1. Introduction

According to the TIMSS and PISA results, the motivation of Czech pupils in education and their relationship to mathematics is worsening. The question is whether we prepare our pupils for the past or for the future. The future is the multicultural, developed and globalised information society. Pupils who enter the educational system come from a society which will already be in the past at the time of their graduation. Globalisation influences all aspects of our lives, including education. For this reason, teachers are aware of the necessity of teaching elementary school pupils key competences, including communicative and working competences. These are closely connected to the ability to recognise the mutual linkage of everyday citizen situations with global problems, and the possibilities of creating our own living and working perspectives in European and global space.

The essential part of the European dimension is the education of future European citizens as responsible and creative characters, who are capable of mobility and flexibility in their citizen and working spheres and in their personal lives. The educational area, implemented within Framework Educational Programmes, which is important for the realisation of these aspects is called Language and Language Communication. The knowledge of foreign languages has a practical importance for both educational and working citizen mobility. It is a means that is necessary for the utilisation of original sources when learning about life and European and world culture.

The School Educational Programmes prepared in accordance with the Framework Educational Programmes may create the preconditions for applying various delivery methods or different timetables based on the teachers’ experience, with new instructional methods. One such method which elementary schools may apply to apply in their School Educational Programmes is the teaching of non-language subjects in foreign languages (referred to as CLIL\(^1\)). As the learning is simultaneous, pupils are exposed to the target languages without requiring extra time in the curriculum. The aim of this teaching is to develop knowledge of the content (non-language) subject and at the same time, exposure to a foreign (target) language helps pupils develop their knowledge of this foreign language.

This paper presents research conducted at elementary school level in the years 2009-2011 in three elementary schools in Mathematics lessons presented in the English language within a project supported by the European Union called The Interconnection of a Foreign Language and a Content Subject at Elementary School Level\(^2\). The project followed the experimental teaching of Mathematics in English in one of the participating schools in October 2006 (which was successful in the author's opinion). This research focused on the pupils’ perception of mathematics in the CLIL environment before and after one year of CLIL teaching at the elementary school level.

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\(^1\)This refers to any dual-focused educational context in which an additional language that is not usually the first language of the learners involved, is used as a medium in the teaching and learning of non-language content. Thus, it could be used to refer to a classroom in which a foreign language teacher instructs learners on non-language subject content in a foreign language. Equally, it may apply to a situation in which a subject teacher uses an additional language, to a greater or lesser extent, as the medium of instruction in any specific lesson” (Langé, 2002, p. 11).

\(^2\) Project No. CZ.1.07/1.1.10/02.0073
2. Research Questions and Methodology

As has been mentioned, the motivation of Czech pupils in education and their relationship to mathematics is worsening and, at the same time, the School and Framework Educational Programmes create the preconditions for applying various delivery and instructional methods such as CLIL. This leads to the question of whether the teaching of mathematics in a CLIL environment implemented in the elementary school curriculum may positively influence pupils’ perception of mathematics and make it more interesting for them. Furthermore, is the CLIL method a motivating element for elementary school pupils? The presented research should reveal, at least to a certain extent, answers to these questions. The research is based on evaluation of questionnaires submitted by the elementary school pupils involved in the project, as well as interviews with them. Semantic differential was chosen as the appropriate research method for evaluating the questionnaires.

3. Research Environment

The research was carried out in classes in which CLIL was gradually implemented in at least one lesson of Mathematics per week, during one school year. The research compared the questionnaire answers of the involved students before and after its implementation. The research data were obtained from questionnaires, prepared for the semantic differential evaluation, given to 280 elementary school pupils in six classes of Grades 6-8.

Pre-research analyses based on observations in Mathematics lessons showed that in all three participating schools there were no significant differences in teaching styles and working methods. The same can be said about the experience with teaching by the CLIL method, as none of the teachers and their pupils in any of the schools had ever experienced this type of teaching before. The pupils sometimes worked on various projects, but they 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 as defined, for example, in (Maňák & Švec, 2003) or in (Hejný, 1989).

Within the mentioned project, the dual-focused experimental teaching covered the following mathematical topics and developed the following language skills:

- **Mathematics topics:** Fractions; Natural Numbers; Roots and Powers; Angles; Pythagorean Theorem; Triangles; Circle; Percentages.
- **Language skills:** making comparisons; talking about numbers, numeric values and quantities; posing questions; expressing the past, the presence and the future; using imperative; describing shapes.

The created teaching materials prepared within the above mentioned project and covering the mentioned mathematical topics and language skills have been made in English in cooperation with native speakers and created to be used on interactive smart boards. A methodological guide has been prepared for each piece of material. The teaching has been 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 interactive smart boards and mathematical software, such as GeoGebra, to the greatest extent. The teaching was designed in such a way that it considered to the greatest extent possible the motivation phase of the process of concept development and, at the same time, enabled teachers to use interactive elements – computers with the mathematical software GeoGebra and interactive whiteboards. The use of computers in mathematics lessons in English was mainly to eliminate unnecessarily long calculations, constructions etc., which could divert the pupils’
attention from the real understanding of the given matter. However, this use was limited, so as not to eliminate essential "craft mathematical skills" that are so valued today (Binterová & Fuchs, 2003).

4. Semantic Differential

The research focusing on the pupils’ perception of mathematics in the CLIL environment before and after one year of CLIL teaching at the elementary school level is based on the confrontation of the basic concept of Mathematics with other accompanying conceptions. The set of these conceptions was chosen very carefully in order to be clear to pupils and not to be too extensive. Moreover, the set had to cover sufficient space of semantic differential. It is a technique, described in detail for example in (Chráska, 2007) or (Osgood, C.E., Suci, G., & Tannenbaum, P., 1957), to measure the meaning of concepts, opinions and attitudes. Although meaning can be viewed and interpreted from various perspectives (linguistic meaning, sociological meaning, relational meaning), the semantic differential explicitly focuses on the observation and measurement of the psychological meaning of concepts. This meaning concerns a person’s subjective perception of and affective reactions to a stimulus. The stimulus itself, also known as concept, in a written form can either be a noun, verb or a noun phrase.

To measure the meaning of the concept, the semantic differential uses a list of bipolar scales. Here, bipolar refers to the use of a pair of antonyms, i.e., two scale anchors that are opposite in meaning. In their simplest form, each of the bipolar scales that make up a semantic differential merely consists of this antonym pair, which are usually two adjectives. In practice, however, bipolar scales in this format may not be sufficiently descriptive for rather complex concepts. Instead, researchers may develop more elaborate bipolar scales by combining the two antonyms with several other words such as nouns and verbs to formulate contrasting phrases, in which the antonyms still remain the only two words that are opposite in meaning (e.g., difficult to use website – easy to use website; complex interface – simple interface). Both theory and empiricism support the adoption of the semantic differential. Theory presents the semantic differential as one of the most appropriate techniques to assess the intensity and direction of the meaning of concepts in general, and of complex and multidimensional concepts in particular.

For the research purposes, the basic concepts of Mathematics and English were confronted, in the questionnaires, with conceptions such as world, I, future, love, learning, family, life, school, obligation, teacher, wealth, mother tongue, game, boredom etc.

The bipolar adjectives were taken from work by Osgood presented in (Chráska, 2007). These adjectives were:

- evaluation factor: necessary–unnecessary, simple–complex, nice–ugly,
- potentiality factor: smooth–rough, narrow–wide, strong–weak,

The set of accompanying conceptions could be divided into three groups:

- connected with the future: I, world, future, love, family, life,
- connected with school: school, teacher, learning,
- others: obligation, wealth, mother tongue, game, boredom.

When constructing the questionnaires, the order of the conceptions was designed in a way that the conceptions from the same groups are evenly distributed among the conceptions from the other two groups. It is important to mention that the questionnaires were purely in Czech to avoid any misunderstanding. Before pupils started filling in the questionnaires they had been instructed to decide about the position between each pair of adjectives according to their personal feelings about the given concept.
5. Research Results

The obtained data from the questionnaires were analysed in order to explore the mutual relationship between the chosen conceptions. The results of the analysis are represented by the following two dendrograms created by Šery (Figures 2 and 3), which are tree diagrams frequently used to illustrate the arrangement of the clusters produced by hierarchical clustering, where clusters at one level are joined as clusters at the next level. However, the semantic plan is, in reality, three-dimensional, so dendrograms are used as an alternative two-dimensional visual means.
6. Conclusion

The conducted analysis, partially visualised by two dendrograms, show that there are some similarities as well as differences in the pupil’s perceptions of mathematics before and after CLIL implementation. It is important to say that the more to the left the items are connected together in the dendrograms, the more closely and positively are these items perceived by the respondents. The similarity is the fact that fear and boredom are in both cases separate from the rest of the conceptions and that learning, school, Mathematics, English, teacher, work, obligation and understanding form a "school" cluster.

On the other hand, an extensive cluster containing game, future, love, family, life, world, and mother tongue was created, which is then connected more on the left with the "school" cluster after implementation (Figure 3). This could be interpreted that CLIL implementation causes the pupils to start to perceive the conceptions making up these two clusters more closely and more positively than before (Figure 2).

The analysis of the answers also showed that positive adjectives (e.g. nice, happy, smooth) in the questionnaires given to the pupils after the CLIL implementation were closer to the concept of Mathematics and this fact is considered as a sign that pupils perceive mathematics presented in English more positively than before the CLIL implementation. This is also supported by interviews with the pupils which showed that, after the implementation of CLIL, mathematics is perceived by pupils more positively and as necessary, not too complex and is regarded as fun.

The pupils also stated that they saw the importance of the knowledge of English in their future life and 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 (more opinions can be found in (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."

• "I like mathematics. Lessons are fun and not boring. Mathematics in English is good and I really like it."

• "It is one of my favourite subjects, it is fun and I can learn English well. I like very much doing geometry in a laptop."

For all the above mentioned findings, we dare to say that the CLIL environment may be considered as a motivating element positively influencing pupils’s perception of mathematics. Moreover, elementary school pupils think that a foreign language used as a language of instruction in Mathematics lessons makes these lessons more interesting and meaningful.

REFERENCES


RÉSUMÉ

Přispěvek se zaměřuje na výsledky výzkumu provedeného na 3 základních školách ve výuce matematiky v anglickém jazyce. Cílem výzkumu bylo odhalit, jak žáci vnímají matematiku v prostředí CLIL. Jako výzkumná metoda byl zvolen sémantický diferenciál a výsledky byly vizualizovány pomocí vytvořených dendrogramů. Výzkum ukázal, že výuka matematiky vedená v anglickém jazyce byla vnímána pozitivněji a vůbec ne složitěji, než matematika vedená v mateřském jazyce, tedy v češtině.

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