

GeoGebra Software Use within a Content and Language Integrated Learning Environment

¹Helena BINTEROVÁ

²Marek ŠULISTA

¹University of South Bohemia, Pedagogical Faculty, Czech Republic

Jeronýmova 10, 371 15 České Budějovice

Ph.D. (methodology of mathematics), Assistant Professor

E-mail: hbinter@pf.jcu.cz

²University of South Bohemia, Faculty of Economics, Czech Republic

Studentská 13, 370 05 České Budějovice

Ph.D. (methodology of mathematics), Assistant Professor

E-mail: sulista@ef.jcu.cz

Abstract. This paper presents results of a research study focusing on the analysis, comparison, and description of students' attitudes towards the teaching of mathematics lessons presented in a foreign language (English) using the Content and Language Integrated Learning (CLIL) method in three elementary schools. It also highlights the difference between the attitudes of the CLIL method learners and those of their student counterparts who experienced similar mathematics lessons but in their mother tongue (Czech). The aim of the research is to test the hypothesis that the teaching of mathematics in a foreign language by the CLIL method would be evaluated positively by participating students. The research also focused on the question of whether or not, or to what degree, the implementation of the foreign language (English) along with the use of an interactive tool, such as GeoGebra software in mathematics lessons, was perceived as being meaningful and as significantly improving the effectiveness of student learning.

Keywords: CLIL method; computer assisted learning; GeoGebra; math teaching

1. Introduction

It is generally acknowledged (Ellis, 2002; Gay, 1988) that foreign (second) languages are most effectively learned in a context that is meaningful and interesting for the learners. This key fact makes language teachers and methodologists think carefully about the importance of the context in terms of a perceived sense of authenticity or real-life implications within the learning process. The effectiveness of the usage of a second language as a medium to convey informational content of interest and relevance to the learners has become a rationale underlying content-based, second language learning and teaching. Nowadays, the knowledge of foreign languages within contemporary society is commonly held in high esteem. There are many ways and possibilities to support foreign language teaching and learning, but one of them which is used

more and more often at lower and upper secondary and at the university level is the Content and Language Integrated Learning (CLIL) method.

2. Content and Language Integrated Learning Method

The Content and Language Integrated Learning (CLIL) method, coined in 1994 by David Marsh (1994), was further promoted by the European Union as an umbrella term to denote any classroom situation in which content and language are taught simultaneously. Amongst teachers, it is most common just to refer to this method as bilingual teaching. According to Marsh (2002), CLIL refers to situations where subjects, or parts of subjects, are taught through a foreign (target) language with dual-focused aims, namely “the learning of content, and the simultaneous learning of a foreign language” (p. 2). As the learning is simultaneous, students are exposed to the target languages without requiring extra time in the curriculum.

David Graddol (2006) described CLIL as,

[A]n approach to bilingual education in which both curriculum content (such as science or geography) and English are taught together. It differs from simple English-medium education in that the learner is not necessarily expected to have the English proficiency required to cope with the subject before beginning study. (p. 86)

As CLIL teaching focuses on both the content and the target language, it therefore requires collaboration between subject teachers and the language teachers, as well as new kinds of pedagogical practices and interactive approaches to be used with carefully designed learning tasks.

3. ICT in Teaching Mathematics and Languages

Technology offers teachers many opportunities to use multiple learning tools in the teaching and learning process, and the use of computers in education brings numerous benefits. In teaching mathematics, technology helps to visualise processes that cannot be done only with a piece of chalk on the blackboard. Dynamic and interactive mathematics learning environments have been developed to support the learning of mathematics through free exploration in a less constrained context. Certain software packages have interactivity and dynamism as key affordances. These are, according to Martinovic and Karadag (2012), especially suitable for enhancing learning and teaching with the technology of the essentially dynamic mathematics concepts.

In language teaching, computers have been used for more than 30 years. Nowadays, technological and pedagogical developments allow teachers to better integrate computer technology into language and mathematics learning processes. Multimedia programs incorporating speech-recognition software can immerse students into rich environments for language practice. Various mathematics and language software titles can create suitable environments for

individual work and student self-study. The development of the Internet has allowed students to investigate language use in an authentic, multimedia context, to communicate in the target language, to access textual and multimedia information, and to publish for a global audience.

But, how do we use computers effectively and not divert students from the essence of the subject matter? This is explored in many studies and research works. We can name, for example, the works of Kutzler (2003) or Healy and Sutherland's work (1990). This is closely connected with a sophisticated use of computers which can lead to even more complex questions: Is it possible to reach the situation where computer technologies would, generally speaking, enable students' individual exploration, and would it be beneficial in the development of their creativity and invention? Can computer technologies help with the actual creation of a conceptual structure in learning? (See, for example, the works of Balacheff & Kaput, 1996; Balacheff et al., 2006; Binterová & Fuchs, 2010).

The development of psychological aspects of learning resulted in applications of new teaching methods and approaches that were designed to respect the personalities of people and their individual cognitive styles, self-knowledge, and cognitive situations. These factors should be taken into account in the use of modern technologies in the teaching and learning process. This is investigated, for example, in studies done by Pitta and Christou (2008) who focused on the influence of dynamic geometry on the cognitive styles of students. Davis and Simmt (2003) verified that learning in a classroom represents a complex reality and the implementation of technologies into the learning process could bring even more complexities.

All of this is closely connected with the necessity to define new representations and ways of mathematical modelling in a computer-assisted teaching process that influences the mathematical thinking of students. In connection with the teaching environment, Papert (1998) explained that the computer-assisted teaching environment is a "micro-world," a place where computers can have an impact on children who are being provided with meaningful experiences. In this environment, children have free access to, and control of their own learning experiences, children and teachers learn together, teachers encourage peer tutoring, and students can increase their knowledge and develop their mathematical thinking. Edwards (1995) emphasised how that the micro-world experiences are built on the pre-existing knowledge of students. Effective teachers provide their students with technology-rich spaces wherein they can explore and realize their ideas, verify mathematical theorems, and also check their own hypotheses (Mousoulides & Philippou, 2004).

Information and communication technologies may have a facilitative impact on concept creation, and may therefore positively influence the achievement of learning goals. To utilise new technologies for the creation of a good learning

environment for students in mathematics and the teaching methodology of mathematics, it is necessary to secure relevant competencies for teachers. In education, it is not always true that the utilisation of modern technologies in lessons equals effectiveness. Rather, the utilisation of modern technologies in accordance with the right teaching principles in lessons can increase the probability of effective learning.

The results of the research investigations entitled, *Interactive Whiteboards, Pedagogy and Pupil Performance Evaluation: An Evaluation of Schools' Whiteboard Expansion* (Moss et al., 2007), show that teachers do not, at the moment, possess expertise in creating well-balanced and methodologically correct teaching materials. Their materials lack comprehensibility and simplicity for use in individual work. As information and communication technologies may have a positive impact on the teaching of mathematics and the learning processes of students, many countries have implemented within their educational curricula a requirement for the maximum utilisation of technology (Hennessy, Ruthven, & Brindley, 2005). This implementation is not easy, as there are many influencing factors at play. These factors are, for instance, the attitude of teachers towards the implementation of new technologies, their concerns about the innovative process, the readiness and further education of teachers, and the choice of suitable programmes and interactive materials for successful implementation (Hennessy et al., 2005). Gibson (2001) says that technology itself cannot really change anything.

4. Students' Perceptions of the Educational Climate

Why is this research focusing on educational climate? It is important to realise that the classroom is a social environment in which students spend many hours during their schooling, and so gain many experiences. For this reason, the social quality in the classroom is important for forming students' feelings, and their attitudes to their peers, to their teachers, to the school subjects, and also to education itself. The time spent in school is a way of learning and of acquiring social experiences which serve as a basis for character development, attitudes towards life-long learning, and future employment in society (Lambert & McCombs, 1998; Lambert, Abbott-Shim, & McCarty, 2002). A necessary, but not solely sufficient, condition for learning is to create the right social climate. This positive climate is formed by mutual relationships between the student and their teacher, and between fellow students, and is derived from a combination of the quality of these relationships, student motivation, and student performance (Fraser, 1986).

The aim of this paper is not a complete definition of all of the relevant terminology. However, it is necessary to define educational climate, as it is understood, perceived, and presented in this research. Mareš (2000) understands school climate as a "set of ways of perception, experiences,

evaluation and reactions of all school participants to what has taken place, is taking place and is to take place in the school environment” (p. 242). This definition is a starting point for our definition of educational climate, which we characterize as a social phenomenon. From the content point of view, it includes the perceptions and experiences of students and their evaluation of the situations happening during the teaching and learning process. We understand the educational climate during lessons of mathematics as a certain quality of the school environment, the life-space of students formed during mathematics teaching and learning. Students perceive these processes in their own way, and they react to them and can characterize them together with the environment wherein they experience the processes.

The adjective “social” is linked with the characteristics of the psycho-social environment in educational establishments. Empirical studies and international comparisons show that there are significant differences between schools regarding their social climate (Allodi, 2007). Research has verified that school climate significantly influences students’ school achievement and even their employment after graduating from school (Rutter, 2000). Fraser and Tobin (1991) stated that classroom climate may be influenced by students’ behaviour, the level of knowledge in the school, students’ study results, their motivation in cognitive fields, and their attitudes to education itself. If the classroom climate is unfriendly, then anxiety, restlessness, and scepticism may appear, leading to intellectual and cognitive depression. On the other hand, in classrooms where the climate is positive and friendly, there is evidence that the abilities and achievements of students are higher (Grecmanová, 2008, p. 63).

5. Research Purpose

The research presented in this paper was conducted during the years 2009-2011 in three elementary schools in mathematics lessons presented in the English language using the CLIL method, within a project supported by the European Union called *Interconnection of a Foreign Language and a Content School Subject in Elementary School*. The project followed, in the authors’ opinion, the successful experimental teaching of mathematics in English in one of the participating schools in October 2006 (Šulista, 2012). The experimental teaching was designed to explore how the implementation of the CLIL method in mathematics lessons was possible, and if it would be well-accepted by students. The evaluation of the experimental teaching came with the following opinions of 49 students:

- 62% of the students stated that they liked the classes of Mathematics in English;
- 53% of the students thought that they had understood everything involved in the lesson concerning English;

- 16% of the students thought that they had understood everything involved in the lesson concerning mathematics;
- 24% of the students would like to continue with mathematics in English;
- 20% of the students would like to have more subjects in English; and
- 73% of the students thought that they had learnt many interesting and useful words and phrases apart from mathematical ones.

This experimental implementation showed that the majority of the participating students liked mathematics lessons in English. The analysis of study results made after experimental teaching in both the mother tongue (Czech) and the target language (English) also showed that the target language does not have a negative impact on the students' acquired knowledge of mathematics. The students who received teaching in the target language did not achieve statistically worse results than their counterparts who received teaching in their mother tongue. However, the experimental teaching results do not imply anything about the educational climate.

The research sought to explore the perceptions of students regarding the two types of mathematical learning environments. Our research design, which was both quantitative and qualitative in nature, focused on the difference in students' learning in classes during an implementation of the CLIL method, supported with an interactive environment in mathematics lessons, and the learning of their counterparts during traditional mathematics lessons presented in their mother tongue, at the lower-secondary educational level.

The aim of the research study was to analyse, compare, and describe educational climate in mathematics lessons presented in a foreign language (English) by the CLIL method at elementary school level and to determine the difference between this educational climate and that found in mathematics lessons presented in the students' mother tongue (Czech). This research was designed to test our hypothesis, based on our previous experimental teaching, that the teaching of mathematics in a foreign language by the CLIL method is evaluated by participating students in a positive light, and to uncover significant differences regarding the students' and teachers' points of view on the learning effectiveness of each approach. It was also meant to identify possible causes of these differences, and to reveal if the implementation of the foreign language and the use of the interactive environment in mathematics lessons were viewed as meaningful and significantly improving the effectiveness of learning. The posed research questions were formulated as follows:

- Do students perceive mathematics and English separately (in the way described by Dreesmann (1982, p. 129))?
- Are students aware of the possible benefits of these subjects for their future lives?

- Do students perceive mathematics presented in English as a difficult subject full of theories and formulae, made more difficult by the environment of the foreign language? and
- Are students sufficiently motivated during such educational processes?

6. Research Methodology

The pilot research was conducted in June 2009 with 55 students from Grades 5 and 6. The aim of the pilot research was, above all, to verify if:

- students understood well the instructions regarding the work with the questionnaire and tests;
- the tests used were valid;
- students understood well the questions posed, and if only suitable questions had been chosen; and
- students were willing to co-operate in the research and to identify their attitudes towards the research.

The conducted pilot research met its purpose and verified the functionality of the research tools and comprehensibility of prepared teaching materials. Any revealed mistakes and insufficiencies were corrected or removed.

For the research purposes, each of the participating classes was divided into two separate groups. In one of the groups, mathematics lessons were presented in the traditional way as had been done in the past, and as described in the following section; while in the other part of each class, mathematics lessons were conducted in English by the CLIL method. The requirement was that the teaching of mathematics in English had to be conducted at least four times per month.

The research involved several research methods. One of these was a questionnaire designed for the investigation of the learning climate within a natural sciences subject (Grecmanová, 2008, s. 184). The questionnaire consisted of 26 statements to which respondents expressed their attitude on a 5-point scale (1-always, 2-almost always, 3-sometimes, 4-almost never, 5-never). For evaluation purposes, particular statements were divided into the following seven categories:

- K1 – teacher’s enthusiasm and skill to capture students’ attention;
- K2 – non-traditional way of teaching;
- K3 – support of students;
- K4 – just approach;
- K5 – meaningfulness of learning;
- K6 – adequacy of requirements; and
- K7 – clear presentation.

Other methods used in the research study were long-term observations of 10 particular lessons in each of the participating schools, video-recordings of 18 chosen lessons, and interviews with the teachers and the students. The students’

attitudes were investigated with the questionnaire, and afterwards their answers were analysed using tools of descriptive statistics for testing hypotheses, in particular the non-parametric Mann-Whitney Test.

6.1 Research Environment

The research was conducted twice, first in September 2010 and then in June 2011, within six classes in Grades 6-8 (243 students in total), at three elementary schools, which closely co-operate with experts from the field of the methodology of mathematics and the CLIL methodology. Nine participating teachers were involved in the study. Groups of classes where Mathematics was presented in English by the CLIL method were denoted as group **M/A**, while the other groups, where mathematics was traditionally taught in Czech, were denoted as group **M**. The mathematics lessons covered the following topics: Natural Numbers, Decimal Numbers, Fractions, Triangles, Powers and Roots, Pythagorean Theorem, Polynomials, and Systems of Linear Equations.

In both groups, the number of girls and boys was evenly distributed. Helmke and Weinert (as cited in Grecmanová, 2008, s. 69) present in their research studies that the number of girls in a class significantly influences the classroom climate in most school subjects (the more girls in a class, the more positively the class climate is evaluated). However, Helmke also admits that there is a difference in lessons of mathematics. Girls consider the teaching of mathematics as less comprehensible and therefore they do not experience so many friendly relationships, nor hopes for success.

In all three participating schools there were no significant differences in teaching styles and working methods. The students sometimes worked on various projects, but the teachers did not intervene actively in lessons of mathematics and their organization. Also, the use of ICT was limited, as well as activating teaching methods, experiment methods, or problem-solving methods. In both of the schools, the education process could be denoted as purely transmissive. Teaching styles of the teachers could be described as authoritative, or tolerant-authoritative.

The teaching materials that were prepared within the above-mentioned project were written in English in cooperation with native speakers, and were created to be used on Interactive White Boards (IWBs). A methodological guide was prepared for each piece of material. The teaching was designed to take into account the motivation phase of the concept creation process as much as possible, and, at the same time, to take advantage of the interactive features of the IWBs and mathematical software, such as GeoGebra, to the greatest extent. According to Balacheff and Kaput (1996), an excessive use of modern technologies may negatively affect students' ability to acquire the mathematical "craft" (see also Balachef et al., 2006; Binterová & Fuchs, 2003). For this reason, the utilisation of computers and other technologies during the implementation

of the CLIL method in mathematics lessons was carefully planned and the teacher/student use of technologies, and the effects of this usage, was observed with great interest by the researchers in light of Balachef's claims. The use of technology in the mathematics lessons, delivered in English, was originally meant to eliminate unnecessarily long calculations, constructions, etc., which could divert the pupils' attention from given concept explorations. As we shall see, however, the use of the technology had much greater affects on student learning, communication, and attitudes than merely providing a powerful calculation tool.

6.2 Experimental Teaching of Geometry with GeoGebra

GeoGebra, the free, open-source mathematics software primarily designed for math classrooms in secondary schools, was used by pupils from group M/A in lessons of mathematics in the English language environment. If necessary, pupils could change the language environment back to the Czech language. As mentioned in the section about ICT and the research environment, the use of computers and other interactive tools can be complicated and therefore the effort was to use it reasonably to the greatest extent without impeding pupils' acquisition of the mathematical "craft".

GeoGebra can well simulate geometric functions, as constructions benefit from dynamic illustrations of the given geometrical phenomenon. For example, one can change geometric figures while keeping the same mutual relationships between algebraic, numeric, and geometrical objects involved. This powerful feature can help teachers to demonstrate more effectively, and students to explore more creatively, several of the traditionally separated models of mathematical phenomena at the same time. Paper-and-pencil sketching or chalkboard representations could never allow for this kind of mathematical modelling. We should also mention that the use of IWBs and software can positively affect the language side of the teaching regarding both precision of the mathematical calculations and also the English language component.

The example presented in Figure 1 covers the mathematical topic *triangles*. The aim of the lesson was to introduce the concept of *height* in triangles. Making similar constructions in traditional workbooks seems less effective in developing the concept than is possible with the use of "dynamic geometry software" (DGS) that enables students to manipulate geometric shapes and figures and to illustrate the properties of the height in obtuse triangles. The aim of the activity was to discover a new piece of knowledge and to explore mutual laws connected with it. Students worked with the tool "Relation between Two Objects" enabling them to determine and to name the mutual location of lines a and b and to construct other heights in a triangle, selecting commands from the tool menu available both in the English or the Czech language environment.

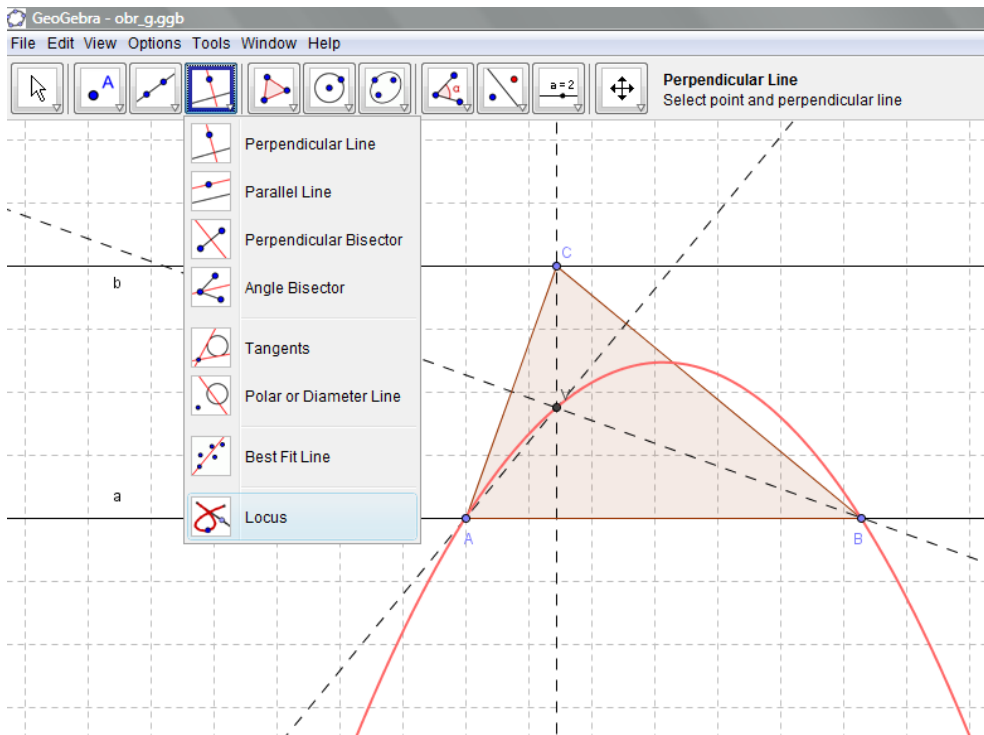


Figure 1. GeoGebra used in lessons of mathematics presented in English

Then, students were asked to construct the intersection of heights V and to move with vertex C alongside line b . They were asked the question, What is the shape of the curve made by the movement of intersection V ?

This task is very difficult to solve without the help of the computer. GeoGebra enabled students to create a new dynamic image of newly discovered concepts. Using the tool *Locus* after tracing point V , students explored the newly discovered concept of the parabola.

6.3. Data Collection

The research data that was collected included marks in Mathematics and English in September 2010 and in June 2011, results of continuous tests, and data from the questionnaires. Primary evaluation used the obtained data for descriptive statistical analysis that enabled us to formulate hypotheses, which were later verified using relevant statistical software such as SPSS or Statistica. Graphical outputs were created using the program environment "R-2.13.0." Dependent variables were the English language and the use of ICT. Independent variables were pupils' knowledge, the relationship to mathematics, and the effectiveness of learning. This paper deals solely with the effectiveness of learning, based on data that was obtained from questionnaires given to 175 elementary school pupils in six classes of Grades 6-8. To make a legitimate comparison, a sample of the obtained data was limited only to those classes where there was only one teacher teaching both in Czech and in English. Group M/A consisted of 78 pupils; group M consisted of 97 pupils.

7. Research Results

The obtained data from the questionnaires were analysed in order to explore if there were significant differences in pupils' evaluation of the learning climates of groups M/A and of groups M. The results are presented in Table 1 and Figure 2—the lower values, the better evaluation of the given climate category. Both groups positively assessed clear presentation, adequacy, and enthusiasm of teachers (average values 1.84, 1.96, and 1.92), and rather negatively non-traditional ways of teaching (average value 2.77). Detailed analysis of the answers of particular categories is presented in Binterová (2012).

The null hypothesis formulated was that the answers of pupils in both groups have the same distribution, while the alternative hypothesis says that the distribution is not the same. The testing was conducted separately for each category of learning climate, at a significance of $\alpha=5\%$. The obtained results are presented in Table 1.

Table 1: Evaluation of questionnaires concerning educational climate.

Educational Climate Categories	M/A	M	Deviation M/A from M	p-value
K1 – enthusiasm	1.92	2.46	0.54	0.000002
K2 – non-traditional way of teaching	2.77	3.09	0.32	0.003735
K3 – support of pupils	2.08	2.52	0.44	0.000211
K4 – just approach	2.06	2.65	0.59	0.000004
K5 – meaningfulness of learning	2.2	2.57	0.37	0.000671
K6 – adequacy	1.96	2.34	0.38	0.004794
K7 – clear presentation	1.84	2.12	0.28	0.003732

The calculated p-values show that in all seven categories we have to reject the null hypothesis and accept the alternative one. This means that in all seven categories the distribution is different. The mean values of answers of students from groups M/A are in all categories significantly lower (are better evaluated). Therefore, we can assume that the educational climate is perceived by these groups of students as being significantly better than was perceived by the other groups.

Observations in lessons and analyses of video-recordings revealed that pupils in the M/A groups were more motivated and more active in particular lessons than those in the M groups. Teachers in mathematics lessons presented in English with the CLIL method used more activating methods and communicated more with their pupils. The examining and testing of pupils in

groups M/A showed less formalism and these pupils were directed not only to find the right solutions, but also to discuss and defend their ways of solution with their peers.

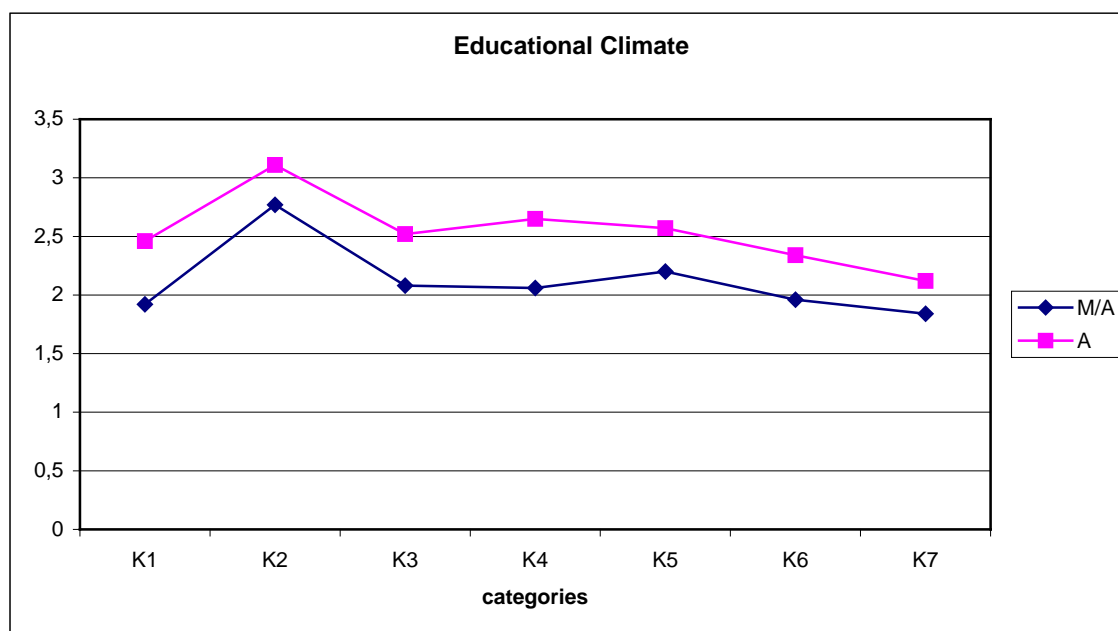


Figure 2. Average values of educational climate assessment by pupils

The observations also revealed that at the beginning of the implementation of the CLIL method, the communication in English was only limited, as there was apparent uncertainty and fear among students caused mainly by a lack of their knowledge of the new mathematical terminology which was reflected in primary obstacles in understanding the presented mathematics subject matter. However, during the experimental teaching within the different teaching environment, in comparison, the mathematics lessons presented in Czech, supported by ICT and a more cautious and careful approach adopted by their mathematic teachers, the students' concerns were significantly mitigated.

The participating students from group M/A stated in the conducted interviews that they saw the importance of the knowledge of English in their future life and that they did not perceive mathematics presented in English to be more difficult than mathematics presented in their mother tongue. Here are a few of their opinions (see also Binterová & Šulista, 2011):

- "It is good that I can practise my English. I like working with a laptop in mathematics lessons. I can learn new English words and I can explore new things with my classmates."
- "I like mathematics. Lessons are funny and not boring. Mathematics in English is good and I really like it."
- "It is one of my favourite subjects, it is funny and I can learn English well. I like very much doing geometry on a laptop."

The teachers of groups M/A used ICT support to a greater extent than did teachers of the groups M. This was caused mainly by the fact that teachers in the CLIL mathematics lessons used IWBs to also present new vocabulary and problem assignments using implemented voice recordings created by native speakers of the English language and implemented using a remote testing (voting) system which was used at the beginning or at the end of almost every lesson.

8. Conclusion

The qualitative and quantitative data analysis of this research implementation, indicates that the educational climate in lessons of mathematics presented in a foreign language (English) and supported with modern interactive technologies, is statistically significantly better than in the case of teaching the same mathematical subject matter in a mother tongue (Czech) without the use of computers and other interactive technology-based means. The learning climate in CLIL lessons was more positively perceived by students, in all its aspects and in all categories.

Analyses of video-recordings, observations, and questionnaires of the teaching process in CLIL lessons indicated more activating methods, an increase in students' activity, and more intensive communication between teachers and their pupils. Students in the M/A groups were more motivated and more active than their peers undertaking the same lessons of mathematics presented in the mother tongue and without a similar in-depth use of technology. Assessment seemed to be less formal with the M/A groups, and pupils were not directed solely to find the right solutions, but also to make comments on the solutions, and to defend their solutions and to discuss other possibilities of solving the mathematical problems.

Novotná and Hofmannová (2000, p. 228) claimed that the CLIL method in mathematics lessons is closely connected with the active engagement of pupils in the more general educational process. Their research included the use of a scale of non-verbal communicative means, various forms of representation (visualization, modelling, schematic and symbolic representations, and graphic organisers, etc.), interesting practical and attractive choices of subject matter, and suitable choices of organisational forms of teaching.

The research findings presented here support these former claims, as students undertaking lessons of mathematics in the English language, supported with interactive technologies, worked significantly harder and demonstrated a better understanding of new mathematical concepts. This way of teaching helped pupils to build their self-esteem regarding their ability to communicate and to use a foreign language practised in real situations within lessons of mathematics. For this reason, we contend that such teaching is meaningful and helps to create a positive educational climate wherein interactive ICT features of

the educational process are well received by students and contribute to the overall effectiveness of the lesson.

Interviews with the involved teachers, as well as our own researcher observations, indicate that there seems to be a noticeable change in teacher beliefs and skills in terms of the teaching process. Teachers are looking for highly engaging teaching methods, and they do not fear working with new interactive environments and in this way they fight against teaching stereotypes and routine instruction. The initial concerns expressed by the involved teachers that such teaching would discourage pupils who do not like mathematics, and that it may negatively influence the climate of the lessons have turned out to be unfounded.

For more generalizable conclusions, further research of the same nature should be conducted at various educational levels, as this research was conducted only on the sample of 180 students in three elementary schools. There are still unanswered questions concerning the essence of school climate as a dynamic social phenomenon. Even though it can be concluded that this research experiment was beneficial, not only for the participating students and their teachers, but also for other teachers in the schools involved and for the school management, we are hopeful that similar approaches to mathematics and language learning will be adopted on a larger scale.

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Helena Binterová is an associate professor at the University of South Bohemia in České Budějovice, the Czech Republic, where she lectures in Mathematics and Methodology of Mathematics. Her research interests include the educational environment, educational climate, and the use of modern technologies in mathematics lessons.

Marek Šulista is an assistant professor at the University of South Bohemia in České Budějovice, the Czech Republic, where he lectures in Mathematics, often using English as the second language medium. His main research interest is in the application of the CLIL method in teaching mathematics at the secondary education and university levels.