geometry, computer assisted learning

1. Introduction

Learning climate is very important, though often underestimated. In fact, the quality of the classroom environment forms the basis for the quality of educational results. Any unfriendly climate in the classroom stirs up hostility, anxiety, unrest and scepticism, while with friendly, hospitable climate we can expect not only self-confident pupils or students, but also their ability improvement.

The paper deals with various pedagogical aspects of the educational issue of the implementation (integration) of the English language into teaching Mathematics when using computers at the same time. The article is backed up by several years of study of literature and by an educational practice research conducted at elementary schools. It aims to contribute to deeper understanding of this issue and also to provide a comprehensive view of educational changes which are associated with it. Our objective was to prove that the new educational method (CLIL) and the related changes in the content of the curriculum – using computers in teaching Mathematics – strengthen the affective component of learning and that this is the reason for a teaching climate change.

The aim of this paper is to analyse the learning climate in relation to CLIL and dynamic geometry. At present, there is a worldwide boom in teaching non-language subjects in foreign languages, both at primary and secondary schools, and also at universities. This paper deals with the implementation of the CLIL method into Mathematics classes at elementary schools.

2. Theoretical Basis

2.1 CLIL Method and Its Tools

The current curriculum requires the integration of subjects and educational fields. Thus, it is necessary to blend and mutually enrich individual fields and disciplines. The classic type of education, which prefers school subjects taught separately, no longer corresponds with today's needs. One of the approaches which stresses the above mentioned integration is an implementation of a foreign language into teaching; the related method is called Content and Language Integrated Learning (CLIL). In its

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broadest sense, CLIL refers to teaching a non-language subject using a foreign language, which then serves as a means of communication and content sharing. Non-language content is mediated and developed using a foreign language while the foreign language is developed by mediating the content. As a result, both the content and language are developed through a mutual relation. This type of integrated teaching sets two basic objectives – the content and the language.

The term CLIL was coined in 1994 and first used in 1996 in UNICOM, University of Jyväskylä, in Finland, and by the European Platform for Dutch Education. CLIL was supposed to define the educational methods through which special subjects are taught in a foreign language and through which content teaching takes place simultaneously with teaching a foreign language. Later, CLIL expanded to teaching via any language that was not the first or native language [1], [9]. Many authors refer to CLIL as an "umbrella term" [6], [7] which includes a number of different approaches in different educational contexts.

The authors of the CLIL concept believed that this was an innovative approach to education and that it would have a long term impact on the quality of education [23]. In 1995, the European Commission adopted the White Paper on education, which emphasizes plurilingual education in Europe. In this document, experts agreed that CLIL can play an important role in this effort. At that time they highlighted the fact that CLIL helped to develop foreign language skills. Today we know that it also brings substantial benefits and innovation in teaching non-language subjects, especially in the context of the traditional, sometimes rather old fashioned, educational system.

Integrated teaching entails certain risks, but it also offers benefits.

The benefits include greater demands on the cognitive processes that are not commonly contained in language textbooks, training compensation strategies and an effective development of communication skills, working with real content that is usable in real life, better chances to find a job, expanding intercultural competence, and increasing teachers´ professional qualification.

The risks associated with CLIL include students' inability to use a foreign language in special subjects, a lack of relevant learning materials (printed and digital) and a lack of evaluation tools for the CLIL, uninformed school management and unsystematic introduction of the CLIL in schools, teachers' unwillingness to cooperate in CLIL teams, time-consuming and difficult preparation for CLIL teaching, and insufficient language or subject skills of the teachers.

Nevertheless, CLIL is a method that assumes changes in teaching methods and in using other didactic means [22].

When planning content objectives, teachers must also take into account the cognitive development of the students so that the mental operations at a lower level (remembering, understanding, application) could be followed by higher-level mental operations (evaluation, creation, analysis).

There are six basic principles of teaching [24]: 1) use of new organizational and methodological approaches in teaching, 2) creative atmosphere, 3) authenticity of teaching, 4) active learning (students' participation in content creation), 5) support in teaching (scaffolding) and 6) cooperation.

The CLIL educational method is based on the didactics of teaching foreign languages and the didactics of special subjects, and it is implemented through pedagogical constructivism, project based learning, critical thinking, etc.

In integrated teaching, a constructivist approach is important because students do not possess sufficient language skills to be able to understand the complete contents of education. New terms must coincide with previously acquired and adopted content, and it is equally important that such content is based on the already acquired language structures and skills [24].

2.2 CLIL and Computers in Teaching

Teaching Mathematics in English language requires all the teacher´s abilities on the highest level. However, the teachers should not be worried, as every modern teaching method still regards the same didactic principles [6]. CLIL is based on more individual work with pupils because they can require

quite different approaches – from giving equations and expressions to visual illustrating the topic (sketches, pictures or dynamic models).

There are many computer programs that can help in forming a good learning environment. These are CAS programs (Computer Algebra Systems – e.g. Maple, Mathematica, Derive), which make symbolic and numerical calculations (solving algebraic expressions, equations, creating functions' graphs, etc.). In addition, there are DGS programs (Dynamic Geometry Systems – e.g. Cabri, GeoGebra), which serve as a geometric sketchpad to render geometric shapes or structures and which allow their users to manipulate with them or perform some calculations. The fact is that the division between CAS, DGS and spreadsheets were appropriate ten years ago, but now most mathematical software started to cover areas of other packages. Every DGS software now covers some algebraic function and some even integrate spreadsheet and full CAS elements into their system. For example GeoGebra is an interactive mathematics software package incorporating geometry, algebra, and calculus, each of which can be used separately. The Cinderella community [19] discussed tighter integration with algebraic and symbolic approaches, methods for numeric simulation. GeoGebra has already started to integrate a CAS [25].

Also, there are other types of educational programs which help to form a good learning environment called spreadsheets (such as Excel). These programs can assist in understanding mathematical concepts by means of using tables, bulk processing of input data, visualization of data in graphs, etc. We should also mention closed learning environment, simulation programs, theorem-proving programs (CoCoa), interactive textbooks, etc.

In Czech schools there is a growing interest in teaching using modern technologies; computer-aided teaching. However, it is important to retain a close link to the curriculum, in mutual symbiosis, in the way that teaching method would be complementing and creating balance. All studies investigating the efficiency of teaching methods have confirmed that there is no universal unity. It was revealed that efficiency is always dependent on respecting the conditions and factors involved in learning process [29].

Frank [10] believes that the foundations of today's computer systems and internet networks contain the principles of cybernetics and cyber education stimuli that enrich learning and teaching in terms of informational and psychological aspects and technology management. All these things served as the foundation for various applications that have occurred in the educational field.

When implementing a foreign language in teaching Mathematics, computer assistance is necessary. A teacher's preparation for classes takes a form of a script in which all activities and situations are carefully thought out. However, it is important to stay focused on the objective – the educational content as the determining component of the curriculum. One way to carry out such a preparation is creating digital teaching preparation that would contain all these attributes. As it will be shown, a computer is an irreplaceable part of the CLIL method; using a computer is therefore an essential part of teaching Mathematics in CLIL. For in-class work, digital preparation for teaching with texts prepared in English language and the use of sophisticated programs in a bilingual environment (GeoGebra) are both of a great importance.

Based on the assumption that the IT can have a positive impact on teaching and learning Mathematics, many countries have introduced these technologies into their Mathematics curriculum [17]. However, this implementation is not easy: there is a number of factors involved, such as beliefs and opinions of Mathematics teachers and also their concerns about adopting this innovation, further education of teachers and the quality of such education, selection of programs and materials for successful innovation of learning environments [17]. Gibson [15] suggests that technology alone will not change teaching. The change will occur only if the process is participated by the teachers who will accept the change and who are sufficiently flexible. These teachers would have to be willing to integrate technologies into the learning environment and to restructure the forms of teaching to the benefits of the students. However, there have been a number of cases in various countries where implementation of the IT in teaching Mathematics failed [17].

As we can see in our research, the change in teaching methods brought about a major use of computers in the form of DGS (dynamic geometry software), new mathematical programs, and also the use of the

Internet. Using modern technologies, such as interactive whiteboards or mathematical programs, teachers can prepare their own worksheets and study materials. All strategies are in accordance with the Framework Educational Programmes.

2.3 Educational Climate

Fraser and Tobin [12] agree that the class climate affects students' behaviour, the level of knowledge, educational performance, motivation, attitudes to the field taught, and education as a whole. If the class climate is hostile, then anxiety, feelings of restlessness, and scepticism occur, which can lead to intellectual and cognitive depression. On the other hand, in friendly class climates, where students exhibit self-esteem and respect for others, their cognitive abilities clearly improve. Lave [20] and Salomon [28] suggest that when measuring and testing the class climate we should also take into account the existing methods of teaching.

Long-term international studies show that a school climate has a significant impact on students' performance at school and even on their success on the labour market after they leave school [27]. Several studies examined the relationship between students' performance and a learning environment and empirically came to the conclusion that students' performance gets improved by creating a learning environment that facilitates learning and respects the concept building process [27].

The above, therefore, shows that if we want to create a good learning environment which activates students, it is necessary to supplement the traditional scheme (curriculum – teacher – student) and change the roles of individual participants in it. Studies on the quality of learning environments and their effect on improving pedagogical practices are described, for instance, in [13, 14]; [31].

As the research objective demands, we should define also the terms “school climate” and “learning climate” as social phenomena. According to what was written in the introduction, both school and learning climate create the basic factors for success in pupils’ ability improvement. Therefore, we talk about the perception, the experience of pupils and their assessment of the situations that take place in the classroom [21]. Pupils spend quite a long time at school, so it creates their living space, which should be taken into account. Different teachers establish different climates, and Mathematics classes are no exception. The climate of Mathematics learning is a pupils´ response to the environment in which the learning takes place [11]. The nature of the learning climate is relatively stable and not homogeneous.

3. Teaching Mathematics in English Language at Primary Schools - Description

The study is focused on the benefits and shortcomings of CLIL. The research objective is to describe the change in the climate of learning Mathematics in connection with the introduction of the CLIL method and in connection with the introduction of computer aided learning.

For evaluating the research results the quantitative data collection methods were used, in the form of questionnaires, and also qualitative methods, interviews with teachers and students and observations.

Creating the new learning environment [2] – in terms of language and the new methods and forms of work – we could observe all the problems and benefits arising from this change.

The project named “Connecting Foreign Languages and School Subjects at Primary Schools” was participated by three primary schools; two of them participated only partly, when an elective subject called “Mathematics in English” was created. 254 pupils of the 6th to 8th grades were involved in the project. A pilot survey was carried out in the school years 2009 – 2011. Full implementation of the project was initiated after that. The project aimed to implement the CLIL methodology into practice of primary school Mathematics teaching at least once or twice a week. All pupils and teachers had had no experience with CLIL when our research started, so the changes in the learning environment and in teaching styles and methods of work came out slowly. During the project, the school actively started the process of educational transformation, and the set objectives were continuously updated according to the current situation and emerging needs.

The research was focused on the shift in students´ knowledge of Mathematics during and after the project, their relationship to Mathematics and the English language when these interacting together,

and the change in the class climate in relation to the new way of teaching. We carried out direct and indirect participant observations, collected items (student worksheets, homework, essays, class and school documents, student projects). The method of data collection during the experiment was a questionnaire which we used in order to evaluate the effect of the implementation of a foreign language in teaching Mathematics. For the evaluation of the classroom climate we used a survey questionnaire [16]. The questionnaire allowed us to assess the climate of teaching in terms of relationships among students in the class, cooperation between them, learning aids, concentration on learning, teachers' approach, student assessment, clarity of rules in the teaching process, teaching institutionalization, diversity of selected teaching methods, etc. Therefore, we were able to compare our results with the results of the survey of 600 respondents [16] carried out in the Czech Republic (climate of teaching Mathematics).

At the beginning of the research, we did not observe any significant differences in learning styles or methods of work. Learning environments did not differ, and students had no experience with CLIL, i.e. there was no teaching of non-language subjects in a foreign language in the classes. Students occasionally worked on projects. They were not engaged in teaching or organization of teaching. Students respected their teachers in all schools. Teaching took place mostly without using the IT and was rather monotonous. Teaching was not carried out in the sense of constructivism; it could be described as rather transmissive. Neither activating methods in schools were common. Teaching methods which we observed were as follows: problem-solving teaching (rather rare), experimenting, modelling, and occasionally computer-aided teaching. The teaching styles of the teachers in all the schools could be described as authoritative or tolerant-authoritative. All three schools joined the process of educational transformation actively. They implemented the set objectives in their School Educational Plans and continuously updated them throughout all phases of the project according to reality and emerging needs.

Teachers prepared worksheets and educational materials for teaching Mathematics. The educational materials were prepared in the SMART Notebook environment. Materials for students were processed in an interactive form and supplemented with sounds (new vocabulary or sentences were recorded by native speakers). They were also provided with a guide for teachers and worksheets for independent in-class student work. Teaching was designed to take in account the motivational phase of the concept building process, to use the interactive whiteboard elements, and to use mathematical programs, particularly GeoGebra. This geometric program was for obvious reasons used in English. However, if it was necessary, the program language could be easily and quickly switched back to Czech. We understand that the use of computers for teaching students can be complicated. We aim to achieve a state when computers help students to understand the studied topics in English, to remove the unnecessary complexity of calculations, structures, etc., which can distract students' attention from the real understanding of the issues studied while retaining the necessary and today often underestimated “mathematical craftsmanship” [3].

3.1 Examples of Activities Using Computers in Mathematics with CLIL

The whole project was focused on teaching and revising arithmetic through CLIL. The principle objectives of the project were to:

1. introduce CLIL approach through different activities
2. revise general knowledge of arithmetic through CLIL activities

Activity 1 – Problem Solving

Teacher used the IWB to explain students the activity. There was a short text and the task was to rewrite the text using numbers and mathematical symbols (see Figure 1). First example was completed together with children. Then they worked in groups and finished the activity. The last example was opened to children´s creativity. Their task was to prepare a similar text for the class [26].

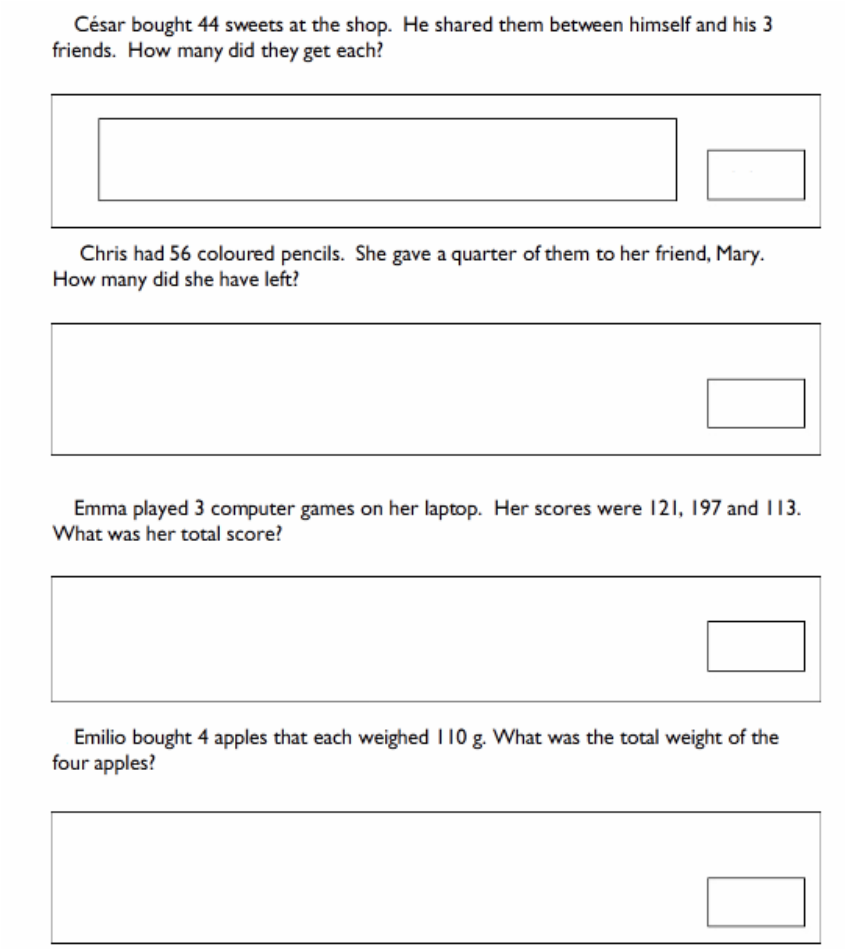


Figure 1*: Problem solving*

Activity 2 – Using Mathematical Symbols

Around the classroom there were posters with worms (see Figure 2). Each worm was divided into a set of mathematical operations. Children were divided into pairs, they walked around the classroom and solved the puzzles. All conversation had to be done in English. The aim of the activity was to revise mathematical symbols in English.

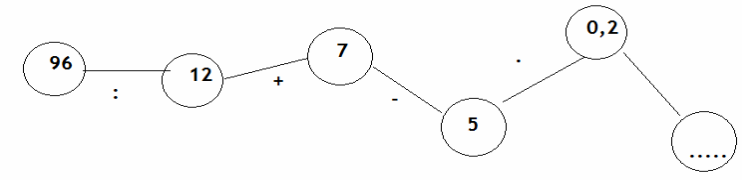


Figure2*: Mathematical symbols*

Activity 3 – Mathematical symbols

At the beginning of the activity children were given a set of cards (blue cards with mathematical symbols, yellow cards with descriptions (see Figure 3). The task was to match the symbols to the descriptions. The teacher checked the answers using the IWB and encouraged students to write down three examples and dictate them to the partner. After revising the teacher explained a running game. Children played in two teams and the aim was to point at the symbol as fast as possible [26].

	Description		Symbol
1	Plus / add	A	÷ or /
2	Minus / subtract	B	≈
3	Divide	C	≠
4	Multiply / times	D	+
5	Is equal to	E	≤
6	Does not equal	F	×
7	Is greater than	G	<
8	Is less than	H	=
9	Is approximately equal to	I	>
10	Is less than or equal to	J	–

Figure 3 : *Activity*

Activity 4 Colouring Game

Teacher explained new vocabulary: the odd and the even numbers using examples (see Figure 4). The task was to colour different squares in the table using crayons. The example was completed on the IWB. After colouring the students got letters and they had to write at least 5 words beginning with a certain letter (see Figure 4). All conversation had to be in English.

Activity 5 Crafts in Aritmetics

The aim of the activity was to revise the whole unit (mathematical symbols, counting, the odd and the even numbers). Students were divided into groups and they had to prepare funny counting activities (using English, mathematical symbols and creativity). Students came up with many activities: using plasticine, lego activities, drawing activities etc.)

The project was successfully completed and students were given a self-assessment grid and a simple questionnaire. According to the questionnaires the analysis of the project was prepared. The results are the following:

1. CLIL activities are interesting, challenging and students like them all.
2. The easiest activity is at the beginning- the running activity.
3. The most difficult activity is a problem solving task.
4. The majority of students prefer moving activities connected with colouring.
5. Using English during the project was not a problem for the students.
6. They feel safe when working in groups.
7. The majority of students want to do the CLIL activities in English again.

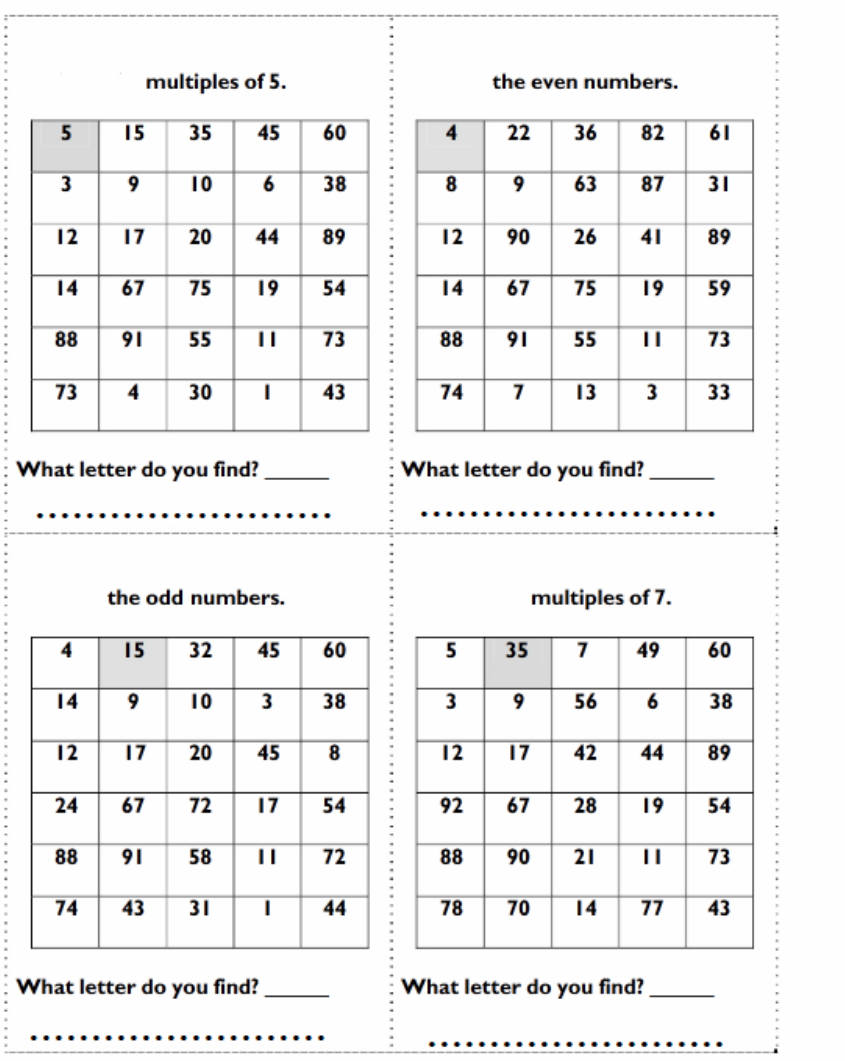


Figure 4*: Colouring game*

Activity 6 Geometry in English

Teachers used GeoGebra because it can simulate geometrical constructions well, it helps to demonstrate and illustrate a large number of separate models (in a better way than just using a pencil and paper). It also leads to cultivation of students' language, forcing them to express themselves accurately, not only in Mathematics but also in English. The provided example is illustrated in Figure 5. We selected a sample of teaching from the field of triangles. This lesson aimed at introducing the concept of altitude in the triangle. Drawing in a workbook does not provide students with a sufficient idea of this concept. A DGS program enables students to see the characteristics of an altitude of a triangle by allowing them to manipulate with geometric objects (to distinguish from other than acute-angled triangles). The purpose of the manipulation with the objects is to let students acquire new knowledge and explore the rules associated with it.

Using the tool called Relation between Two Objects in the upper bar enables students to determine correctly and identify the relative position of the lines *a* and *b* (Figure 5), to explore other important relations between the objects, or to construct altitudes of a triangle by selecting from the toolbar, both in English and Czech, as required [4].

After we continued with students to draw altitudes in the triangle, they were given another task:

Construct the intersection of the altitudes in the triangle. Move point C on line b. What will be the shape of the curve along which point V moves?

The task is difficult without the aid of a computer. GeoGebra, however, enables students to create a new dynamic image of the concept. Using the tool Locus, students construct a set of points (after tracing point V) and learn about the curve, the properties of which will be examined in more detail later (they will receive a preconception of the parabola).

During the project an interactive white board was used in order to support clearness and explanation. Using computer seems to be very effective because it is possible to decorate, adapt and copy the worksheets. Modelling was used also in order to support children's creativity. It is also essential to use computer when adapting worksheets for SLD children (learners with specific learning difficulties).

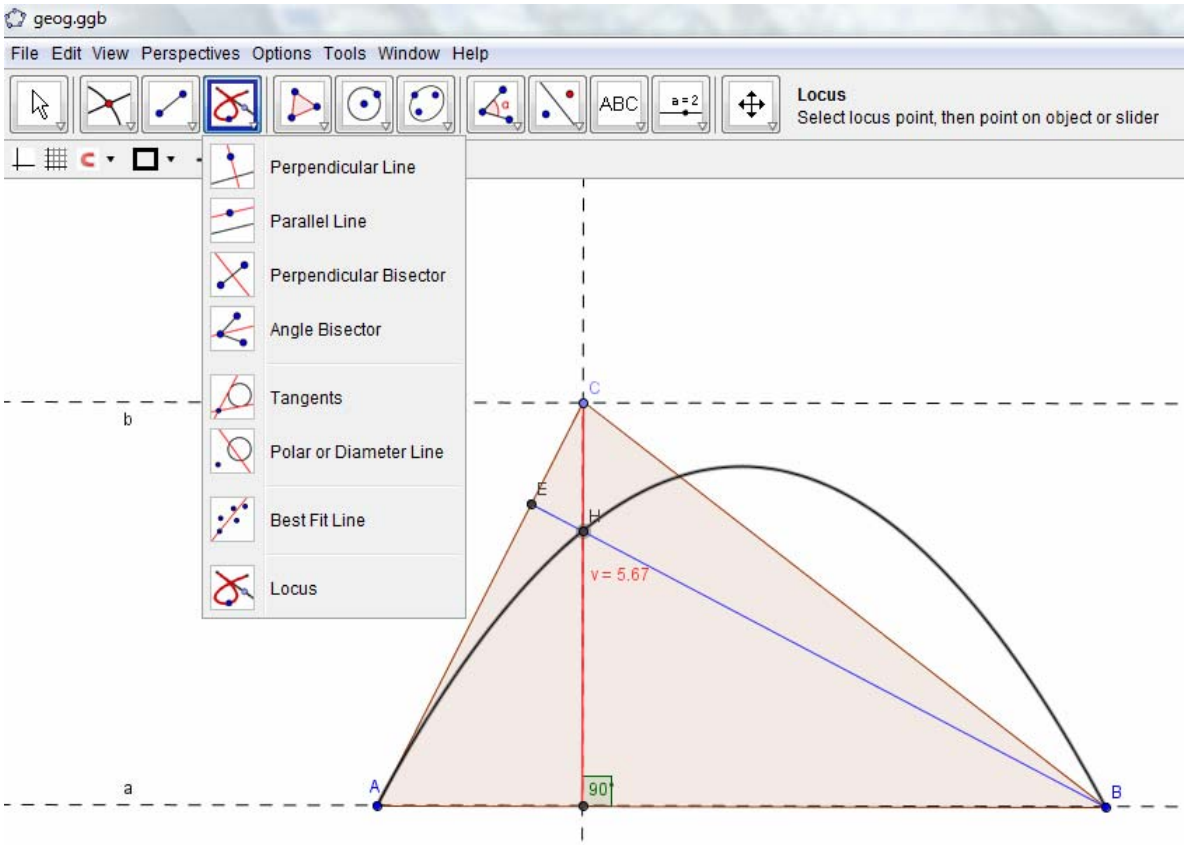


Figure 5: *Using GeoGebra*

4. Research

4.1 Data Collection Organisation

Data for this survey were collected from pupils of the 6th to 8th classes (6 in total) of elementary schools. For better comparison of the collected data, we reduced the sample of pupils to the classes in which one of the participants in the research worked as a teacher. There were 78 respondents who underwent Mathematics teaching in English (further only as group M/A). The control group consisted of 97 respondents. This control group of students who had not previously attended teaching Mathematics in English in the school year 2010/2011 will be further referred to as group M. The groups were balanced in the terms of the number of girls and boys. In their research, Helmke and Weinert [16] showed that the number of girls in the class affected evaluation of the class climate in most subjects (the higher the proportion of the girls, the more favourable the class climate). Differences were found only in Mathematics. Girls consider Mathematics less understandable and do not feel friendly relationship towards Mathematics. Also they lack confidence in their own success.

4.2 Questionnaire Description

For our experiment, we did not prepare our own questionnaire, we used the questionnaire for the research of the teaching climate of natural science subjects – *Questionnaire to Assess the State of Teaching in Individual Subjects* [16] (further only as "G", see Appendix). At the end of the first year of teaching Mathematics in English, all pupils of the above classes were given this questionnaire (Table 1) in order to determine whether their evaluation of the teaching climate would differ after the introduction of CLIL – and if so, in which categories. The comparison was carried out both in relation to the results of G and the question *Teaching using the CLIL method – Yes or No.*

Questionnaire G was composed of 26 statements, to which the respondents were supposed to provide their answers at a five-point scale: 1 – always, 2 – almost always, 3 – sometimes, 4 – almost never, 5 – never. To facilitate the evaluation of the questionnaire, individual statements were grouped into seven categories: K1 – K7. K1 represents a teacher's enthusiasm, insight, and competence, K2 evaluates unconventional methods of teaching, activity, and cooperation, K3 contains questions about a teacher's support and interest in pupils, K4 evaluates fairness of a teacher's approach, K5 addresses meaningfulness of teaching, K6 evaluates adequacy of requirements and tasks, and K7 addresses the issue of clarity.

4.3 Results of the research

As the research went on, the climate of learning Mathematics in English was perceived by pupils more positively. Main factors appreciated by pupils were the clarity of teaching and the enthusiastic approach of teachers. Pupils evaluated the classes as more interesting. Teachers perceived these classes as very attractive both for themselves and for their pupils. This was caused mainly by new environment, new technologies and new teaching methods needed, so it could be understood as a deviation from a stereotype.

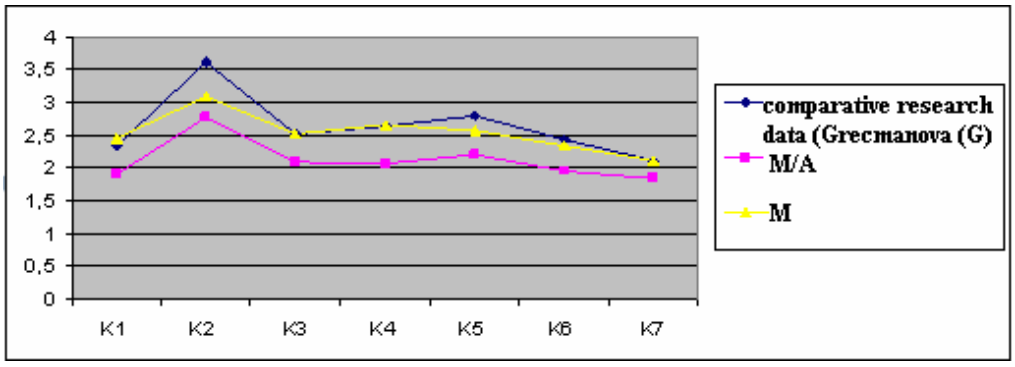
Objectively, the results of the pupils improved during our research, because they really involved in classes and found all these new ways of learning exciting and attractive. Their perspective of seeing Mathematics changed and they could finally feel motivated and interested in the subject although they had found it boring and difficult in the past. Some of them, rather keen on foreign languages, highly appreciated the possibility of its practical use, and they focused even harder to understand all the matters. Succeeding in this, they began to feel more self-confident. The same results were described for example in [3]. According to this experience, pupils worked harder in foreign language classes and they tried to understand better every new term.

Our results confirmed that pupils of the traditional Mathematics classes had the same feeling about the climate of learning as pupils in the research [15] of the climate of natural science subjects. We can see all the results illustrated in Table 1 and Graph 1 below.

Table 1 - Comparison of the climate of learning

CATEGORY (average value)	Grecman	M/A	M	deviation M/A from G	deviation M from G	deviation M/Aj from M	*p*-value M/Aj and M
K1 (enthusiasm)	2,33	1,92	2,46	0,41	-0,13	0,54	0,000002
K2 (unconventional methods of teaching)	3,62	2,77	3,09	0,85	0,53	0,32	0,003735
K3. (teacher's support in pupils)	2,52	2,08	2,52	0,44	0	0,44	0,000211
K4 (teacher's fairness)	2,64	2,06	2,65	0,58	-0,01	0,59	0,000004
K5 (advisability of learning)	2,8	2,2	2,57	0,6	0,23	0,37	0,000671
K6 (adequacy)	2,43	1,96	2,34	0,47	0,09	0,38	0,004794
K7 (concerns clarity)	2,11	1,84	2,12	0,27	-0,01	0,28	0,003732

*657 respondents group G, 78 respondents group M/A, 97 respondents group M



Graph 1 - Evaluation of the Mathematics teaching at the primary school

The M/A pupils positively evaluated the clarity of teaching, teacher's ability to make learning interesting, and their enthusiasm (average value 1.84; 1.92). The categories with poor results are, as it was in Grecmanova, unconventional ways of teaching, activity and collaboration (average value of M/A 2.77). There was a positive shift in the K5 category – meaningfulness of learning. The pupils began to understand the fact that they would be able to use their knowledge of Mathematics in the future. The deviation in the results of the M/A group and the M group pupils is 0.37. The K2 category, non-traditional teaching methods, activity and collaboration, also showed better results in the M/A group, as was already mentioned in this paper [3].

Pros and cons of the CLIL method were analysed, too. As we already mentioned the advantages of this method, we should also mention the disadvantages.

Teachers may have some difficulties using new technologies. Also, the change of the learning environment could be accepted embarrassingly at the beginning, both by the pupils and the teachers.

Changing teaching methods led to the use of new technologies and thus to a change in the learning environment (see previous chapters). This helped to understand better the concepts taught. Explaining of the concepts was carried out by repeating or paraphrasing, and in some interactive tests, pupils had a chance to check their understanding with immediate evaluation. By using the tools that are part of the programs for interactive whiteboards, interactive tests were prepared for pupils and the pupils were supposed to solve the tests using voting equipment. The test results were then published in the statistics of the solutions of the entire class, including the incorrect and incomplete answers. Therefore, the K4 category – *Fairness of a teacher's approach* – was rated better by the M/A pupils than by the M pupils. In Mathematics classes, the M group did not use interactive tests and the evaluation was not that open. This was influenced by the fact that it is very difficult to establish a good method of evaluation in teaching by the CLIL method. Therefore, we paid considerable attention to the evaluation process. The issues related to the evaluation are, for instance, a wider range of continuous assessment, validity, language, types of questions, etc.

In the evaluation of the K5 category, we can see pupils' interest towards applicability of Mathematics in practice, formation of mathematical literacy, and orientation towards the future career. Again, the M/A group pupils rated this category better than the M group pupils; the deviation in the results in this category was 0.37.

The data obtained were further tested to establish whether the differences in the evaluation by pupils were statistically significant or not. This time, the data from G were considered the norm, and we compared only the data that we obtained from the questionnaire filled in by M and M/A. Since we could not assume that the answers to each question were normally distributed, the nonparametric Mann-Whitney test for testing hypotheses was selected. For these purposes, the null hypothesis was formulated so that the pupils' answers in both groups M and M/A to the questions in each category had the same distribution. The alternative hypothesis was formulated so that the distribution was not the same. The testing of the hypotheses was carried out for each of the seven categories separately, each at

the significance level α = 5%. The obtained values for each of the categories K1 to K7 are presented in Table 2 (last column). As the values of the *p*-value clearly show, we must reject the null hypothesis in all seven categories in favour of the alternative hypothesis, i.e. the distribution was different in all observed categories. Main values of the responses in all the categories of the M/A group were lower (correspond to better evaluation). Therefore, we can reasonably assume that the climate of teaching Mathematics was rated significantly better by the M/A group than by the M group.

The biggest problem is that there are not enough teachers who would be able to deal with the CLIL method. This method requires some abilities introduced in the 2nd chapter of this paper, and not every teacher accustomed to traditional teaching method, has these abilities. One of the most important objections of the teachers is the difficult method of evaluation [4].

5. Summary

Using the CLIL method requires understanding the new teaching methods. Teachers need to get accustomed to using computers in classes. Moreover, they should be aware that this method changes the learning climate.

It was proved that the CLIL method is able to make Mathematics attractive even for those who disliked it in the past. It produces more efficient teaching results and draws higher attention of all pupils in the class. As we could work with all pupils of one primary school and not only with selected ones, we can imply that the knowledge of Mathematics did not suffer some decreasing trend using the CLIL method. These new tools significantly affected the overall form of teaching and the learning environment attributes. As pupils were taught Mathematics as a scientific discipline with a logical construction, illustrated by applets, animations and interesting programs, pupils gained their knowledge in a more active way. They became more motivated to learn something new and even difficult because they found this new method attractive. This was the result of the combination of interactive educational tools and foreign languages teaching. It was proved that pupils gradually got rid of their fears of both English and Mathematics.

It was very positive to observe the teaching in a quality learning environment; in the environment that stimulates naturally in-class discussion on Mathematical issues, where it was not wrong to answer incorrectly, where pupils displayed true interest in the topics taught (not with aim to receive better grades). A well-prepared environment offers relevant and interconnected questions, problems, and tasks (regardless of the language used) instead of the standard series of tasks that children are used to do. These new tasks can determine the level of understanding by pupils by using programs or applications. Pupils use them meaningfully with the support of concept visualization and dynamics of the new learning environment. Such teaching then reflects all the effort put in preparation. On the basis of statistical surveys, we succeeded in proving that teaching Mathematics in English, carried out long-term and regularly in all 6th – 9th classes of an elementary school, leads to improvement of the teaching climate. Teachers in the project IMA increased their expertise (in Mathematics, professional didactics, English) and improved their internal motivation based on self-reflection during mutual consultations. Teachers evaluated their experience with teaching Mathematics in English very positively, viewed it as a way to avoid "burnout", and felt motivated for further work.

There are, however, questions to be answered concerning the selection of schools, pupils, and teachers for CLIL, mostly due to the generalization of our results. We intend to investigate better the questions that remained open (regarding the impact of external variables); in further research we will aim to take a closer look at their internal and external validity. Our further research will deal with the division of studied groups into those which used CLIL without computers and those which used CLIL and computers. Coyle [7] concluded that the CLIL develops pupils' confidence, communication skills, problem-solving skills, and enhances learning ability. Using CLIL can result in better motivation and strengthening the pupils´ independence. It can also develop concentration and build positive attitudes and intrinsic motivation to learn. Day and Shapson [8] and Van de Craen [30] confirm that pupils taught using CLIL perform better in non-language subjects than their peers, under the condition that testing takes place in their mother tongue. Huitbregtse [18] arrived at the same conclusion: her research confirmed the fact that pupils from bilingual programs achieve better results in all tested

subjects. There are studies that point to a connection between CLIL and the knowledge of pupils [5] or the motivation [7]. However, there are still no results regarding the climate of teaching Mathematics using CLIL in relation to computer-aided teaching.

Our goal was not to state general conclusions but to defend the fact that teaching Mathematics in a foreign language at an entire elementary school (not only in selected classes and by selected teachers) may improve the climate of teaching mathematics. It should be taken into account that the research was carried out in the time when children's motivation to study Mathematics has been decreasing, which is also documented by the results of the Czech pupils in international comparative tests.

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The Appendix

The questionnaire

K	STATEMENTS
74	I can tell my opinion to the teacher without being afraid
75	I have to explain my opinions
76	There are clear rules for work in the classes
77	I have to fulfil my tasks accurately and reliably
78	Tasks are continuously checked
79	Tasks are adequate to what we have learned
80	I have no problems with preparing for school at home
81	I can apply my good ideas in the classes
82	The teacher is supportive when I am interest in something in the subject
83	When I am not able to finish tasks in the classes, the teacher helps me
84	When I finish tasks sooner than others, the teacher gives me more work
85	Classes also takes place outside the school
86	The teachers' classes are interesting and they do it with enthusiasm
87	The teacher explains us how and where to apply what we have learned
88	The teacher tells us in which professions the things we learn can be applied
89	The teacher uses visual aids and examples
90	The results of my work in the classes are fairly evaluated
91	I feel OK before tests
92	Tests examine how I understand what we were taught
93	We work in groups when working on tasks
94	We are supported to discuss processes of fulfilling tasks in the classes with classmates
95	We are asked about our knowledge before moving on to new subject matter,
96	The teacher appreciates my study succeess
97	The teacher deals with teaching subject matter, keep up the topic

98	The teacher keeps my attention in a way of teaching
99	The teacher corresponds to pupils on issues related to curriculum