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MULTIPLE INTELLIGENCES ACTIVITIES IN CLIL LESSONS OF MATHEMATICS IN ENGLISH AT UPPER SECONDARY SCHOOL: STUDENTS' INVOLVEMENT AND LEARNING OUTCOMES

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PREFACE

Content and Language Integrated Learning (CLIL) is an innovative educational approach which is gaining popularity in Estonian schools. It is believed that CLIL improves the target language competence, increases students' motivation and contributes to the learning of a subject.

Mathematics, as a core subject, belongs to any Estonian School curricula, although Mathematics taught in English is a relatively new approach in schools of Estonia. Therefore, the biggest issue CLIL teachers of Mathematics face is teaching students how to operate the target language in terms of solving Mathematical problems, to teach them to think, talk and write like mathematicians.

In order to help students acquire the content of the subject of Mathematics and obtain the English language mastery at the sufficient level according to the Estonian National Curriculum for Upper-Secondary Schools, the theory of Multiple Intelligences (MI) is taken as a basis to develop learning and scaffolding activities, as this theory has a strong psychological and scientific background in developing specifically those intelligences that are needed in the CLIL class of Mathematics.

The research is focused on the analysis of a present day situation with CLIL teaching in Estonian Schools with respect to the content area and the volume of CLIL teaching; the aim is to reveal how the use of student-centred teaching, and the use of multiple intelligences activities in particular, support involvement into content studies, and to develop a set of MI activities for teaching Mathematics in upper-secondary school and analyse their impact on students' content and language integrated learning.

The paper consists of the introduction, two chapters and the conclusion. The introductory part places the present research in the context of the National Curriculum of Estonia for Upper-Secondary schools regarding the subject of Mathematics. Chapter I "CLIL Student-Centered Teaching: Multiple Intelligences" reveals the main concepts and notions of Content and *Langu*age Integrated Learning as a student-centred teaching approach and the theory of Multiple Intelligences with the overview of the features of both. Chapter II "Involvement in CLIL Classes of Mathematics in Upper-Secondary School: MI Activities" introduces the patterns of MI activities to be used in CLIL lessons of Mathematics at Upper-Secondary Schools in Estonia with the purpose to raise students' involvement into in-class activities and achieve results both in language and content competences. The conclusion sums up the outcomes of the research and gives comments on the hypothesis.

PREFACE

Contents

INTRODUCTION

Estonian Context of CLIL

The Content and Language Integrated Learning (hereinafter CLIL) approach firstly appeared in Estonia in the early 1960s. It was brought from other countries, such as Norway, Finland or even other continent – Canada, and its province Quebec in particular, where the majority of population is at least bilingual, but most commonly multilingual. The country of Estonia belongs to the list of multilingual countries, with the official language – Estonian and other languages of minorities living within the country: the Estonian society consists of ethnic Estonians (circa 68 percent), ethnic Russians (approximately 26 percent) and Ukrainians (comprise 3 percent of the whole population). Next to that, there are more than 120 ethnic groups in Estonia who claim their mother tongue to be different from the official language of the Estonian State, which is Estonian (Asser et al, 2007:52).

Inspired by the successful Canadian experience of implication of an early language immersion model into school curriculum, the Estonian Ministry of Education decided to try a similar programme in case of the Estonian language in Russian language medium schools. At that time, the Russian language was commonly used at schools as the medium of instruction, and English was basically used only in several private schools, such as Tallinn English College. Nevertheless, this newly implemented language immersion programme was successful, and the Ministry of Education in Estonia decided to continue using this educational model for three different target groups: early total immersion programmes starting from kindergarten, early partial immersion programmes starting from 1st grade of school and late immersion programmes, which are basically separate language courses (Tampere, 2010:13). Although the curriculum in the majority of Estonian universities is taught in Estonian, they are not considered to be late immersion programmes, as it is assumed that by the time students apply to study at an Estonian-language tertiary study programme they are expected to have a sufficient Estonian language proficiency level, corresponding to B2 level, or the Independent User level of the Common European Framework of Reference (CEFR, 2014:59).

With the success of the language immersion programme, it was decided to try CLIL as an innovative educational approach in schools in Estonia. At the beginning CLIL programmes were used for a number of elective subjects in both Estonian language medium and Russian language medium schools, such as Literature or Culture, starting from grade 6 to grade 12. With the process of globalization becoming more topical, the development of the system of education, specific skills and competences were needed. In the 1990s, Russian speaking parents expressed much concern about the future of their children, so they insisted on the implementation of bilingual programmes into school curricula. The introduction of dual language instruction into school curricula was supposed to simplify the process of integration of Russian-speaking children into the Estonian-speaking society, with language immersion programmes being commonly perceived as extra valuable. As a result, by the year of 2000, a great amount of school subjects was taught in a target language, which was Estonian for Russian language medium schools (ibid.).

CLIL in Upper-Secondary Schools: The Content Area and the Volume of CLIL Teaching

According to the Basic Schools and Upper-secondary School Act and in respect with the decision of school's council and local government's approval, any language can be a language of instruction in municipal schools. As for state schools, the same approval must be given by school's council and the Ministry of Education and Research. There are neither other limitations or restrictions on the implementation of CLIL programmes into schools of Estonia, nor any standards of CLIL programmes – National Curricula guidelines are equally applied to any chosen language of instruction. The definition of "language of instruction" itself can be formulated as – a language that is used for at least 60 percent of curriculum per week. Despite the requirement of the National curricula, the number of subjects and hours of teaching can be changed, and it is based on agreements within schools offering such programmes, with the fact that there must be sufficient amount of competent teachers available taken into consideration (Asser et al, 2007:55).

As for the English language as the language of instruction, it is introduced to children starting from the 3rd grade in Estonian language medium and Russian language medium public schools as a foreign language (L3). Next to that, the CLIL approach is used in six upper-secondary schools in Estonia with the entirely English Curriculum; and in seven primary and secondary schools in Estonia as a part of extra-curricular activities. The content and the volume of a delivered curriculum in English must be based on guidelines of the school curriculum which, whereas, must correspond to the National Curricula of Estonia. In fact, compared to the two ways language immersion programme for Estonian language – early and late immersion, the English language programme has totally different paths – via a compulsory English language course in schools in Estonia as a standard course starting from 3rd grade; or as a part of a late immersion programme provided by public and private organizations, such as language courses aimed at obtaining a specific level of mastery in English (Asser et al, 2007:57). The recent research by Kaire Tampere (2010) shows that CLIL classes in Estonian schools are commonly delivered in English; for example, in 2004 there were eighteen schools in Estonia offering CLIL in English, next to five schools with CLIL in German and one school providing CLIL in French (Tampere, 2010:15). Yet, by the year of 2015 the exact number of schools in Estonia offering CLIL in English is debatable, as there is no official statistics of such schools provided by the Estonian Ministry of Education and Research and the Innove Foundation.

From the existing official statistics provided by the Ministry of Education and Research in Estonia in the year 2010, there were ten schools in Estonia, offering Content and Language Integrated Learning programmes in English for several subjects. By the year 2016, the number of such schools has increased, although it is still not completely clear to what extend the curricula of these schools are in the English language. According to Kaire Tampere (2010), most commonly, English is the language of instructions of those subjects which have the direct connection with countries where the target language is actually the official language: literature, history, economics et cetera, whilst the subjects related to the field of science: Mathematics, Physics, Chemistry – are not offered in the English language (Tampere, 2010:15). The question of content of CLIL in schools in Estonia is not the only one to discuss – another one is its accessibility.

According to the Innove Foundation (Organization, 2016: para 3), a state agency, which was established by the Ministry of Education and Research in 1997, Estonia is one of the best-performing countries in terms of education. Moreover, the Innove Foundation supports international students and adults by providing them with international foreign examinations, and development and integration of bilingual and multilingual education in kindergartens, primary and secondary schools in Estonia, by means of language immersion programmes. (Foundation Innove, 2016). Nevertheless, schools in Estonia, offering English-taught subjects are not accessible for any layer of society. In case of Estonia, such schools are considered to be prestigious, targeted on students belonging to upper-class society and supported financially and socially (Tampere, 2010:16). These assumptions can be made taking into consideration the entrance requirements and examinations of those schools, as well as other means of competitions among applicants.

Mathematics in CLIL

Mathematics provides fundamental tools for understanding such areas of study and research as engineering, sciences and technology. The distinctive features of the subject of Mathematics are the particular competences which give the general ability to solve various mathematical problems, which includes raising a problem, finding a proper solution or applicable solution strategies and the successful implementation of those solution strategies in order to verify the accuracy and reliability of the results. The following competences include: ability to use mathematical terms and notions; ability to analyse and differentiate; ability to think critically, rationally and logically; ability to use abstract thinking et cetera (Dale et al, 2012:68).

As CLIL is a content driven approach, according to Coyle (2010:1), the subject of Mathematics requires an extra attention specifically in terms of content, as Mathematics is a discipline in which non-verbal tools of communication, visual and graphical material, such as symbols, graphs et cetera are used most commonly. The subject of Mathematics includes less textual input than any other subject and the language is used in describing mathematical problems, finding solutions or explaining mathematical concepts (Dale, 2012:68). In terms of CLIL, it is important to mention that curricular content leads the process of learning, and only learning mathematical terms is not considered to be the CLIL approach or the process of learning per se. Learning Mathematics involves making a sufficient base for students to think like mathematicians: making hypothesises and finding solutions, proofs and confirming those hypothesises. (Cambridge ESOL, 2010:2). In order to achieve a particular level of mastery in both mathematical "language" and target language, the structure of the lesson must follow the guidelines and requirements made by the National Curriculum of Estonia for upper-secondary schools, where the subject of Mathematics belongs to the list of compulsory disciplines.

According to the recent issue of the Estonian Curriculum of Upper Secondary Schools, dated by the year of 2011, the present domain of Mathematics includes narrow Mathematics which consists of 8 courses, and extensive Mathematics, which consists of 14 courses. Both courses include "Numerical quantities", "Trigonometry", "Vector on plane", "Probability and Statistics", and "Functions". The extensive course of Mathematics includes the following topics next to the listed ones: "Limit and derivative of function", "Applications of derivative", "Integral. Review of planimetry" and "Applications of Mathematics and study of actual processes". Both courses differ not only by content but also by approach – the narrow course of Mathematics gives a brief overview of a subject per se in terms of understanding the world around us in a scientific manner, whilst the extensive course develops particular skills necessary to understand Mathematics as science (National Curriculum General Part 2011: § 8).

Regardless the volume of a course taught at school, teachers of both courses are expected to achieve particular levels of proficiency in English and mastery in Mathematics to be able to deliver curricular material to students. It is obvious that CLIL teachers of Mathematics face several challenges during the process of learning, as they are expected to teach learners the understanding of the essential mathematical concepts so they could use both language and content competences like mathematicians, not concentrating on terms or notions during the process. Another challenge is to provide a sufficient scaffold for students in terms of developing target language via the specific language of Mathematics. Taking into account the fact that lessons of Mathematics are mostly practical – which means that developing students' language competence is generally limited by teacher's explanations of the topic and giving instructions, it becomes difficult for CLIL teachers of Mathematics to create an opportunity for writing activities (Dale, 202:68-69). In other words, the present method of teaching is teacher-centred which conflicts with the concept of the

CLIL approach, and standard activities for an in-class work during the lesson of Mathematics, provided by the National Curriculum of Estonia, are not enough for learners to develop sufficient skills in both content and language. To reverse the focus from the teacher to the student, the theory of Multiple Intelligences (hereinafter MI) is to be implied in CLIL lessons of Mathematics in upper-secondary school. The main concepts of the theory of Multiple Intelligences are based on needs and requirements of a certain learner, therefore MI activities correspond to the student-centred approach, which satisfies the main concept of CLIL.

Taking into consideration all the facts and observations listed above, several assumptions can be made of what is to be proved from the research:

1. Most of CLIL teachers of Mathematics in Sillamäe do not use the theory of Multiple Intelligences in order to increase students' involvement and to help students achieve learning outcomes.
1. CLIL teachers of Mathematics focus either on the target language or on the content of a subject.
2. The Extensive Course of Mathematics in upper-secondary school requires the teacher of CLIL with higher competences both in language and content areas comparing to the Narrow course of Mathematics.
3. The MI activities correspond to the features of the CLIL approach in terms of student-centred teaching strategies, and are useful for upper-secondary school students and teachers participating in the present experiment.
4. The MI activities meet the demands of the Estonian National Curriculum and the requirements of the subject of Mathematics in particular.

Out of these assumptions and on the basis of the present research question the following hypothesis has been formulated:

Teaching on the basis of multiple intelligences activities in the CLIL class of Mathematics in English – with all types of MI students taken into consideration – increases students' involvement into both content and language studies and positively influences their learning outcomes.

CHAPTER I CLIL STUDENT-CENTERED TEACHING: MULTIPLE INTELLIGENCES

The process of learning is bilateral, there are always two sides involved – teacher and students. When skilfully operated, the focus can be either on teacher or on students, in both cases being beneficial for achieving the aim of a lesson. The traditional teacher-centred approach is commonly called "lecturing" or "theoretical" as teacher has the leading role in conducting the lesson mostly by means of explanations. The student-centred approach involves practice as the active part of a lesson (Teacher-centred approach, no data: para 1-4). In case of Mathematics, the process of learning includes a minimal textual input, as the main activities include solving mathematical problems graphically or listening to teacher's explanations, so the actual process of learning becomes a routine conflicting with the main principles of the subject of Mathematics: involvement into critical thinking and problem solving (Dale, 2012:68).

Motivation is an essential aspect in the process of learning and a specific issue in the teacher-centred approach. According to Coyle (2010:10), a learner, willing to participate in learning via the language of instruction other than mother tongue, enhances general motivation towards the subject itself, which positively influences the process of acquiring both content and language.

In this case, the traditional teacher-centred approach is no longer acceptable, as it does not take into account all the students' learning styles and ways of acquiring information. As the focus is on teacher, the main students' task is to receive information passively, as a result, students easily get bored and unmotivated during the lesson, which negatively influences the process of learning and its outcomes (Classroom resourses,2012: para 4).

To avoid the problem described above, both students and teachers are in need of another, new educational approach that would give them this opportunity to reach individual's learning potential and to learn to express themselves verbally during the class of Mathematics. The main idea is to reverse the focus from teacher to students making the process of learning active as students would be able to experience what they are learning, discuss the topic with teacher and classmates, make and prove hypothesis via the target language. In order to do so, the theory of MI is to be implied, as student-centred teaching is the main principle of the theory of Multiple Intelligences by Howard Gardner (Gardner, 1993: xv), next to "individualism".

In order to prove the purposefulness and meaningfulness of MI activities in the CLIL class of Mathematics the following topics are to be discussed: the main principles of the CLIL educational approach, the implementation of MI theory in practice, the influence of MI theory on students' involvement into the process of learning, the implementation of MI theory and activities into CLIL classes of Mathematics.

1.1 Principles of CLIL Teaching

In order to understand CLIL principles, it is necessary to grasp what differentiates CLIL from all the other educational approaches and what makes it so special. It is essential to know that CLIL is not only the combination of language and content studies, it is the concept of integration among content and language learning. According to Coyle (2010:40), the process of integrating content learning and language learning into particular context emphasizes mutually beneficial relationships between these elements, and as the result of these symbiotic relationship effective CLIL takes place.

The visual explanation of what this concept includes can be given via the 4Cs Framework (Figure 1), which has become one of the main models of the CLIL approach. The model shows the interconnection between content (subject matter), communication (language learning and using), cognition (process of learning and thinking) and culture (the process of development intercultural understanding and creating basis for global citizenship).

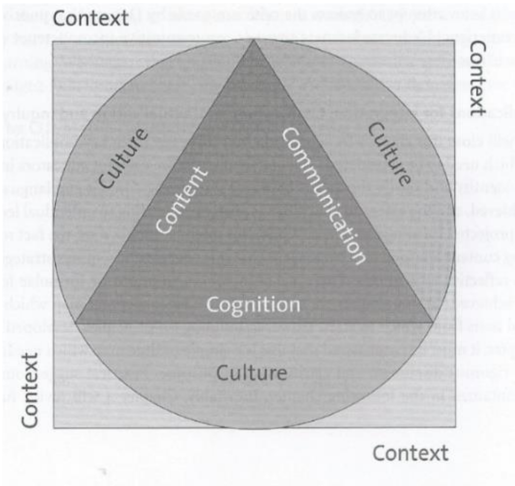


Figure 1. 4Cs Framework (Coyle, 2010:41)

The main idea of this concept is that integration takes place on different levels. Nevertheless, the fostering of the model into teaching does not guarantee the process of learning to be successful per se. There are several CLIL principles to be considered in order to create an appropriate basis for successful learning and teaching. Do Coyle (2010:42) determines those principles as the following:

1. As the CLIL approach is student-centred, it is expected that learners *create* their own understanding of content, and *develop* sufficient skills.
2. Content is directly related to cognition – process of learning and thinking. Learners must analyse the content for its linguistic requirements in order to create their own, personal interpretation of it.
3. The language of content must be as clear and transparent as possible.
4. Interaction in the learning context is an essential part in the process of learning through the medium of a target, foreign language.
5. Intercultural awareness is fundamental.

In order to understand how these key elements can be formulated in reference to lesson planning, the examples regarding cognition, content, communication and culture are to be described.

Cognition. First of all, cognition refers to critical thinking skills, that learners use for understanding the content of a subject. In order to get successful learning outcomes, learners must be cognitively involved (Coyle et al., 2010:41). Most of the time learners need sufficient support in order to develop their thinking skills in a language other than their mother tongue. Via CLIL learners meet challenging material from the beginning, as they need to practice academic, cognitive language next to the function language they all learn at school. In this case, such support as *scaffolding* can be provided to learners at the beginning to help students (temporary) develop cognitive skills. Such structures are temporary because in fact the amount of support and needs of every student vary, and therefore teacher must decide at what extend and for what period of time scaffolding is implemented (Cambridge English, 2010:5).

Peeter Mehisto (et al., 2008:31) provides exact examples of how successful learning outcomes can be achieved with planning a lesson. According to the author, to develop sufficient cognitive skills, the process of learning must be based on learners' existing knowledge of the subject, their skills and attitudes towards the content and the language, their area of interest and existing experience. Next to that, a key element for developing academic thinking skills is co-operation between teacher and students – it is essential when content, language and learning skills outcomes are formulated both by teacher and students, so they would be able to analyse achievement of those learning outcomes either independently or with other students and teacher, in order to get feedback and set new outcomes. Another point to be taken into account is intersubjective connection and cooperation: learners do not only use knowledge and skills for one particular subject, which is taught via CLIL, but are able to apply them in several other subjects.

Despite all the preparations, there might still be a chance that input is difficult to learners. In case of that, they tend to lack in remembering and understanding the content. In order to prevent the problem, Bloom's Taxonomy (classification of cognitive outcomes), which orders the process of cognition into knowledge, understanding, application, analysis and evaluation by means of hierarchy, should be applied in lesson planning (Mehisto et al., 2008:32). Bloom's new taxonomy (Anderson et al., 2001) is an essential supportive framework for creating questions and tasks that request the movement from lower-order thinking to the higher-order thinking – from remembering, understanding and applying to analysing, evaluating and creating (Figure 2) (Dale et al., 2012:32).

Skill	Question	Words	Examples of tasks and questions
Remembering	Can learners remember?	tell, recall, repeat, list	• Tell me what Pythagoras' theorem is. • Identify five characteristics of a living organism.
Understanding	Can learners explain?	describe, explain, paraphrase	• Tell me what you observed during the experiment and explain why that happened. • Describe Mary Queen of Scots' character.
Applying	Can learners use the information in another situation?	demonstrate, dramatize, illustrate	• How can you interpret these graphs about AIDS? What do they mean? • Make a brochure to inform teenagers and give them some advice about sexuality transmitted diseases (STDs). Provide illustrations.
Analysing	Can learners break the information into parts and see relationships?	compare, contrast, criticise, test	• Compare plastics with polymers in this Venn diagram. • What is the relationship between oil production and consumption?
Evaluating	Can learners justify a position?	argue, judge, evaluate	• Design a questionnaire for our class to evaluate and assess our work during the project. • Select and explain the most important improvements which you can recommend for this experiment.
Creating	Can learners create new products?	construct, create, design	• Create a lighting circuit for a greenhouse which comes on at sunset and goes off at sunrise. • Compose eight bars of a melody with the same rhythm as the one we are studying.

Figure 2. Key idea: questions and tasks for CLIL according to Bloom's new taxonomy (Dale et al., 2012:32).

The revised model of Bloom's taxonomy, provided by Anderson and Krathwohl (2001:67-68) contains also several added features in relation to the knowledge gained on each level:

1. Factual knowledge, including basic information such as
    a. Specific terminology
    b. Specific details or features

2. Conceptual knowledge, that shows relationships among parts of the whole bigger structure, such as
    a. Knowledge of classes, subclasses and categories
    b. Knowledge of principles and process of generalization
    c. Knowledge of theories, different structures and models
3. Procedural knowledge, focusing on how to do something, as for
    a. Knowledge of particular subject-specific skills and algorithms
    b. Knowledge of specific techniques and methods related to subject
    c. Knowledge of different criteria for actual use of appropriate procedures
4. Metacognitive knowledge, consisting of knowledge of the process of thinking generally and individually, such as
    a. Strategic knowledge
    b. Knowledge of cognitive tasks
    c. Self-knowledge (cited in Coyle, 2010:31).

The main idea, however, is not the model of taxonomy itself, but rather to identify cognitive and knowledge processes in CLIL. It gives a clear view on what happens on each level and what expectations both teachers and students might have. It is important to be sure that all learners are able to participate in the process of learning, yet that they have language to operate during this process (Coyle et al., 2010:30).

Communication. Language is the main tool of delivering information, especially in the CLIL approach where it participates as the medium of instructing. Relatively recently a new "communicative" approach was developed (20th century) in order to assist in the process of learning a second language. In the new discovery the main focus was put on meaning, and not only on form. As CLIL was one of those approaches, it can be said that its focus is also on meaning. Moreover, it has become one of the biggest problems for in-class activities, as teacher must always decide whether to focus on grammatical issues or not. It is expected that learners progress in both content and language learning, so it was important to find the balance between them. In order to achieve this balance, teacher and students must cooperate by means of dialogue and communication, as suggested by Coyle (et al., 2010:35) and by Freire (1972:81). They all assumed that a CLIL class does not fulfil all needs of a learner in terms of the language (as there is no exact progression). Therefore, they propose as a solution that an alternative syllabus for grammar content must be altered. The target language can then be divided into three groups with interrelated perspectives (Figure 3):

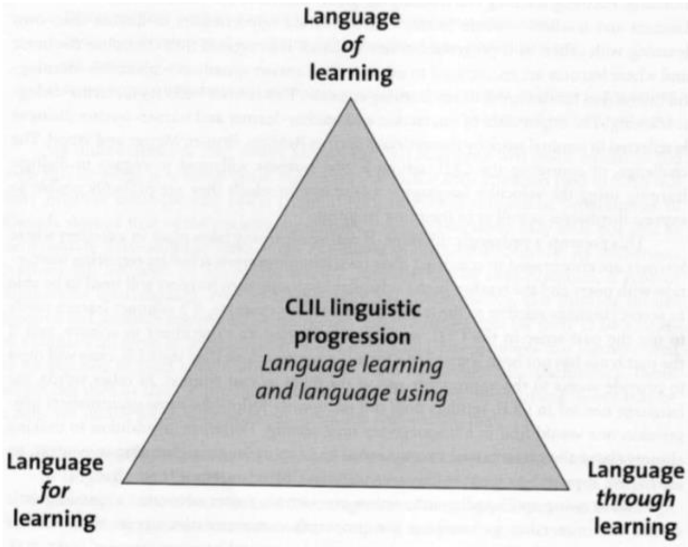


Figure 3. The Language Triptych (Coyle et al., 2010:36)

The use of the Language Triptych as a specific tool, will allow to enable teachers to strategically sequence their language and content objectives. For strategic planning such as this to take place, teachers need to make explicit the interrelationship between content objectives and language objectives. A conceptual representation — the Language Triptych — makes these connections. It has been constructed to take into account the need to integrate cognitively demanding content with language learning and using. It provides means to analyse language needs across different CLIL contexts and transparently differentiates between types of linguistic demand which impact on CLIL. It also provides a means to conceptualize language using as language 'for knowledge construction'. The Triptych does not replace grammatical progression but rather enhances it. It supports learners in language using through the analysis of the CLIL vehicular language form three interrelated perspectives: language of learning, language for learning and language through learning (Coyle et al., 2010:36).

The language *of* learning is in this case an analysis, a kind of feedback or reflection about the language contents and language skills that are needed to understand a topic. It can be achieved by switching from grammar to functions and notions in order to create a linguistic progression. The authentic material gives learners the possibility to use an appropriate language to the given content in a significant way (Coyle, 2010:61).

The language *for* learning is focusing on the language which is needed to operate successfully in a target language environment. Learners need particular strategies in order to be able to use a foreign (target) language appropriately. In the CLIL approach it means that learners need support in developing skills such as pair or group work, debating, memorizing, chatting, thinking et cetera (Coyle et al., 2010:62).

The language *through* learning is based on the concept that the process of learning will only take place if the active involvement of language and thinking exist: students, successfully articulating their knowledge by means of language, participate in a deeper level of learning, according to Coyle (2010:63). In other words, the author points out that learners support and advance their processes of thinking with the help of language. Next to that, the progress is to take place via acquiring new knowledge (Coyle, 2010:38).

According to Peeter Mehisto (2008:31), these ideas can serve as the main references for planning a lesson. He provides exact examples of using these principles in order to develop the process of communication: students actively participate in given activities and in the process of communication both in the classroom and outside of it; the process of learning is supported by physical environment in a classroom – desks' placement, displays of useful information on classroom walls and other recourses aimed to support learners; the meaning can be easily co-constructed and negotiated by both teacher and students; language and communication skills in particular are developed to be used in all subjects.

Culture. Another essential principle of CLIL is developing cultural awareness and intercultural understanding. In reference to Brown (1980:138, cited in Coyle et al., 2010:39):

> Cultural patterns, customs, and ways of life are expressed in language: culture specific world view are reflected in language…[L]language and culture interact so that world views among cultures differ, and that language used to express that world view may be relative and specific to that view.

The key idea according to Coyle (ibid.) is that the language is used to express our personal interpretation of the world, and in CLIL it becomes even more intercultural, as learners' experience broaden concepts that they might have in monolingual community. In CLIL, students develop both – awareness of their own culture and other cultures, as well as disciplinary cultures (for example writing conventions). It means that cultural aspect leads to accepting other perspectives and shared experience and understanding. Examples of how cultural aspects can influence learning outcomes are provided by Peeter Mehisto (et al., 2008:31): in terms of planning a lesson it is important to highlight that students understand what it means to be a member of a learning community; learners are able to work in groups and communities as they have self-confidence and co-operative skills are developed; the balance of interests both among teachers and students must take place; all participants (teachers, students, parents) are considered to be partners in the process of learning and education; students are aware of their social role both in/outside the classroom.

One way of acquiring intercultural awareness if intercultural dialogue, which involves articulating skills between different cultures (one's own and other) (Coyle et al., 2010:40). In other words, intercultural awareness is a key point in the CLIL approach, but in order to have an impact corresponding to culture, learners need to be involved in dialogues and so-called interactive learning as within the classroom, and beyond.

Content. Content is the key term in the CLIL approach. According to Coyle (et al., 2020:27) CLIL context does not have to belong to the traditional curriculum of a school, and can be applied to any discipline possible. CLIL context is very flexible and can be adjusted in reference with learners' needs and interests. Another benefit of CLIL context is that it provides not only overall understanding of a subject, but allows learners to use gained knowledge, skills and experience to investigate other subjects. However, most commonly only one side of CLIL is reviewed – *what* is the content of CLIL learning, and now *how* of content learning. When creating, or adapting the context for the CLIL approach, usually the process of simplification happens– because of doubts teachers mostly just simplify the context of a subject to the level they assume their learners are at. As a result, learners stay at the same level they started working with and no successful progress takes place. The aim of CLIL is totally opposite – it has to challenge learners both in language and content in order to achieve successful learning outcomes, yet to provide them with sufficient basis for understanding. According to evidences provided by Coyle (ibid.), when learners are intellectually challenged – involved into the process of transformation information and ideas, solving any kinds of problems, obtaining new skills via gaining knowledge and understanding, the level of achievements rise. Young learners do not only need the constantly growing volume of content, they need to learn how to use it and how to get knowledge.

The book "Teaching Math through English – a CLIL approach" (2010:2) provides an example of using the model of 4Cs by Coyle (et al, 2010:36) especially in the CLIL class of Mathematics, where *Content* area includes questions related to the topic of mathematics: algebra, functions et cetera; *Communication* is connected with mathematical terminology which students use during the lesson; the process of *cognition* relies on particular thinking skills required from learners, such as identifying, reasoning, classifying et cetera; and *Culture* or cultural awareness is closely focused on the methodology used in CLIL class of Mathematics in other cultures, or comparison of the process of learning the subject of Mathematics among students with different language and cultural backgrounds.

The successful learning process directly depends on thematic learning, next to related process of acquisition of new skills, knowledge and understanding, as it is important to provide learners with the access to the knowledge, without simply knowledge acquisition (Coyle, 2010:53). For progress to take place in the process of learning, two main ideas can be regarded: 1) adjusting the content towards the needs of the learners, and 2) providing supportive structures, also called *scaffolding.* There are many different kinds of such scaffolding strategies to be implemented in CLIL classes. The use of them depends mostly on the content itself, as well as on learner's needs and existing knowledge. Several of those strategies are described by Aida Walqui (2006:170-177):

1. Modelling is a presentation of examples, in other words teacher demonstrates what is expected from students and lets them imitate.
2. Bridging is the way of support by means of links between previous knowledge and prior knowledge. Teacher connects the existing knowledge of students with the new content, input, experience.
3. Metacognitive development makes sure that students can choose their own strategies of thinking and completing tasks and are able to evaluate their choice.
4. Contextualization is a specific way of scaffolding, that achieves comprehension via use of illustrative materials, verbal tools et cetera.
5. Text representation is a form of changing, paraphrasing and editing the text into other representative form in order to achieve understanding.
6. Schema building is connected with text representation, with the aim to help learners organize their knowledge by means of schemas.

Scaffolding is an essential part of a CLIL lesson, as it generally reduces the amount of delivered material, allows learners to achieve their learning outcomes by completing tasks, and provides them with useful structures in order to help learners verbalise their process of thinking (ibid.).

To generalize, the core principles and features of CLIL can be classified by categories:

1. Multiple focus
   - It provides support of language learning in content classes
   - And supports content learning in language classes
   - Gives an opportunity for integrating several subjects
   - Organizes the process of learning by means of cross-curricular themes and projects
   - Supports feedback and reflection on the process of learning
2. Safe and enriched learning environment
   - Use of routine activities and critical thinking
   - Supportive language and content displays in the classroom
   - Supporting development of student self-confidence for operations with language and content
   - Use of learning centres in the classroom
   - Authentic learning materials and environment and a full access to them
   - Supporting student language awareness

3. Authenticity
    - Ensuring student to be able to ask for help if needed
    - Enlarging students' interests
    - Creating the connection among the process of learning and its usefulness in a real life
    - Interaction with other speakers of target (CLIL) language
    - Using authentic material (as from media and other recourses)
4. Active learning
    - Interaction and communication among learners (student-focused)
    - Discussing with teacher regarding the content, language and learning skills outcomes
    - Learners' feedback and reflection on the progress (achievement) of learning outcomes
    - Use of co-operative learning and peer work
    - Discussing and negotiating the volume and the meaning of language and content with teacher (student-centred)
    - Teachers are guides, coaches, not the ultimate authority
5. Scaffolding
    - Based on learners' previous knowledge, existing skills, interests, experience and attitudes
    - User-friendly way of delivering information
    - Supporting creative and critical thinking
    - Challenging learners to leave the comfort zone
    - Supportive different learning styles (Mehisto et al., 2008:29).

In other words, CLIL demands and supports the whole – holistic development of all the skills and competences of learners. Its main goal is to guide learners on their way to become a motivated, bilingual, independent learner, supporting individual needs in the process of learning. CLIL is an ultimately student-centred approach, which takes into account all the learning styles of students, supporting them during the process of learning (ibid.). In this case, the theory of Multiple Intelligences by Howard Gardner (1993:5) fits perfectly into CLIL classes, as it helps "individuals to realize their human potential", next to enhancing learners' educational opportunities and options (Gardner, 1993:10).

1.2 Multiple Intelligences Theory in CLIL Classes

There is a big variety of ways learners acquire knowledge in the classroom. For many years it was believed that there are only three types of learners – kinaesthetic learners, visual learners and learners acquiring knowledge via listening – auditory. Moreover, it was commonly used in the classroom, assuming there are only three main groups: for auditory learners - lectures, verbal instructions, songs, oral examinations and other verbal techniques; visual learners had to deal with illustrations, diagrams, charts and other visual representations; kinaesthetic learners faced master class projects, role playing, multimedia assignments and other methods where they could actively participate in the process of learning (Sarah, 2015: para 5-8). But as the process of teaching and learning has been developing, many other theories and approaches have been created towards understanding of human learning potential. CLIL in this case is a relevantly modern approach. Moreover, it covers the variety of CLIL-style activities and educational approaches, such as language showers, immersion programmes, bilingual and multilingual education, student exchange; such teaching strategies, for examples, as active learning, including cooperative learning and theory of multiple intelligences (Cooperative Learning and Multiple Intelligences, 2011: para 4). The common feature of all those approaches and activities is that within the CLIL environment they take into account all learning styles of students (the student-centred approach), and maximize their learning potential in content and language learning. A special place among all those educational approaches belongs to the theory of multiple intelligences (Mehisto, 2008:12).

The theory of Multiple Intelligences (hereinafter MI) appeared in 1993, it was developed by Howard Gardner – professor of education at Harvard University (Sarah, 2015: para 1). Before that research, it was commonly believed that intelligence, or *smartness* is an inherit feature, and some people were considered to be gifted over the others who failed in the same activity. However, people started to think that measuring all the individuals with the standard IQ test is not equally fair (Gardner, 1993: 2-4). The need of change appeared when the author decided that traditional assessment was no longer appropriate in terms of giving feedback on connections between previous and prior knowledge, and cognitive processes. Moreover, assessment of knowledge had nothing to do with assessment of new skills, acquiring new information and processes of problem solving. Gardner was sure that in order to understand the realm of individual's process of thinking, the broader variety of human competences had to be taken into account (1993: px). Moreover, the whole traditional system of teaching and assessment was there to deliver information and give a feedback on it, without dealing with the process of learning itself or supporting active learning in any ways for the future growth (1993:18). However, the author does not reject the concept of so called *general intelligence*, and does not consider traditional testing as completely useless. He believes that giving equal attention to every student in class taking into consideration difference in their learning styles, will return with higher learning outcomes (Gardner, 2005:7). The theory of MI gives all the possibilities both for teachers and students to develop productive learning environment and relationships, especially in CLIL lessons, when content studies are delivered via a foreign language.

The word *intelligence* does not automatically mean smartness. Howard Gardner explains the concept standing behind the word as the "capacity" – the volume of particular learning skills, attitudes and ability which all together enable an individual to acquire knowledge and understanding (2001:6). According to the analysis of Nicholson-Nelson (1998:9) the main points of the concept of Gardner's theory could be described as a set of the following features:

1) Ability (to create meaningful products)
2) Skills (that allow a learner to solve various problems)
3) The potential (that allows a learner find appropriate solutions for problems in order to acquire knowledge)

In other words, the theory of MI sees an individual with his/her own set of skills and knowledge as well as potential for their development (ibid.).

According to Gardner, the theory proposes that there are eight different learning styles, or intelligences, to reach the maximum of human potential:

- Verbal-linguistic intelligence
- Mathematical-logical
- Visual-spatial
- Interpersonal
- Intrapersonal
- Bodily-kinaesthetic
- Naturalist
- Musical-rhythmical

Gardner presented a detailed description of each intelligence, their strengths, weaknesses and possible roles, and he believes that every learner has a blend of different intelligences, not the single one and only. However, individuals show a preference for some way of learning material over the others. The author himself finds the causes of these differences from the biological and culture background of a human being as well as personal experience (ibid.).

The author also provides possible in-class activities for every type of intelligence (See Appendix 1), such as:

1. Linguistic Intelligence: giving oral presentation;
2. Logical-Mathematical intelligence: performing a mental mathematical calculation;
3. Visual-spatial: designing a logo;
4. Interpersonal: coaching other students;
5. Intrapersonal: considering and deciding one's own aims and personal changes required for these aims to be achieved;

6. Bodily-Kinaesthetic: arranging workplace;
7. Naturalist: using microscope and magnifying glass for the research;
8. Musical-rhythmical: identifying music (Gardner's multiple intelligences, no data: 3-9).

The distinctive features of MI as well as CLIL is approaching individuals' needs in order to achieve positive learning outcomes and reach every student's involvement into the process of learning. The implementation of MI activities into CLIL classes will reverse the focus from teacher to students, their personal skills, needs and ambitions in order to achieve higher learning outcomes.

To give a clear understanding of the theory of MI, Thomas Armstrong (2009:15-16) provides the following key points:

1) **Every individual possesses the whole spectrum of all eight intelligences.** However, they all function on different levels and in their own capacities, unique to each person. Armstrong believes that all people master in some intelligences, modestly operate with others and relatively struggle with the rest of them. The quantity and quality of each group vary and is unique for every individual.
2) **Mostly, it is possible for a person to develop each intelligence to a sufficient or expected level of competency.** Based on Gardner's theory, it is theoretically possible to develop any, or even all of seven intelligences on a level which seems appropriate or expected for a person. As a reference, Armstrong brings the development of musical competence via musical schools.
3) **All seven intelligences always work together in their own, complex way.** The author proves the key point with an example of cooking, which corresponds to reading the recipe (linguistic intelligence), developing a menu which can satisfy all the needs of a family (interpersonal intelligence) and focusing on one's own tastes and requirements (intrapersonal intelligence). All intelligences always cooperate, always interact and connect with each other in order to achieve an outcome.
4) **There are a lot of possibilities to succeed within each area-category of intelligences.** According to Armstrong, there is no standard, required set of attributes for an individual to be considered *smart* or intelligent in a particular area. Some people possess highly developed linguistic intelligence, whilst fail in visual-spatial one. Others are great at mathematics and hardly manage languages.

Moreover, the author makes a direct connection between Bloom's levels of cognitive complexity and the MI theory. He provides the example of how MI curricula can be designed in reference with all the levels of Bloom's taxonomy (Armstrong, 2009:170):

1. Linguistic intelligence

a. Knowledge: memorising the terms
b. Comprehension: explaining the idea in words
c. Application: suggesting the idea from given description
d. Analysis: describing the details in connection with the whole
e. Synthesis: describing the idea in a form of a written task
f. Evaluation: rating differences related to the idea

2. Logical-mathematical intelligence
    a. Knowledge: memorising the numbers
    b. Comprehension: converting English into numeric symbols
    c. Application: comparing two given data
    d. Analysis: in-depth analysis of data
    e. Synthesis: providing the chart/graph related to given data
    f. Evaluation: rating differences related to given data
3. Visual-spatial intelligence
    a. Knowledge: remembering details related to visual representation
    b. Comprehension: understanding differences from given diagrams
    c. Application: using geometrical principles
    d. Analysis: drawing detailed schemas of visual representation
    e. Synthesis: creating extensional scheme
    f. Evaluation: evaluating practicality of extensional schemes
4. Bodily-kinaesthetic intelligence
    a. Knowledge: identifying feelings
    b. Comprehension: identifying details for each specific type
    c. Application: searching the location for each specific type
    d. Analysis: handmade work or master classes
    e. Synthesis: gathering all the materials needed for handmade work
    f. Evaluation: evaluating the quality
5. Musical Intelligence
    a. Knowledge: remembering songs and tunes
    b. Comprehension: explaining the concept of songs in relation with the topic
    c. Application: working with the lyrics or the tune
    d. Analysis: classifying the songs by issue and/or historical period
    e. Synthesis: creating of one's own song or tune in relation with the topic
    f. Evaluation: rating songs from best to worst with reasoning
6. Interpersonal intelligence
    a. Knowledge: remembering other learners' responses on the question in relation with the topic
    b. Comprehension: determining the most common answer
    c. Application: using survey results
    d. Analysis: classifying learners into groups in relation with their answer
    e. Synthesis: arranging extra-curricular activity, contacting people
    f. Evaluation: evaluate several methods of gathering data
7. Intrapersonal intelligence
    a. Knowledge: remembering own experience in relation with the topic
    b. Comprehension: sharing feelings about that experience
    c. Application: developing the set of rules based on own experience
    d. Analysis: dividing own experience into specific groups
    e. Synthesis: planning extra-curricular activity bearing in mind own previous experience
    f. Evaluation: explaining the best and worst feelings connected with the new experience
8. Naturalist intelligence
    a. Knowledge: determining distinctive features by sight
    b. Comprehension: describing the benefits another living creatures might have in relation with the topic
    c. Application: creating criteria of classifying
    d. Analysis: analysing the main functions in the natural environment
    e. Synthesis: developing an approach to save the nature in relation with the topic
    f. Evaluation: evaluating the neighbourhood in terms of eco-valuable system.

In general, the MI theory takes into account the diversity of the class and provides specific attitude towards each individual in order to deliver the content of a subject in equal amount or volume, needed to get all students actively involved into the process of learning, and make them achieve positive learning outcomes.

1.3 Students' Involvement via MI Theory Application

In order to successfully implement MI activities into CLIL classes of Mathematics, two main aspects have to be considered: first of all – it is needed to create the MI profile of the class – students with what kind of intelligences predominant in the classroom and what intelligences are poorly developed, in order to create such MI activities for a CLIL lesson of Mathematics, so they would be able to participate in the process of solving mathematical problems and effectually achieve learning outcomes related to the subject; and secondly, to develop a set of activities in reference to students' MI profile. In other words, what intelligences and competences are needed to develop in students in order to deliver the subject of high school Mathematics so it could be possible to achieve successful learning outcomes – in other words, which multiple intelligences allow students to complete assignments and solve mathematical problems successfully.

The subject of Mathematics is very specific itself. As it was mentioned previously, the distinctive feature of content of Mathematics is that it requires minimum textual input and is focused on the practical part of learning – actual solving and practicing mathematical problems (Dale, 2012:68-70). In this case, the delivery of the content happens mostly via visual tools – graphs, formulae, functions, which belong to the core activities of visual-spatial intelligence. Another distinctive feature of the subject of Mathematics is certain patterns and logic, needed to understand the process of solving mathematical dilemmas. These features belong to logical-mathematical intelligence (Howard Gardner's theory of multiple intelligences, no data: para 3).

According to this information it is clearly seen that two of eight multiple intelligences are dominant in lessons of Mathematics in particular. In reference to this fact it is clear why the subject of Mathematics is not very popular among students – it causes difficulties for those students whose learning styles differ from the ones required for understanding of the content of Mathematics (Irina, 2015: para 1). As a result, the attitude of students towards Mathematics changes in a negative way, failing causes anxiety and, according to the author, even phobia in some cases, which definitely influence the involvement into the process of learning and successful achievement of learning outcomes (ibid.). The use of traditional activities, such as written solving of mathematical problems and endless counting affects the process of learning, causing passive learners in the classroom, which is the opposite of the aim of Mathematics lesson where the active participation is expected and even required in order to understand the content (Bednar et al, 2002:3).

In other words, students' participation in the process of learning of the subject of Mathematics is basically the presence or the absence of motivation[1]. Motivation, especially self-motivation of students can be easily affected by many separate factors or even by the set of these factors, therefore increasing and maintaining the level of motivation among the learners require many operations, starting from creating an appropriate and safe physical atmosphere in the classroom and to ensuring students in their security on a mental level (Davis, 1999: 22-39). The aspect of motivation itself, as well as strategies of increasing motivation among students, is a very large and specific topic itself, and in this research the process of involvement is to be analysed ex post – students' involvement into the process of learning of the subject of Mathematics is to be observed during the CLIL lesson of Mathematics to reveal problems and struggles which students are facing during completing of mathematical assignments. In order to see the real image of students' attitude towards the subject of Mathematics, a questionnaire is to be led among students of upper-secondary school before and after the introduction of MI activities into the CLIL classes of Mathematics (Figure 6).

The student involvement observation checklist was adapted from *Student engagement handbook* (Jones, 2009:29) according to the main characteristics of natural involvement of students into the process of learning:

1) **Positive body language** – the author claims that being involved into the process of learning is shown via typical non-verbal signals – particular body postures indicating that students are paying attention to the teacher and other students.
2) **Consistent focus** – students are focused on their activities with minimal distraction.
3) **Verbal participation** – students answer questions, share ideas and express their own thought with teacher and other students. On the other hand, they actively ask questions related to the topic and reflect on problems.
4) **Student confidence** – students feel confident with participating in the learning process – they initiate and complete assignments and tasks and work in pair or groups with the exhibition of interest.
5) **Fun and excitement** – students exhibit positive attitude via use of appropriate content and volume of humour and show their enthusiasm (ibid.).

On the basis of those characteristics, the student involvement observation checklist was created to monitor students' involvement into the process of learning in CLIL classes of Mathematics. A particular field *Notes* was added to specify the situation in the classroom – to remark what challenges students might face during the CLIL lesson of Mathematics and what meaningful steps

[1] Motivation - the act or process of giving someone a reason for doing something (Merriam-Webster dictionary, No data: para 1).

they do to avoid struggling or to solve problems. Such criteria of measurement, as degree, or level of involvement into the process of learning was chosen. An observing teacher monitors the situation in the classroom during the CLIL lesson of Mathematics and rates the involvement according to the checklist from "very high" to "very low", next to that, according to the answers, received during an observation, an overall involvement is to be revealed via the compilation of all observation criteria (Figure 5):

Student Involvement Observation Checklist	Very high	High	Medium	Low	Very low
1. Positive body language *Students exhibit body postures that indicate they are paying attention to the teacher and/or other students* Notes:	❑	❑	❑	❑	❑
2. Consistent focus *All students are focused on the learning activity with minimum disruptions* Notes:	❑	❑	❑	❑	❑
3. Verbal participation *Students express thoughtful ideas, reflective answers, and questions relevant or appropriate to learning* Notes:	❑	❑	❑	❑	❑
4. Student confidence *Students exhibit confidence and can initiate and complete a task with limited coaching and can work in a group* Notes:	❑	❑	❑	❑	❑
5. Fun and excitement *Students exhibit interest and enthusiasm and use positive humour* Notes:	❑	❑	❑	❑	❑
6. Overall students' involvement Notes:	❑	❑	❑	❑	❑

Figure 5. Student Involvement Observation Checklist (Jones, 2009:31)

Next to observation, in order to collect information based on students' subjective opinion about activities of Mathematics in a CLIL lesson, and their own personal experience in the process of learning, another questionnaire was adapted from *Student engagement handbook* (Jones, 2009:30) in reference with researcher's interest and needs. Questions for students, in the form of statements – positive and negative, were intentionally and imaginatively divided into five sub groups, suggested to indicate the level of students' attitude towards Mathematics (ibid.). The questionnaire itself does not differentiate the level of involvement in reference with the gender or the age of the respondents, as its main focus is on an overall degree of involvement into the subject of Mathematics. Therefore, learners, despite their differences in gender or age span were required to evaluate their own level of interest on a rating scale with possible answers “Always”, “Sometimes” and “Never”. Subgroups, presented by Jones (2009:30) and adopted by the researcher are the following:

1) **Meaningfulness of work.** Students find activities and tasks interesting, challenging and connected to the topic, learning process.
2) **Clarity of learning.** Students understand the purpose of process of learning and presented activities, tasks and assignments.
3) **Critical, logical thinking.** Students solve complex mathematical problems using nonstandard, original solutions and are able to evaluate their own quality of work.
4) **Individual attention.** Students feel comfortable in seeking and finding help from teacher or other students, and are able to ask questions related to learning. Scaffolding is used during the lesson.
5) **Performance orientation.** Students understand what amount of work will be assessed and how. They understand the criteria for their own quality of work to be evaluated.

As the experiment takes place in the CLIL class of Mathematics, such subgroup as **Content and Language** was added to clarify the attitude towards the complexity of the topic and difficulty of the language as the medium of instruction.

6) **Content and Language.** Students cope with the volume of the content and specific terminology presented during a CLIL lesson of Mathematics.

On the basis of those subgroups, a questionnaire was created to reveal the attitude towards the subject of Mathematics in the CLIL class. In order to make questionnaire reasonably short, 4 questions per each criteria were presented for students:

Students’ involvement questionnaire

Class ___________________

		Always	Sometimes	Never
1.	I think Mathematics is interesting	○	○	○
2.	I usually do well in Mathematics	○	○	○
3.	I think Mathematics is too difficult for me	○	○	○
4.	I think I need more time than the other students	○	○	○
5.	I think learning Mathematics is important for my future	○	○	○
6.	Tasks and assignments are interesting and exciting	○	○	○
7.	I learn Mathematics because I have to	○	○	○
8.	I would choose another subject instead of Mathematics	○	○	○
9.	I solve mathematical problems easily and fast	○	○	○
10.	I can not solve mathematical problems without the help of computer or calculator	○	○	○

11. I can find several ways to solve the same mathematical problem	○	○	○
12. I can explain my solutions	○	○	○
13. I enjoy working in pairs or in groups	○	○	○
14. I would rather work independently	○	○	○
15. I feel embraced when I can't solve mathematical problems as quickly and easy as the other students	○	○	○
16. I am afraid to ask for help	○	○	○
17. I am well prepared for test or quiz when needed	○	○	○
18. I think I have too much homework	○	○	○
19. I think reviewing homework is important for learning	○	○	○
20. I think my grades are fair in relation to the quality of my work	○	○	○
21. Speaking English during the class is difficult for me	○	○	○
22. I use specific mathematical terminology in my explanations and solving	○	○	○
23. I am afraid to speak English in front of teacher or/and other students	○	○	○
24. I think I can use what I learn during the class of Mathematics in my daily life	○	○	○

25. Brainstorm any words or ideas that come to your mind when you think of Mathematics

____

____

Figure 6. Questionnaire for students in order to reveal their attitude towards the subject of mathematics (Jones, 2009:30).

It is important to know students' MI profile in order to create appropriate activities for the CLIL class of Mathematics (Berube, 2014: para 2). The MI class profile has the form of a questionnaire consisting of several statements which students are expected to mark in relation with their level of agreement with the statements (on a rating scale from A=Always, S=Sometimes and N=Never) (ibid.). As the original questionnaire consists of seventy questions (plus five questions regarding Naturalist intelligence were added by the researcher), it was decided to shorten the form by selecting only five statements per intelligence, and the questions used for the final version of the questionnaire are marked with asterisks symbol "*" (See Appendix 2).

In order to devise MI activities to be implemented in the CLIL class of Mathematics, it is important to know the MI class profile – in other words, what intelligences are preferable among the learners. The set of activities the researcher provides is focused on two main goals – to check students' involvement and achievement of learning outcomes. The level of involvement into in-class activities and topic of Mathematics itself is to be checked by means of an observation checklist and questionnaires for students, achievement of learning outcomes is to be assessed via the assessment of MI tasks completion in reference with the aims of those MI activities.

However, the aims of MI tasks depend on the MI class profile and have to be related to the National Curriculum for upper-secondary school in Estonia, to the topic of Mathematics, in particular, as the teacher's work schedule follows the requirements of this document and is based on the main principles of the National Curriculum for upper-secondary schools in Estonia. Therefore, learning outcomes also follow the general principles (including educational and pedagogical objectives; general learning outcomes and learning outcomes in relation with the particular course of Mathematics,) (National curricula for upper secondary schools, 2011: Appendix 3).

As it was mentioned before, the subject of Mathematics is taught in Estonian schools in the form of two separate courses – a narrow course and an extensive course of Mathematics, hence those courses have different sets of learning outcomes. The research is focused on the extensive course of Mathematics, however, it has been decided to choose the topic belonging to both courses in order to provide examples of MI activities that might be used in both cases equally (ibid.). The list of topics covered by narrow and extensive courses of Mathematics, was compared in order to reveal similar sub courses. As a result, similar topics are marked in **bold** (Figure 7):

Narrow course of Mathematics	Extended course of Mathematics
1. **Numerical quantities. Expressions.** Equations and inequalities.	1. **Numerical quantities. Expressions.**
2. Trigonometry	2. Inequalities. Trigonometry Part 1. 2.1 Trigonometry Part 2.
3. **Vector on plane. Equation of a line.**	3. **Vector on plane. Equation of a line.**
4. **Probability and statistics.**	4. **Probability and statistics.**
5. Functions Part 1.	5. Functions Part 1: Numeric sequences.
6. Functions Part 2.	6. Functions Part 2.
7. Plane figures. Integral.	7. Integral. Review of planimetry.
8. Stereometry.	8. Geometry Part 1. 8.1 Geometry Part 2. 9. Equations and equations systems. 10. Limit and derivative of function. 11. Applications of derivative. 12. Applications of mathematics and study of actual processes.

Figure 7. List of topics covered by narrow and extensive courses of mathematics in upper-secondary school (National Curricula, 2011: Appendix 3: 2).

From the list it can be clearly seen that only a few topics are more or less the same for narrow and extensive courses of Mathematics in upper secondary school. However, the main difference is not only in the content of courses, but also in their approaches (National Curricula, 2011: Appendix 3: 2). The main focus of Narrow Mathematics is to give learners basic knowledge about the subject and its application, while the extensive course examines the mathematical content in-depth, teaching students how to learn Mathematics with its laws, formulae and logical discussions. Nevertheless, it is not implied that the extensive course of Mathematics is an intensive course – as it is stated in the National Curricula, both narrow and extensive courses of Mathematics may have the same obligatory courses included in the syllabus (ibid.).

However, the formulating of learning outcomes comes directly from particular aims in reference with the topic, therefore it is important to know what is expected from learners in order to plan the lesson and supporting activities. The researcher has decided to focus on topics which are covered by both narrow and extensive courses of Mathematics with their generalised learning outcomes provided by the National Curricula for upper secondary schools in the field of Mathematics (National Curricula, 2011: Appendix 3: 8-10):

1. Numerical Quantities. Expressions.

General learning outcomes: by the end of this course student is expected to

   a. have knowledge and skills to distinguish between different types of number (rational, irrational and real numbers);
   b. have knowledge and skills to distinguish between equivalence, equation and inequality, identity; be able to explain the solution of equations and inequalities;
   c. be able to solve linear, quadratic simple fraction equations when there is one unknown value;
   d. be able to perform different mathematical operations with powers and roots (by transforming the latter into powers with rational number exponents);
   e. be able to transform simple rational and irrational expressions;
   f. be able to solve linear, root and the system of linear inequalities with one unknown;
   g. to be able to solve simple word problems;

2. Vector on plane. Equation of a line.

General learning outcomes: by the end of this course student is expected to

   a. have knowledge and skills to explain the term “vector” and its coordinates;
   b. know a line, parabola and circumference, their equations and opposite positions on a plane;
   c. be able to do such mathematical operations as adding, subtracting and multiplying of vectors both geometrically and in a form of coordinate;
   d. be able to find the scalar product of vectors (by using the properties of perpendicularity and collinearity of vectors);
   e. be able to determine the mutual positions of a line on a plane;
   f. have knowledge and skills to compile the equation for a circumference by a central point and a radius, as well as if the line is determined by a point and a slope, by a slope and a starting ordinate and by two points;
   g. be able to draw accurate lines, circumferences and parabola by their equations;
   h. be able to use vectors and their equations for lines in relevant content;

3. Probability and statistics.

General learning outcomes: by the end of this course student is expected to

   a. know the definitions of random, certain and impossible events and able to distinguish between them;
   b. be able to explain the collocation “probability of event”;
   c. be able to explain the meaning of the product of independent event and the sum of exclusive events;
   d. have knowledge and skills to explain the terms “factorial”, “permutations”, “binomial coefficient”, “sample”, “general dataset”;
   e. explain the meaning of the numerical characteristics of random variables and the meaning of reliability;
   f. be able to explain what is data classification and statistical decision;
   g. have knowledge and skills to calculate the probability of an event and solve relevant mathematical problems;
   h. have knowledge and skills to calculate the numerical characteristics of a random event and be able to make conclusions for it;
   i. be able to use additional supportive devices and tools, such as computer and calculator in order to collect data and analyse it.

Teacher’s work schedule, and therefore lesson plans are based on the National Curriculum (National curricula, 2011: General provisions of national curriculum for upper secondary school:

14). It can be assumed that learning outcomes per each lesson are also based on learning objectives from the National Curriculum, hence the teacher is expected to set learning goals and create activities, tasks and assignments for the lesson in reference with the ones described in Appendix 3 of the National Curriculum for upper secondary schools in Estonia (2011:8-10).

The general learning and educational objectives to be accomplished in upper secondary schools, as stated in the National Curriculum (General provisions of national curriculum for upper secondary school, 2011:2) are the following:

1. To teach students to be independent learners, who are able to operate with their obtained knowledge and skills in the real world;
2. To teach students to shape their own self-esteem on an adequate level;
3. To teach students to cooperate with teacher and other students;
4. To introduce to them the information about the future educational career and to assess them if needed;
5. To teach students to operate with their civic skills, responsibility and activity;

In relation with these goals, it can be suggested that implementation of MI activities in CLIL classes of Mathematics will only be beneficial in terms of accomplishment of goals stated in the National Curriculum among the students of upper secondary schools in Estonia, as the MI theory is based on individual needs of every student – the student-centred approach (which also corresponds to the CLIL educational approach) (Gardner, 1993: xv).

To conclude, the first chapter shows the importance of the CLIL approach and the use of the MI theory during CLIL lessons of Mathematics for students to achieve positive learning outcomes and raise their level of involvement into the process of learning. Chapter one describes the main principles of the CLIL educational approach and its connection with the MI theory in order to provide the field for this research and show the necessity of the experiment.

The study of sources above helps to perform the present research about the possibility and outcomes of the implementation of the MI theory and MI activities in particular in local school's environment in order to prove its purposefulness and efficiency during the CLIL lesson of Mathematics in terms of student's involvement and the process of achieving learning outcomes. However, it is more convenient to practice MI activities during only one part of the lesson, and later on as learners become familiar with the approach, implement the approach in other parts.

CHAPTER II INVOLVEMENT IN CLIL CLASSES OF MATHEMATICS IN UPPER SECONDARY SCHOOL: MI ACTIVITIES

The chapter describes the implementation of the MI theory and MI activities in particular in practice with the aim to prove that they can be successfully used in order to increase students' involvement[2] into the process of learning of the subject of Mathematics in a CLIL class. Moreover, it shows whether it helps learners achieve their learning outcomes. The research is conducted by means of lesson observation and a survey among students in order to see the involvement situation in the classroom from the researcher's point of view and students' opinions; by presenting MI activities and their assessment based on the MI class profile, and by the analysis of students' academic results both in English and in Mathematics in reference with the objectives listed for specific topics of Mathematics in the National Curriculum for upper secondary school.

The present research is presented in the style of an action research, as the same group of learners will be examined via three stages – diagnosis or observation, action – or the implementation of MI activities in the CLIL classes of Mathematics and reflection – analysis of the results (Cohen et al., 2007:298). The first stage of the research – diagnosis, is focused on the present situation in the classroom among the students of a CLIL class of Mathematics – in particular, their involvement and achievement of learning outcomes by means of passive observation and analysis of the questionnaires answered by students; the action is performed via the process of application of MI activities designed by the researcher based on the MI class profile in relation with the learning outcomes and to consider the hypothesis; and the reflection stage is there to analyse and evaluate the results of the action – whether the hypothesis is proven or not.

According to the sample's types by Cohen (Cohen et al., 2007:213), the present research is based on a non-probable sample[3], that was chosen from the local upper secondary school with the purpose to study the effect of application of MI activities in the CLIL lesson of Mathematics in order to examine students' involvement into the process of learning and see the results of it.

The examined group consists of 17 students of Sillamäe upper secondary school (12th grade) who participate in the extra-curricular educational programme based on the CLIL approach, where they learn different compulsory school subjects via the medium of the English language (including Mathematics, Physics, Social Studies, Word building, English et cetera). The class has two teachers – one head teacher and the assistant whose main tasks are more or less the same as the main teacher's ones: to assist in in-class activities, substitute the teacher other day and check

[2] Involvement – verb "to involve" – to engage the interests or emotions or commitment (Dictionary, no data: para 10)

[3] Non-probable sample does not represent the whole population, but the particular group of people in a small-scale research.

students' completing of assignments. The researcher herself is an assistant teacher in the examined class. All students have different levels of English language proficiency, but the majority speaks English on B1.1-B1.2 level which corresponds to the Intermediate level of English proficiency according to the Common European Framework of References (CEFR, 2014:59).

The action part of the research is divided into five steps followed by the conclusion:

1. Analysis of the situation in the CLIL class before presenting MI activities – observation and evaluation of the questionnaires in terms of students' involvement.
2. Analysis of the post-lesson results – evaluation of students' achievements of set goals.
3. Presenting designed MI activities, based on the MI class profile – two activities per a topic, six activities in total.
4. Analysis of the in-class situation after application of MI activities – learners' involvement level according to the involvement checklist mentioned above.
5. Analysis of the achievement of students' academic results – learning outcomes, according to the students' results table[4] (General provisions of national curriculum for upper secondary school, 2011:12).

The analysis of the initial situation in the CLIL class before MI activities should be started via observation of the researcher, with the help of developed involvement checklist. Next to that, students' personal evaluations are to be considered via the analysis of questionnaires.

The implementation of MI activities is an action new both to teacher and students. The majority of lessons before the research were mostly teacher-centred, focused on learners with two learning styles, preferred intelligences – audio-lingual and logical-mathematical, as the information was usually delivered by means of lecturing and practice, during which students were expected to solve mathematical problems on the basis of certain patterns and formulae provided by teacher. However, active learning was presented in the classroom by means of group work, pair work, peer assessment and creative projects such as presentation, group evaluation, group discussions and, rarely, games. In general, the process of learning emphasizes the systematic remembering of certain mathematical patterns and possible ways to deal with mathematical problems and to find appropriate solutions. The syllabus follows the National Curriculum of

[4] Students' results table – 5-point grading system using evaluating students' knowledge and skills according to 100 percent scale:
100-90: Very Good, grade "5"
89 -75 : Good , grade "4"
74 -50 : Passable , grade "3"
49 -20 : Not passable, grade "2"
19 -1 : Failed , grade "1"

Estonia, but with specific pace as the content of the subject is delivered via English as the language of instruction. Internet resources are commonly used for in-class teaching, next to specific course books by means of which learning proceeds. The main course books for Mathematics are provided by the foundation of ACE programme[5]. Even though the programme itself is religious, the syllabus of this particular class does not focus on spiritual development but only achievement of high academic results. It can be said that this educational programme was adapted by school and taught in its own, more traditional way, when the emphasis is on delivering the content to learners regardless their preferred learning styles and abilities. The course books are completely in English and follow the National Curriculum for upper secondary schools, therefore, provide sufficient material for learning process of subject of Mathematics. As both for content and language environment it follows the requirement of the CLIL educational approach.

Regarding the fact that the researcher herself is an assisting teacher in this classroom for two recent years, it can be mentioned that it was possible to monitor the process of learning for a longer term to give objective enough evaluation on in-class activity including students' involvement into the process as well as their learning outcomes. The involvement checklist (Figure 5) created to observe the in-class activity helps to give feedback in details in reference to a particular area of overall involvement of students. There was no preparation for the observation as the researcher's intention was to check the initial, true situation in the class and to make assumptions regarding it. The results are the following in reference with five parts of involvement according to Jones (2009:29):

1) **Positive body language**:

   Low- students pay attention to teacher's lecturing but soon enough they get bored and try to entertain themselves of each other by talking, moving around or simply not listening to the teacher. The majority of students are focused on their own activities, some of them were observed by the researcher in order of their popularity: using phone, talking to the desk neighbour, drawing, doing nothing meaningful – searching something in the course book, looking at their agendas, turning over the pages et cetera.

2) **Consistent focus**:

   Low- Students are easily distracted by any movement of sound. Even during the practical part they tend to find activities apart from dealing with mathematical problems.

3) **Verbal participation**:

[5] ACE programme stands for Accelerated Christian Education – specific programme of education focused on high academic outcomes and Biblical studies (Reaching the world for Christ…One child at a Time, 2016: para 1)

Medium- Students ask questions mostly related to the language of instruction, rather than content. They prefer not to share their ideas and answer only if teacher asks someone in particular. The last statement might be connected with lack of confidence and fear of using English as the main language, therefore it makes sense to move to Student Confidence area.

4) **Student confidence**:

Low- Students avoid speaking English as such, producing separate words or phrases. This is not connected with their gaps in vocabulary but rather with their fear of making mistakes, as their writing, reading and listening follow the demands of English level of proficiency B1-B2. In group work or pair work learners use Russian as the language of communication.

5) **Fun and excitement**:

Medium- Students prefer group or pair work to solve mathematical problems or to complete tasks. For independent learning they do not look excited, even rather unmotivated and disappointed. The application of games of physical activity in the classroom stimulates their involvement as noted.

6) **Overall involvement:**

Low- Lack of student-centred teaching, scaffolding and variety of different activities cause the low level of involvement for in-class activity during the subject of Mathematics. Students tend to be reluctant and not interested in the learning process. The interest shown during the application of games and new non-traditional tasks is the key point to assume that learners need to be involved into the process of learning not by traditional means, but by implementation of the student-centred approach and wide variety of activities regarding their interest and preferred learning styles (intelligences).

Next to the observation checklist, the questionnaires were analysed in order to reveal students' interest and their own attitude towards the subject of Mathematics as it is taught during the CLIL class. The results showed that the majority of students find Mathematics difficult and are not able to easily solve mathematical problems. They also do not think the subject of Mathematics is somehow meaningful or purposeful for their future, as they would rather choose another subject instead if Mathematics was not compulsory at school. The fact that Mathematics is taught in English makes the process of learning even more complicated (according to students' opinion) and difficult to understand. The table below shows the results of the questionnaire in a visual representation according to the areas provided by Jones (2009:29) – Meaningfulness of work; Clarity of learning; Critical, logical thinking; Performance orientation; Content and language (Table 1; Table 2; Table 3; Table 4; Table 5; Table 6):

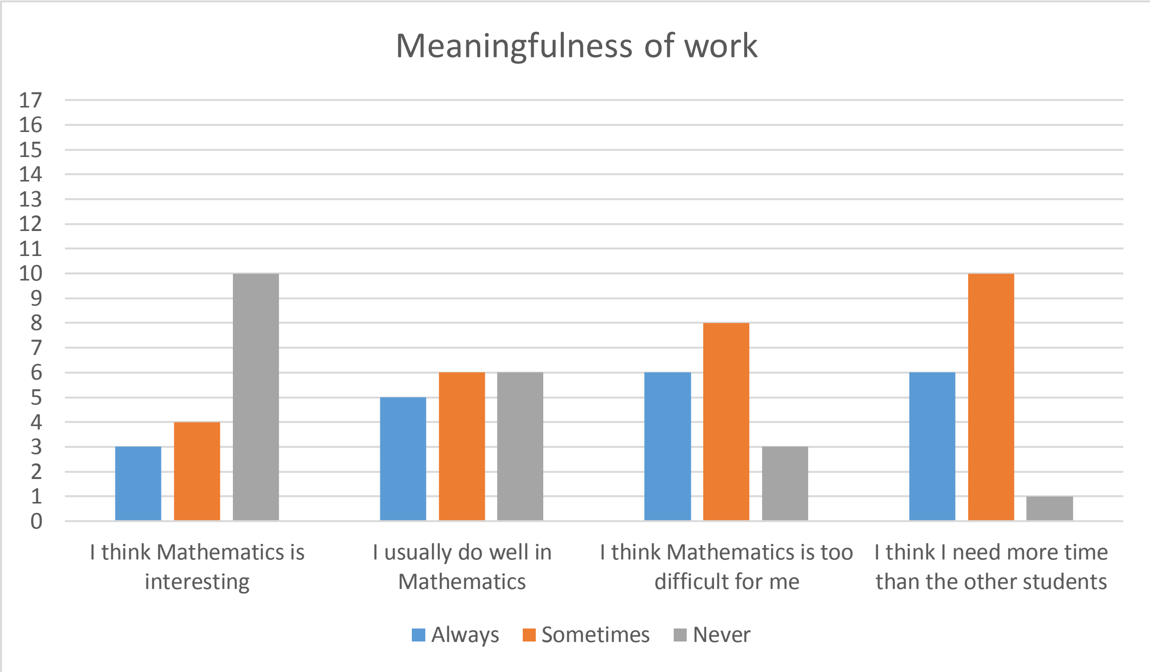


Table 1. Meaningfulness of work.

As it can be seen from the table, most students do not find activities and tasks during the CLIL class of Mathematics interesting. They do experience difficulties during the studies.

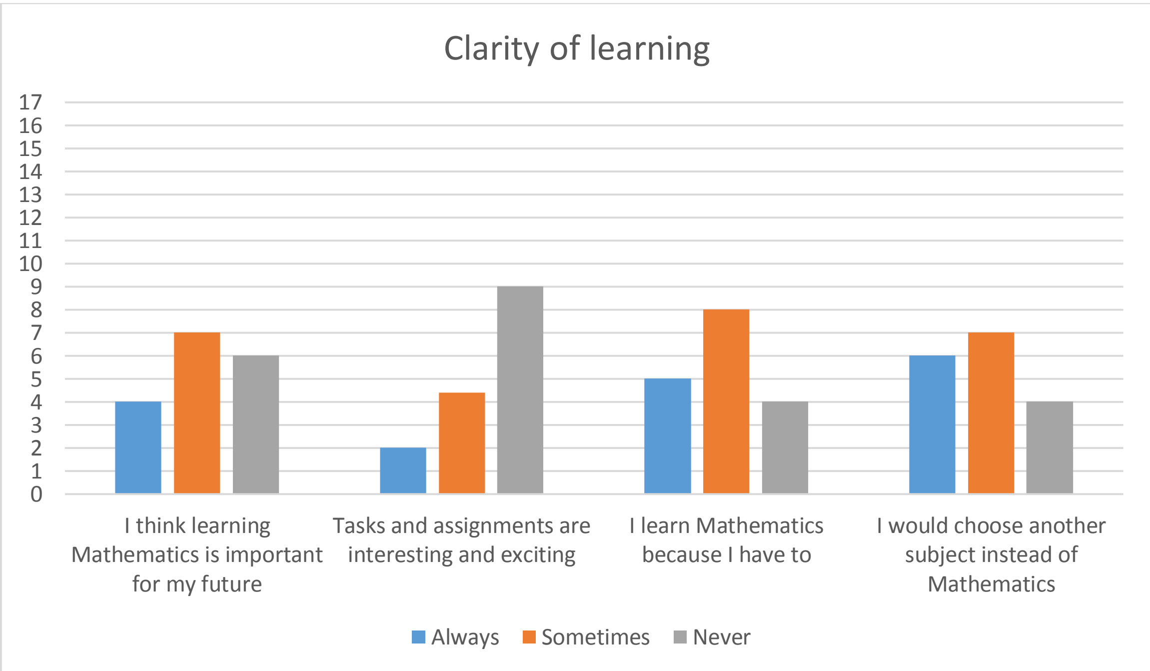


Table 2. Clarity of learning.

According to this table, students barely understand the purpose of studying the subject of Mathematics, as it is clear from their answers that they would choose another subject instead, if they had a choice.

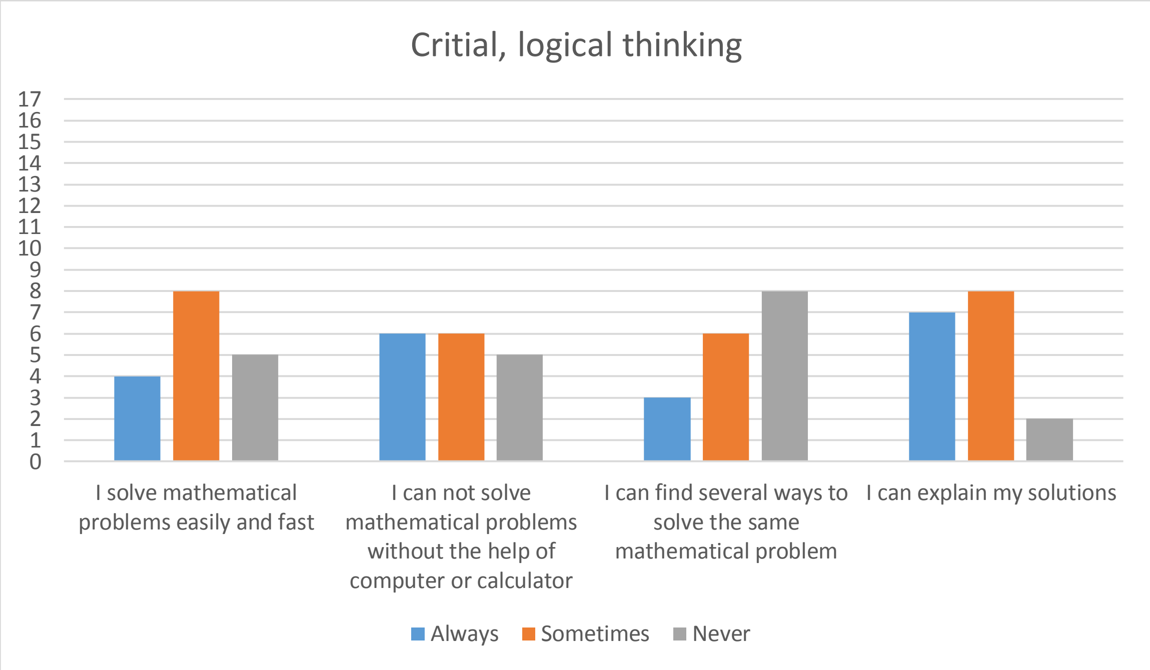


Table 3. Critical, logical thinking.

Students do not find solving mathematical problems an easy and fast process, next to that, they have difficulties in explaining their ways of thinking and thinking processes per se as they prefer using calculators and computers to find answers. The lack of variety of different activities cause the impossibility to solve the same mathematical problem in various ways.

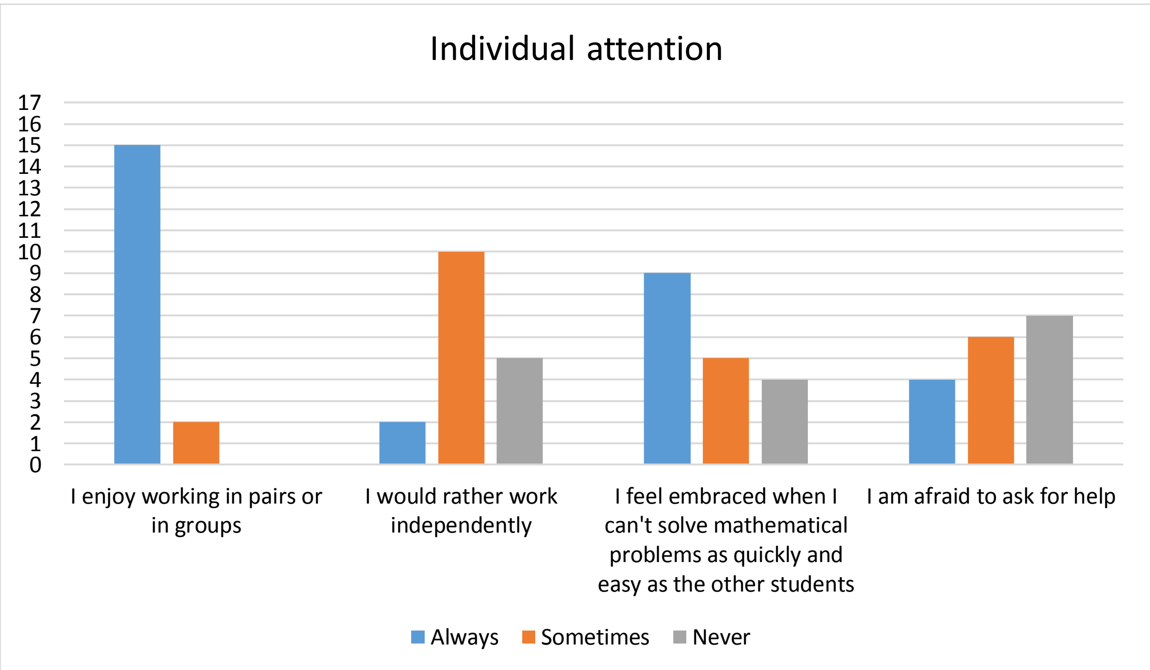


Table 4. Individual attention.

Students feel comfortable working in groups or pairs as in this case they have necessary support from other learner. The questionnaire showed that students are simply afraid to ask help from the teacher because they feel uncomfortable looking “less smart” than the other classmates. They compare their own work with the quality and speed of work of their fellow students and become unmotivated if the results are lower. Inconvenience and insecurity appears in the classroom as a result.

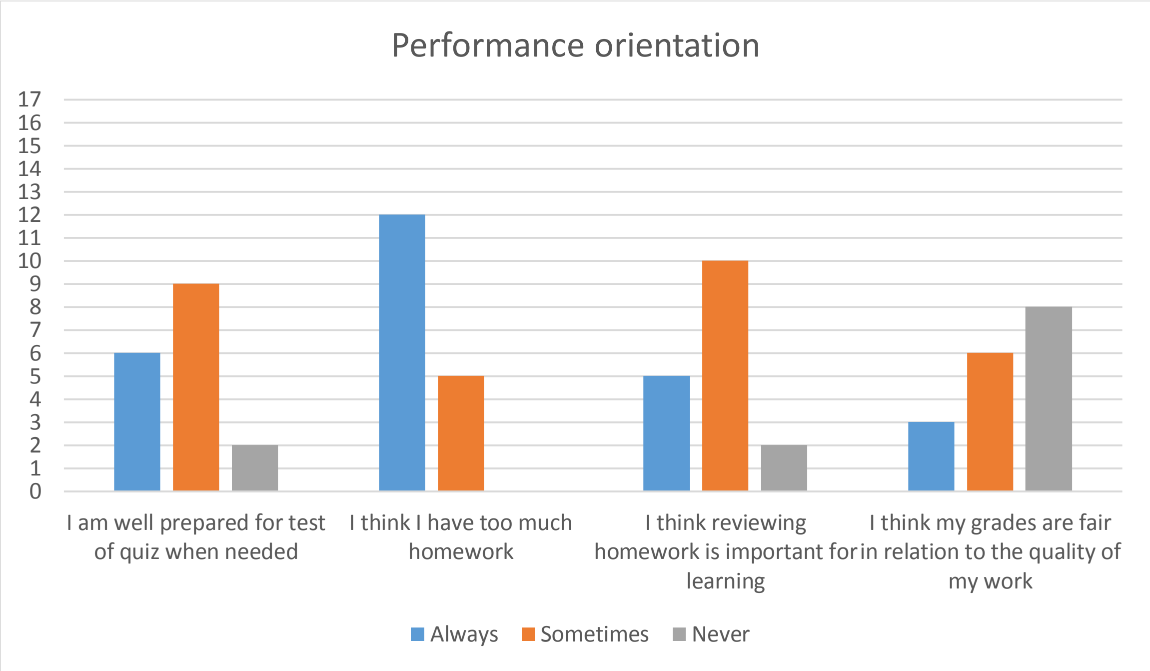


Table 5. Performance orientation.

The table shows that students are unsure about the amount of work and homework they need to complete. They do think that they have too much homework to be reviewed and that their results might have been higher comparing to their expectations. It is clear that they do not understand the criteria for assessment of their own quality and quantity of work.

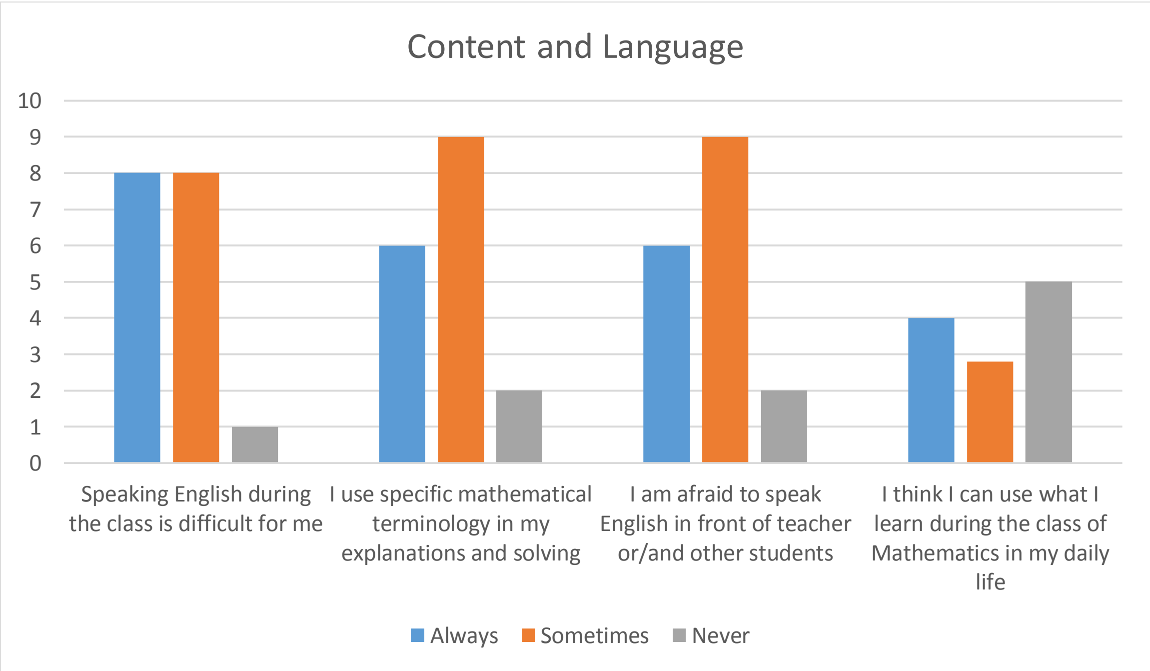


Table 6. Content and language.

Students face challenges speaking English for in-class activities, which goes from insecurity and the volume of content they need to examine. As it was clearly seen from the table – they sometimes use specific mathematical terminology, although they find it difficult to actually use it in their speech, as they feel uncomfortable to present their explanations or understandings regarding the topic in front of the teacher or/and classmates. Lack of supportive devices, such as scaffolding, cause the main challenges connected with content and language during the CLIL classes of Mathematics. The poor choice of activities during the class causes the reluctance of the learners and influences their involvement process as well as motivation in achieving high academic results and learning outcomes. In order to change the situation in the CLIL class of Mathematics, several steps are needed to be taken:

1. to understand what learning styles are preferred by students by creating and examining an MI class profile;
2. to design activities for in-class work based on MI class profile with reference to the aims of the lesson – learning outcomes;
3. to put MI activities in action during the CLIL class of Mathematics;
4. to analyse the result of application of MI activities in terms of students' involvement into the process of learning and their accomplishment of learning outcomes.

In order to understand what types of MI activities are needed for learners it was necessary to create a MI class profile, with the help of questions indicating preferred learning styles of each student (see Appendix 2). In this case, five questions were chosen to indicate each intelligence in each particular learner, therefore forty questions in total were expected to be answered by each student. The results are the following:

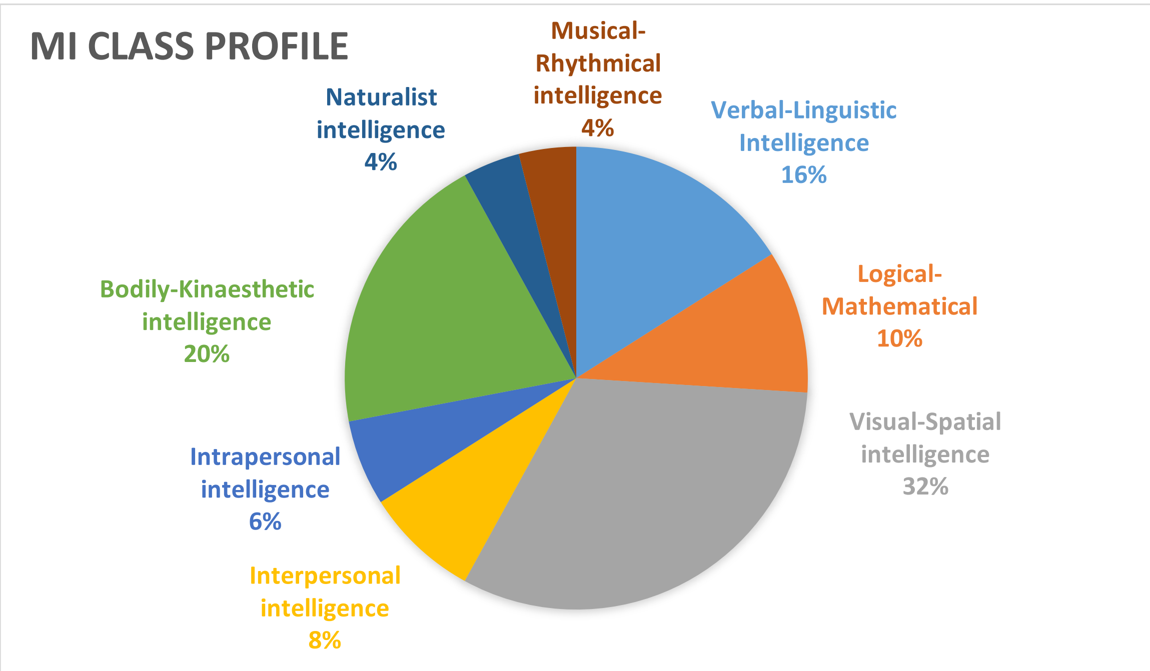


Table 7. MI class profile chart.

The chart above shows that the dominant intelligence in this particular class is Visual-Spatial, with the total amount of sixteen students out of seventeen appeared to have this preferred learning style. Next one, with the total amount of ten students out of seventeen have marked statements belonging to indicating Bodily-Kinaesthetic intelligence (Appendix 2) as "Always". The third intelligence that was revealed in eight out of seventeen students was Verbal-Linguistic intelligence. Logical-mathematical intelligence, which is ideally to be developed in classes of Mathematics, appeared in only five students out of seventeen, who have marked statements indicating this intelligence with "Always" or "Sometimes". According to the results of the questionnaire and the created MI class profile the learning process is supposed to be based with the help of such tools as images, graphs and other visual representations, which correspond to Visual-Spatial intelligence. Yet, the learning process has to be vivid and dynamic to correspond to Bodily-Kinaesthetic intelligence presented in the class. It can be assumed that appropriate activities, which focus on increasing students' involvement as well as on helping them achieve high academic results – accomplish their learning outcomes, are to be based on those four principles for the researcher to be considered:

1. MI activities and tasks have to contain visual representatives and demand students' movement in the classroom.
2. MI activities and tasks have to be based on and correspond to the aims of the lesson.
3. MI activities and tasks have to be assessed properly and evaluated in reference with students' results table.
4. MI activities and tasks have to be easily understood by students and correspond to the topic.

The aims of the lesson can be formulated in reference with the National Curriculum for upper secondary school (National Curriculum for upper secondary school: Appendix 3:8-10) and Bloom's taxonomy (cognitive outcomes) levels, which are the following in terms of visual-spatial and bodily-kinaesthetic intelligence (Armstrong, 2009:170):

9. Visual-spatial intelligence
    a. Knowledge: remembering details related to visual representation
    b. Comprehension: understanding differences from given diagrams
    c. Application: using geometrical principles
    d. Analysis: drawing detailed schemas of visual representation
    e. Synthesis: creating extensional scheme
    f. Evaluation: evaluating practicality of extensional schemes
10. Bodily-kinaesthetic intelligence
    a. Knowledge: identifying feelings
    b. Comprehension: identifying details for each specific type
    c. Application: searching the location for each specific type
    d. Analysis: handmade work or master classes
    e. Synthesis: gathering all the materials needed for handmade work
    f. Evaluation: evaluating the quality

The researcher focuses her attention on three topics of Mathematics, which are: course Numerical quantities. Expressions – Topic “Types of numbers”; course Vector – topic “Vector and its coordinates”; and course Probability and Statistics – topic “Random, certain and impossible events”. All three topics are presented in the form of a traditional lesson of forty-five minutes. All three topics are completely covered within three months, however the researcher’s intention is to notice and analyse the difference in the process of learning – students’ interest and their learning outcomes, via the presence or absence of MI activities and tasks during the CLIL lesson of Mathematics.

The subject of Mathematics is taught to students three times per week in the shape of introducing lesson, practicing lesson and reviewing lesson. The main action is always within the classroom; however, the teacher is able to give extra homework if she finds that lesson time is not enough for learning of a specific concept. As it is impossible to test students’ knowledge of the main topic without introducing it first, the researcher decided to put designed MI activities into the practicing lesson and to give students the post-test in the reviewing lesson. However, in order to see how MI activities influenced students’ involvement and their learning outcomes, it is important to test their previous knowledge which they have got via the traditional way of teaching – teacher-centred approach with lecturing as the main tool of delivering information.

In order to see students’ academic results, a short test (in reference with the undergoing topic) was taken before the application of MI activities in the classroom as well as after: for all three classes of Mathematics the researcher designed a simple fifteen-questions test based on the topic of the introduction lesson in order to check students’ previous and prior knowledge of the content and language (five open questions, five questions of multiple choice and five matching questions). It was decided to give students a shorter test in the beginning[6], including only five questions which were formulated on the basis of the full test – to be given in the reviewing part of the lesson, after the application of MI activities (Appendix 3: PRE-TEST ONE, PRE-TEST TWO, PRE-TEST THREE). The short test, however, includes the same concepts that the full test has, but the researcher’s idea was to check students’ knowledge on specific topics in a general way before the application of MI activities, to be able to compare the results with the post-test, which corresponds to the aims of the lesson in a more detailed way. Both tests are based on lesson goals (learning objectives) taken from the topics of ongoing courses of Mathematics from the National Curriculum. The assessment of the result of the pre-test was conducted via students’ results table: all the five right answers per topic – “5”; four right answers – “4”; three right answers result in the

[6] *In the beginning* here does not automatically mean in the beginning of a lesson. It corresponds to the time when MI activities are not yet introduced to the class.

mark “3” and two right answers correspond to “2”. One right answer means “1” or “fail” which corresponds to lack of knowledge in the given topic. The assessment of the post-test corresponds to the students’ results table (Appendix 3).

2.1. CLIL Class of Mathematics: “Types of Numbers”

The lesson which was chosen for application of MI activities was a practicing lesson with the aim to let students practice their existing knowledge of the topic. In fact, it was the second lesson dedicated to the topic “Types of Numbers”. The lesson had two main learning outcomes:

1) Student knows all the types of numbers and can differentiate one type from another according to its characteristics (either by matching terms with their examples or definitions).
2) Student knows formulae related to the topic and can solve polynomial equations via those formulae.

The analysis of the test which was administered before the application of MI activities (Appendix 3:PRE-TEST ONE) is shown via the following graph:

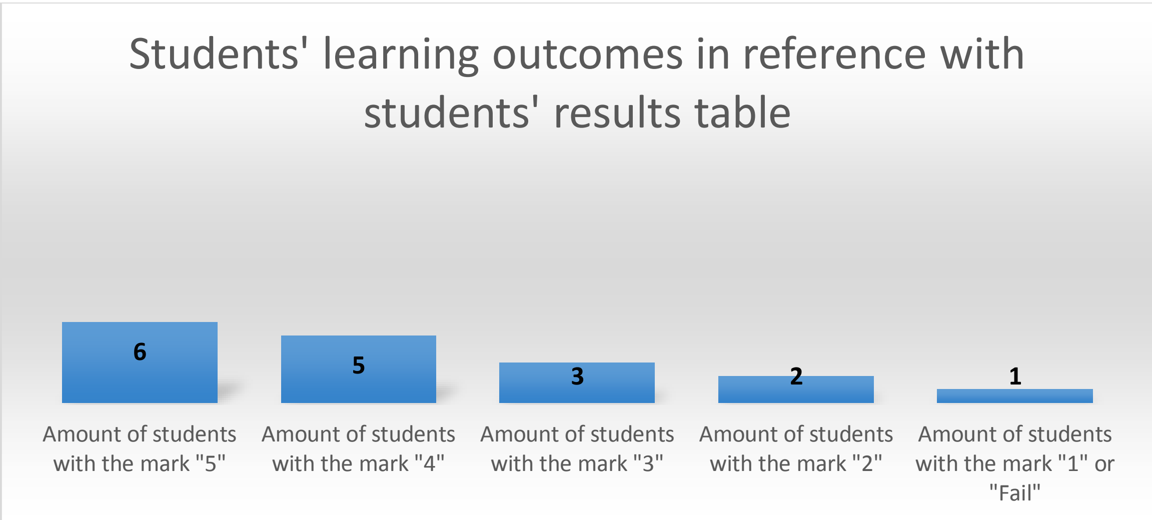


Table 8. Students' learning outcomes in reference with students' results table – pre-test one.

As seen from the graph, only six students out of seventeen successfully coped with the test given before the application of MI activities into the CLIL class of Mathematics. The average score of the class of the completion (means without the “negative” marks which are “2” and “1”) of assignment is therefore ≈ 3.47.

In order to analyse the achievement of learning outcomes by students it is necessary to provide class with the activities which are aimed at the same learning results. In this case it is easy and accurate for the researcher to see the difference between the results and observe the (theoretically positive) influence of MI activities on those learning outcomes.

As it was proposed above by the researcher and based on the MI class profile, activities must follow the following requirements: they must contain visual representations as stated in the theory of MI intelligences for learners with Visual-Spatial dominant intelligence (Gardner's multiple intelligences, no data: 3-9; see Appendix 1).

The researcher decided to give students the opportunity to design their own parts of graphs with given terms (The evolution of numbers, 2006) which tend to stay in class and be put on classroom walls to give students additional support during the following lessons and tests. The activity in this case was shaped in the style of group work to provide students with additional scaffolding and support both in terms of given a task:

Group one (four members)

1. Design the table consisting of the following terms: **Natural numbers**; **Integers**
2. Write in their distinctive characteristics and examples

Group two (four members)

1. Design the table consisting of the following terms: **Rational numbers**; **Irrational numbers**
2. Write in their distinctive characteristics and examples

Group three (four members)

1. Design the table consisting of the following terms: **Algebraic numbers**; **Transcendental numbers**
2. Write in their distinctive characteristics and examples

Group four (five members)

1. Design the table consisting of the following terms: **Real numbers**; **Imaginary numbers; Complex numbers**
2. Write in their distinctive characteristics and examples

After completing the assignment in separate groups, students are expected to design the complete table of all the number types with their distinctive features and examples. The purpose of this task is to let students use the opportunity to design and create their own visual representation of classification of numbers with the examples which are expected to guide them during other classes of Mathematics and also quizzes and tests.

The completion of the task did not take a lot of time (approximately 10 minutes in groups and 5 minutes all together), as students were able and allowed to use their previous knowledge, printouts provided by the teacher and course books. The presentation of the final table with all the types of numbers and their examples was done in the form of discussion – before teacher actually put the table on the wall and asked students questions about different types of numbers by writing her own examples of the blackboard.

The second activity was supposed to be based on bodily-kinaesthetic intelligence, which required students' movement within the classroom (Gardner's multiple intelligences, no data: 3-9; see Appendix 1). The teacher decided to use so-called Mathematical Charades (Alternatives for Innovative Math Study, 2015: para 10) in order to give students an opportunity to explain different concepts in their own way and also let them use the target language – English to define the hidden word. The list of different charades was designed based on the topic "Types of Numbers" including terms, examples of different types, theorems and formulae, then cut into separate pieces of paper – each including only one term (Appendix 4). The class is divided into two big groups. One participant from each group (by turn) explains the term whilst the rest of his/her group remain silent, the explanatory is able to use only chalk and black board to draw hints – formulae, or examples of types of numbers or corresponding equations. His own group guesses the term or the formulae within the time limit – 1 minute. If they fail, the competitive team guesses the same term. The group whose guess was right sends the next one to run to the blackboard, pick up his/her term, example or formulae and explain. All the terms for explanation are provided by teacher in the shape of random choice. As there are 17 students in the class, it is expected that the time for this particular assignment is no more than 20 minutes including teacher's instructions and organizing. The winning team was granted with the ability to choose one home assignment from two of them provided by teacher.

For the beginning of the next class of Mathematics – the reviewing lesson, with the same topic, the full test (Appendix 3: POST-TEST ONE) was given to students in order to check their knowledge and their results of the process of learning in respect with the aims described above:

1) Student knows all the types of numbers and can differentiate one type from another according to its characteristics (either by matching terms with their examples or definitions).
2) Student knows formulae related to the topic and can solve polynomial equations via those formulae.

The results of the test are the following:

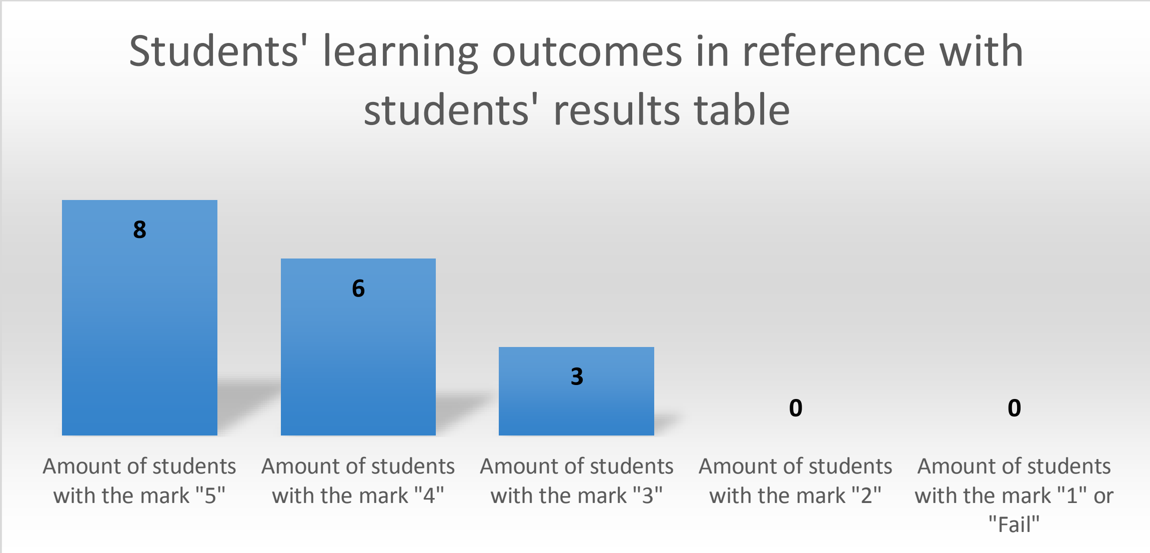


Table 9. Students' learning outcomes in reference with students' results table – post-test one.

As it is seen from the graph, eight students out of seventeen successfully coped with the test and got the best mark possible after the application of MI activities in the CLIL class of Mathematics. The average score in this case is therefore ≈ 4.29 (only positive results including marks “5”, “4” and “3”, which is approximately ≈ 0.82 points higher than the previous test before the MI activities application. It should be mentioned that none of the students failed the test or got the “negative” mark – “2” or “1”.)

It can be assumed that MI activities given for this topic led students to the better understanding of the main concept of this particular topic of Mathematics. It is also needed to keep in mind, that working in groups provided students with necessary support in terms of content and language (scaffolding), as well as reduced stress from working independently. The product of the Visual-Spatial intelligence activity gave students an additional confidence from the physical environment of the classroom.

2.2. CLIL Class of Mathematics: “Vector and its Coordinates”

The practicing lesson (in fact, the second lesson dedicated to the same topic) was chosen by the researcher to check students’ existing knowledge on the topic “Vector and its coordinates” with the pre-test based on the main concepts of the topic (Appendix 3:PRE-TEST TWO).

The aims of the lesson are the following:

1) Student has knowledge to describe terms “vector”, “parabola”, “scalar”, “coordinates” and “circumference” and skills to distinguish them from each other;
2) Student has skills to operate with “vector” by subtracting, adding and multiplying.

The analysis of this pre-test is the following:

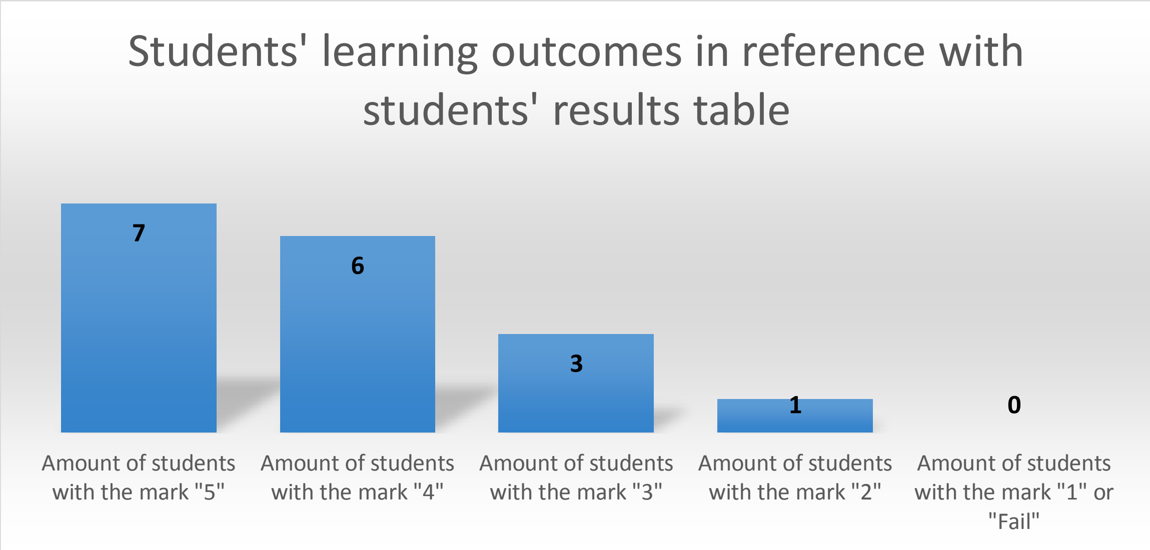


Table 10. Students' learning outcomes in reference with students' results table – pre-test two.

As it can be easily seen from the graph, only seven students out of seventeen successfully coped with the test given before the application of MI activities into the CLIL class of Mathematics. In this case, the average score of the class of the completion of the test (means without the "negative" marks which are "2" and "1" or "Fail") is therefore exactly = 4, which is reasonably high. It can be said that students coped with pre-test two in approximately ≈ 0.53 points better than with the pre-test one.

On the basis of the MI class profile and dominant intelligences (Visual-Spatial and Bodily-Kinaesthetic intelligences), the researcher decided to give students two assignments to complete: one pair work assignment with the focus on Visual-Spatial intelligence and one group work with the focus on Bodily-Kinaesthetic intelligence. Both assignments are based on the lesson aims.

For the assignment number one – pair work, students have so-called "Information gaps" lists (Appendix 5): two identical pieces of paper with the information about the topic in the shape of a mind map. The issue is that both papers have certain information, required to complete the assignment, missing, and the learners have to communicate with each other in order to complete the gaps. Logically, they are not allowed to show their list to the partner (Dale et al., 2012:177). The activity is considered to be done when every student has its list complete. The teacher has her own list in a format bigger than students' (A3) to be hung on the blackboard. After all students complete their lists the teacher asks them to guide her in filling her own list – one by one learners help the teacher to complete her own list with the information they have.

The activity is rather time consuming, but the format of pair work gives students required confidence and support to complete the assignment and to participate in the discussion with the teacher. Practically, the activity was under 20 minutes. The teacher's list is to be hung on the wall with the other supportive materials to enrich the physical environment for the process of learning.

The second activity is a group work activity. The class is divided into four groups of three students and one groups of four students and each group is given an answer sheet (Appendix 6). The classroom is divided into five stations: Multiplying Station; Adding Station; Subtracting Station; Matching Station; Real Life Examples Station. Each group starts at the station chosen by its members by drawing lots. There are three assignments at each station (Vectors, 2016): solving the mathematical problem, matching the definitions with the terms, distinguishing different types of lines or providing the examples of vector in the real life (Appendix 6). Each group has to complete all three assignments per each station to win, however, they need to take into consideration such rules, as:

1. Only one group per station – the other groups need to wait or to move to another free station.
2. Examples provided by the previous groups cannot be used again.
3. Each member of the group has to solve one mathematical problem – but the help of other members from the same group is allowed.
4. Each member of the group has to put his/her name next to the question/problem he/she has solved (the teacher can review the paper later to see what difficulties each student faced and who might need additional support).
5. The team that completes all the assignments from all the station first is able to work in pairs or in groups at the next lesson of Mathematics.

The main idea of the activity is to let students walk freely in the classroom and to give them opportunity to decide themselves what assignment they do first. It gives a certain feeling of freedom of choice, even though learners eventually do all the assignments planned by the teacher for the lesson. The team who won is allowed to assess all the other teams and their marks (the grade for in-class work) will be taken into consideration by the teacher.

The next class – the reviewing lesson starts with the post-test (Appendix 3: POST-TEST TWO), and the results are the following:

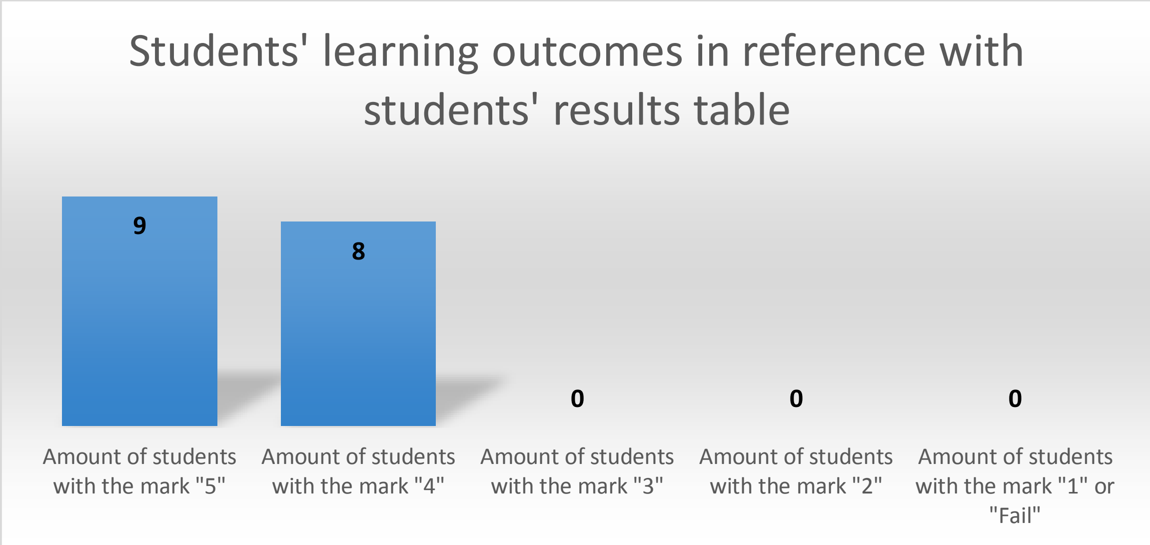


Table 11. Students' learning outcomes in reference with students' results table – post-test two.

The table shows that practically all students successfully coped with the test (none of the students got a "negative" mark – "2", "1" or "Fail"). Even though students showed reasonably high results in the pre-test, the application of MI activities affected the process of learning in a positive way in terms of achieving higher learning outcomes by students – the average "positive" (only marks "5" and "4" were taken into account) score in class was approximately ≈ 4,52, which is ≈ 0,52 points higher that the test before. It is also needed to be mentioned that none of the students failed the test or answered less than eleven questions right (as eleven right questions correspond to the mark "4").

Working in pairs and in groups provided students with the support in terms of language and content – as they were allowed to help each other. The freedom of choice, or in other words, the illusion of freedom – because they still had to complete all the assignments, given to students in the form of the Five Stations activity was to awake their interest and responsibility to decide themselves which task should be done firstly.

2.3 CLIL Class of Mathematics: "Random, Certain and Impossible Events"

The set of MI activities for the next topic – "Random, certain and impossible events" was chosen to be implemented via the same scheme – into the practicing lesson dedicated to the given topic. With the aims below the pre-test (Appendix 3: PRE-TEST THREE) showed the following results:

1) Student has knowledge to describe terms "random event", "certain event", "dependent event", "independent event", "probability", "impossible event", "statistics" and "mutually exclusive" and to distinguish them from each other;
2) Student has skills to calculate the probability using particular formula and make the connection between certain event and its results.

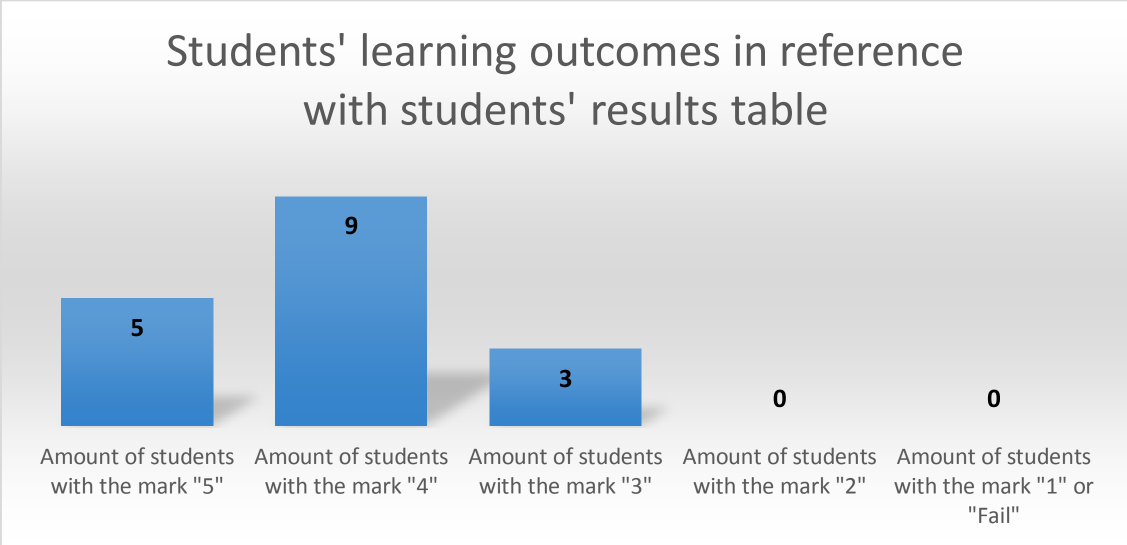


Table 12. Students' learning outcomes in reference with students' results table – pre-test three.

The results of the test are more or less satisfactory, as most students successfully coped with the questions and none of the students failed the test or got a "negative" – "2" or "1" mark. The average score is ≈ 4,11. However, the amount of students who answered all five questions right is considerably less in comparison to those who made one or two mistakes – only five students knew answers to all the questions. Nevertheless, the MI activities are focused on the achieving of higher learning results, therefore the researcher offered two types of activities – one based on Visual-Spatial and another on Bodily-Kinaesthetic intelligence respectively.

Both activities are conducted during the practicing lesson in order to support the existing knowledge of the topic. The first activity is called "Paradox" and based on several statements in respect with the topic (Probability: Types of numbers, 2016). Students are divided into two groups of 6 and one group of 5 members. All three groups have their own piece of paper (A3 format) on the table divided into four equal sections. Next to the sheet, there are twenty statements on separate paper strips – one statement on each strip (Appendix 7). Within 10 minutes, students are expected to put all statements on their right places into every section and not to cause a paradox – a self disposed fact. After all, groups exchange their tables and they need to assess their classmates' works – in case of mistakes they need to explain the right answer to the other group. Teacher's role is to monitor, guide and ask questions when the activity is finished – what was difficult, what was easy and what was doubtful. The overall time limit for the activity is not more than 20 minutes including teacher's instructions and evaluation.

The second activity corresponds to Bodily-Kinaesthetic intelligence, therefore demands student's personal experience and physical movements within the classroom. The students need to work both independently and in pairs/groups. First of all, they are given the answer sheet with five questions (Appendix 8) when the first one they need to answer independently. They need to toss the coin (their own coin or provided by the teacher to be returned after the activity) five times and write the results into their personal answer sheets. When they are all done the teacher asks them to find someone who has the same results as they have in the class and calculate the probability of finding someone with the same results. Then, with the partner or in a group (or if one student has neither a partner nor a group – therefore he works independently) students are asked to calculate the probability of the results they have in decimals, fractions and percentage. The evaluation is conducted in terms of a class discussion – the teacher writes the examples of the results with the probability formulae on the blackboard to give students extra visual representation. The approximate time limit for this activity is 20 minutes maximum, including all the actions and teacher's explanations of the activity.

For the reviewing lesson students are given the post-test (Appendix 3: POST-TEST THREE) to check their knowledge of the given topic, and the results of this test are the following:

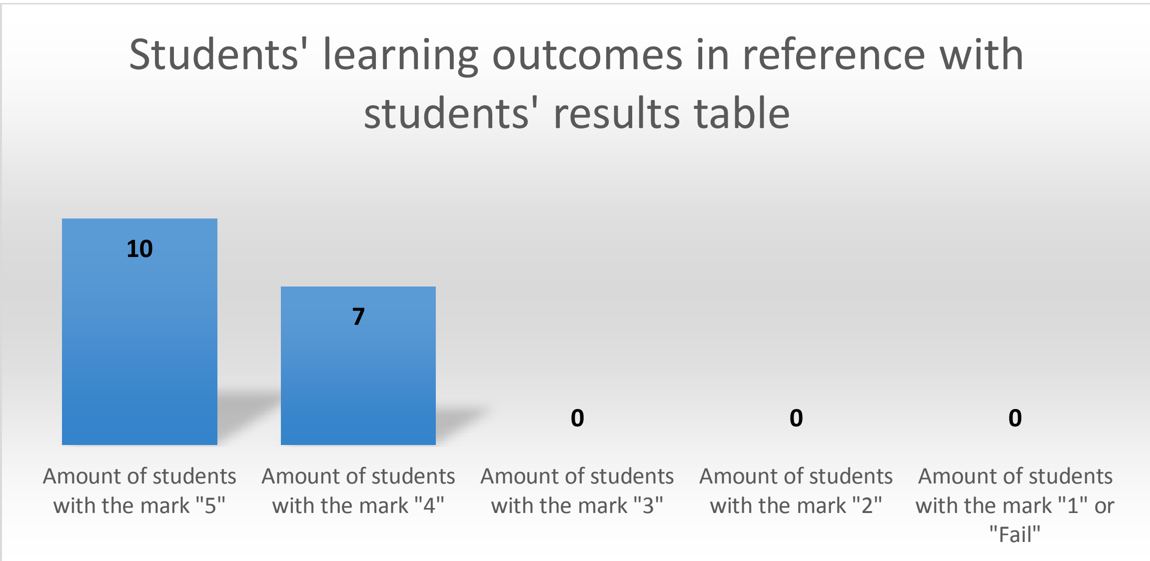


Table 13. Students' learning outcomes in reference with students' results table – post-test three.

The analysis of the test's results shows that all the students got only the "positive" grades – none of students failed or got the "negative" grades – "2" or "1". The average score in this case is approximately ≈ 4,58, which is around 0,47 points higher than before the application of MI activities. It has to be mentioned that ten students out of seventeen answered all the fourteen-fifteen questions right and the minimum amount of questions answered right by seven students is eleven (as eleven rightly answered questions correspond to the minimum for the grade "4").

To sum up, all students were more or less satisfied with their own results and expressed their will to continue the process of learning in the shape of similar activities. Students were proud of their own abilities and achievements so they tried to underline the fact that they learn Mathematics in the form of a play and find the subject easy and understandable this way. Their concerns were mostly about the language, however students mentioned that working in groups helped them in order to find required vocabulary and remember specific terms. Creating the tables, graphs and other visual tools in the classroom they have considered as some sort of game – although they were certain that putting visual representations in a logical order is helpful in order to understand the concept and physical movement within the classroom reduces stress and awakens the brain as the body is in action. The researcher is impressed with the results, although the main teacher is not willing to continue the application of MI activities in the classroom, as she mentioned the academic load and time limits as the main issues.

The researcher’s idea was to observe all three lessons during the application of MI activities in order to see students’ involvement and give an overall feedback by the end of the research. The analysis of the involvement in respect with the involvement observation checklist, is the following (Based on Jones, 2009:29):

1) **Positive body language**:

High - students pay attention to teacher’s instructions and explanations for the activities, and become visibly excited – start moving, choosing the partner or the group, preparing physically and mentally (picking up the pen, moving to the other place, picking up their notes).

2) **Consistent focus**:

Medium- Students are engaged with the activity, however, they try to be competitive and focus not only on their own group/pair but also on other groups in order to evaluate their chances to win.

3) **Verbal participation**:

High- Students actively communicate within the group or in pairs using both target and native languages, switching from one to another. In the groups it was observed how other students provided certain vocabulary –scaffolding for their group mates, by using specific mathematical terminology.

4) **Student confidence**:

Medium- Students are still anxious to speak English in front of the class, but they feel more comfortable to divide their presentation among group members so everyone says something.

5) **Fun and excitement**:

High - Students were excited to work in groups or in pairs and could not wait for the teacher to finish her instructing to move to their partners. They tried to be creative by using multiple colours in their group works as they knew that their tables and graphs will be hung on the classroom walls.

6) **Overall involvement:**

High - Several aspects were observed during the lessons with the MI activities – students used scaffolding both in content and language areas; visual representations were created very accurately and detailed and in a logical order; physical movements within the classroom and their own personal practical experience (tossing the coin) reversed the focus from the teacher to the students, their needs, interests and preferred learning styles. It creates positive environment for the process of learning, grants students with the certain amount of responsibility for their own process of learning, and gives them the ability to assess their own knowledge and skills in reference with the topic.

The aims of the present research were fulfilled and the hypothesis was proved, therefore the author of the present paper considers the research to be ended successfully.

CONCLUSION

The present research investigates the impact of MI activities in CLIL classes of Mathematics in English – whether MI activities have a positive influence on students' involvement into the process of learning of both content and language of Mathematics in English, and on the learning outcomes – how they support the process of learning in order to achieve high academic results. It is needed to be kept in mind that learning results must correspond to the learning objectives for the subject of Mathematics in the National Curriculum, therefore the Estonian National Curriculum for upper secondary school was studied and taken into consideration. In order to reveal the dominant intelligence(s) in the class, the researcher had to present the MI class profile, on the basis of which the set of MI activities were designed. The set of activities was implemented into three practical lessons covering three different topics in reference with the courses of both narrow and extensive Mathematics from the National Curriculum. The results of pre-tests, administered before the application of MI activities in the class, and post-tests for each specific topic and in reference with those topics' aims, were analysed and compared in order to reveal the significant difference in students' academic results and to prove the positive influence of MI activities on students' involvement and learning outcomes.

Chapter I explains the main principles the researcher basses her work on – the CLIL approach, the MI theory and student-centred teaching. It provides necessary literature studies in relation with CLIL and MI theory, and it illustrates the main principles on the basis of which the researcher designed a set of MI activities. The National Curriculum and its learning objectives for the subject of Mathematics in upper secondary school is also described in Chapter I. This chapter provides the theoretical background of the research, and it is based on works of such researchers as Howard Gardner (1993), Kaire Tampere (2010), Do Coyle (2010), Thomas Armstrong (2009) et cetera.

The main principles revealed in Chapter I and, therefore, served as the basis for designing the MI activities, are:

1) One of the main CLIL approach principles is student-centred teaching, which provides students with the required scaffolding both in content and language – whether in the form of group work, pair work or peer assessment;
2) Students have their own preferred learning styles on the basis of which the MI class profile can be made;
3) The MI class profile gives an overview of the dominant intelligences existing in the majority of learners and serves as the basis for designing MI activities in respect with those intelligences;
4) The application of MI activities positively influences students' involvement into the process of learning and provides the way for students to achieve their learning outcomes.

Chapter II presents the MI class profile analysis, shows the steps of application of MI activities in the class, describes the designed MI activities and illustrates the analysis of the situation in the class before the application of MI activities and after it in order to compare the results of pre-tests and post-tests, as well as the involvement of students into the process of learning. The findings and the results of the application of MI activities are the following:

1) Students are excited to take part in the activities provided by the researcher because they require student-centred teaching and are focused on students' needs and demands;
2) Students prefer working in groups and in pairs as in this case they provide each other with scaffolding – support in content and language areas;
3) Based on the MI class profile, students require physical movement in the classroom, therefore practical activities, where the learners are expected to physically experience the concepts of the topic they are learning, cause an interest and excitement;
4) Students are amused creating their own supportive material in the form of visual representations in order to enrich their physical environment in the classroom;
5) Students become active as they are excited with the amount of responsibility they get during the student-centred teaching;
6) Learning outcomes have proved that MI activities provide students with the strong input in relation with the topic, so they are able to actively participate in the process of learning and remember the necessary material.

The present study confirms the hypothesis of the present thesis, and the findings prove the positive influence of MI activities on students' involvement into the process of learning of the subject of Mathematics in English at the upper secondary school level; as well as it illustrates the positive impact on students' learning outcomes.

REFERENCES

1. Accelerated Christian Education. 2016. Available at http://www.aceministries.com, accessed 03.05.2016.
2. Alternatives for Innovative Math Study. 2013-2015. E-twinning project. Available at https://aimscomenius2013.wordpress.com/activities/bodily-kinesthetic-intelligence/, accessed 10.05.2016.
3. Anderson, L. W., Krathwohl, D. P. 2001. Bloom's taxonomy revised. Available at http://thesecondprinciple.com/teaching-essentials/beyond-bloom-cognitive-taxonomy-revised/, accessed 02.05.2016.
4. Anderson, L. W., Krathwohl, D. P. 2001. A taxonomy for learning, teaching and assessing: a revision of Bloom's taxonomy of educational Objectives. Boston: Pearson Education Group.
5. Armstrong, T. 2009. Multiple Intelligences in the classroom. Available at https://erwinwidiyatmoko.files.wordpress.com/2012/08/multiple-intelligencies-in-the-classroom.pdf, accessed 02.05.2016.
6. Asser, H., Mehisto, P. 2007. Windows on CLIL: Content and Language Integrated learning in the European Spotlight. Alkmaar: European Platform for Dutch Education
7. Bednar, J., Coughlin, J., Evans, E., Sievers, T. 2002. Improving students' motivation and achievement in mathematics through teaching to the multiple intelligences. Available at http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1017&context=mathmidsummative, accessed 02.05.2016.
8. Berube, N. 2014. Multiple Intelligences – Activities for Creating a Good Student Profile at the beginning of the school year. Available at http://ldatschool.ca/assessment/multiple-intelligences/, accessed 02.05.2016.
9. Cambridge English. 2010. *Teaching Maths through English – a CLIL approach.* Cambridge: Cambridge University Press.
10. Calculating the circumference of a circle. No data. Available at http://www.mathplanet.com/education/pre-algebra/more-about-equation-and-inequalities/calculating-the-circumference-of-a-circle, accessed 08.05.2016
11. Classroom recourses. 2012. Which is Best: Teacher-centred or Student-centred Education? Available at http://education.cu-portland.edu/blog/classroom-resources/which-is-best-teacher-centered-or-student-centered-education/, accessed 02.05.2016.
12. Cohen, L., Manion, L., Morrison, K. 2007. Research methods in Education. New York: Routledge Taylor & Francis Group.

13. Common European Framework of Reference for Languages. 2000. Available at http://www.coe.int/t/dg4/linguistic/Source/Framework_EN.pdf, accessed 02.05.2016.
14. Cooperative Learning and Multiple Intelligences. 2011. Available at http://ulises.cepgranada.org/moodle/mod/page/view.php?id=14868, accesses 02.05.2016.
15. Coyle, D., Hood, P., Marsh, D. 2010. Content and Language Integrated Learning. Cambridge: Cambridge University Press.
16. Dale, L., Tanner R. 2012. CLIL activities. *A resource for subject and language teachers.* Cambridge: Cambridge University Press.
17. Davis, B. G. 1999. Motivating Students. *From tools for teaching.* Available at http://www.nssa.us/journals/2007-29-1/2007-29-1-16.htm, accessed 02.05.2016.
18. Dictionary. No data. Available at http://www.dictionary.com/browse/involvement, accessed 10.05.2016.
19. Estonian Language Proficiency Levels. No data. Available at http://www.innove.ee/en/language-examination/for-whom, accessed 02.05.2016.
20. Freire, P. 1972. Cultural Action for Freedom. Harmondsworth: Penguin.
21. Foundation Innove. 2015. Available at http://www.innove.ee/UserFiles/International%20cooperation/Innove%20tutvustus%20updated.pdf, accessed 02.05.2016.
22. Gardner, H. 1993. Frames of Mind. *Theory of Multiple Intelligences.* USA: BasicBooks.
23. Gardner, H. 2001. The three meanings of Intelligence. Available at https://howardgardner01.files.wordpress.com/2012/06/the-three-faces-of-intelligence1.pdf, accessed 02.05.2016.
24. Gardner, H. 2005. Multiple Lenses on the mind. Available at http://www.ac-grenoble.fr/ien.annecy3/IMG/pdf/gardnermultipleintelligence.pdf, accessed 02.05.2016.
25. Gardner's Multiple Intelligences Theory. 2015. Available at http://clilsteps.blogspot.com.ee/2015/03/gardners-multiple-intelligences-theory.html, accessed 02.05.2016.
26. Graphing parabolas. No data. Available at http://2012books.lardbucket.org/books/beginning-algebra/s12-05-graphing-parabolas.html, accessed 08.05.2016.
27. Jones, R. D. 2009. Students Engagement. *Teacher handbook.* New York: International Center for leadership in education.
28. Mehisto, P., Marsh, D., Frigols, M. J. 2008. Uncovering CLIL. UK: Macmillan Education.

29. Merriam-Webster dictionary. No data. Available at http://www.merriam-webster.com/dictionary/motivation, accessed 18.05.2016
30. National Curriculum for upper secondary school. 2011. Available at https://www.hm.ee/en/national-curricula, accessed 02.05.2016.
31. Nicholson-Nelson, K. 1998. Developing students' multiple intelligences. New York: Scholastic.
32. Probability: Types of events. 2016. Available at http://www.mathsisfun.com/data/probability-events-types.html, accessed 11.05.2016.
33. Tampere, K. 2010. Content and language Integrated Learning. *Estonian CLIL teacher Profile.* Germany: LAP LAMBERT Academic Publishing AG & Co.
34. The evolution of numbers. 2016. Available at http://www.mathsisfun.com/numbers/evolution-of-numbers.html, accessed 08.05.2016.
35. Using Multiple Intelligence Theory in Math teaching. 2015. Available at http://blog.scientix.eu/2015/01/26/using-multiple-intelligence-theory-in-math-teaching/, accessed 02.05.2016.
36. Vectors. 2016. Available at http://www.mathsisfun.com/algebra/vectors.html, accessed 08.05.2016.
37. Walqui, A. 2006. Scaffolding Instruction for English language Learners: A conceptual framework. *The international journal of Bilingual Education and Bilingualism.* Volume 9, No 2.

SUMMARY IN ESTONIAN

Antud töö pealkiri on “Mitmekülgse intellekti tegevused gümnaasiumiastme LAK-õppe klassi inglisekeelses matemaatika tunnis: õpilaste kaasamine õppeprotsessi ja selle mõju õpitulemustele”. Käesolev töö uurib mitmekülgse intellekti (MI) tegevuste mõju LAK-õppe klassi inglisekeelses matemaatika tunnis: kas MI tegevused loovad positiivset mõju õpilaste kaasamisele õppeprotsessi, seda nii sisu omandamise kui ka keeleõppe perspektiivist, ja kas need MI tegevused mõjuvad positiivselt õpilaste õpitulemustele - kuivõrd MI tegevused toetavad õppimise protsessi ning aitavad saavutada kõrgeid akadeemilised tulemusi. Ka on vaja meeles pidada, et õppimise tulemused peavad vastama gümnaasiumi matemaatika ainekava põhieesmärkidele riiklikus õppekavas, mida ka antud töös on arvestatud. Selleks, et määrata klassis domineerivad intellekti tüübid, lõi antud töö autor MI klassi profiili, mille põhjal planeeritud MI tegevused olid kujundatud. Planeeritud MI tegevused viid läbi kolme praktilise klassitunni jooksul, hõlmates kolme erinevat teemat lähtuvalt nii kitsast kui ka süvendatud matemaatika riiklikust õppekavast. Õpilastega viidi läbi ka uuringueelsed ning –järgsed testid ning analüüsiti võrdlevalt saadud tulemusi, et vaadelda erinevust enne ja pärast MI tegevuste kasutamist ning tõestada MI tegevuste positiivset mõju õpilaste kaasamisele ja õpitulemustele.

I peatükk selgitab põhiprintsiipe, millest autor oma töös lähtus – LAK-õppe lähenemine, MI teooria ja õpilasekeskne õpetamine. Peatükk annab vajaliku kirjanduse uuringuid seoses LAK ja MI teooriaga ning illustreerib peamisi põhimõtteid, mille alusel uurija kujundas oma läbiviidavate MI tegevuste komplekti. Teoreetilise raamistiku kujundamisel on autor toetunud peamiselt Howard Gardneri (1993), Kaire Tampere (2010), Do Coyle`i (2010), Thomas Armstrongi (2009) jt käsitlustele. Samuti esitab peatükk Eesti riikliku gümnaasiumi õppekava ja selle õppimise eesmärkide analüüsi gümnaasiumi matemaatika aine teemakäsitluste osas.

Peamised põhimõtted, mis on kirjeldatud esimeses peatükis ja mille põhjal on koostatud läbiviidavate MI tegevuste komplekt, on järgmised:

1) Üks peamine LAK-õppe lähenemise põhimõte on õpilasekeskne õpetamine, mis annab õpilastele vajalikku tuge nii sisu kui ka keele arendamiseks - kas rühmatöö, paaristöö või vastastikku hindamise kujul;

2) Õpilased omavad oma eelistusi õpistiilide osas, mille alusel saab luua MI klassi profiili;

3) MI klassi profiil annab ülevaate domineerivast intellektist, mis on olemas enamikul õppijatel ja mille alusel on võimalik planeerida MI tegevusi klassi jaoks ;

4) MI tegevuste kasutamine mõjutab positiivselt õpilaste kaasamist õppimisprotsessi ja annab õpilastele võimaluse saavutada paremaid õpitulemusi.

II peatükk tutvustab MI klassi profiili analüüsi, näitab samme MI tegevuste klassis kasutamiseks, kirjeldab planeeritud MI tegevuste komplekti ja esitab olukorra analüüsi klassis nii

enne MI tegevuste kasutamist kui ka pärast seda, et võrrelda uuringueelsete ja –järgsete testide tulemusi. Samuti oli autori eesmärk analüüsida õpilaste kaasamist õppeprotsessi. Uuringu tulemused ja järeldused on järgmised:

1) Õpilastel oli uurija poolt koostatud õppeprotsessi tegevustest põnev osa võtta, sest need olid suunatud õpilaste vajadustele ja nõudmistele ning koostatud õpilasekeskse õpetamise printsiipe järgides;

2) Õpilased eelistavad rühmatööd ja paaritööd, sest need tegevused annavad igale õppijale vajaliku tugistruktuuri - toetuse nii sisu kui ka keele valdkonnas;

3) Lähtudes MI klassi profiilist, nõuavad õpilased füüsilist liikumist klassiruumis, seega tekitasid praktilised tegevused, kus oodatakse, et õppijad võiksid omandada teemat läbi füüsilise kogemuse, õpilastes huvi ja põnevust;

4) Õpilased on huvitatud ise oma teadmisi toetava visuaalse materjali loomisest, kas tabelite või graafikute kujul, et rikastada klassi füüsilist keskkonda;

5) Õpilased muutuvad aktiivseks, kui neil on vastutus oma õppeprotsessi eest, mida nad saavad kogeda õpilasekeskse õpetamise käigus;

6) Õpiväljundid on tõestanud, et MI tegevused annavad õpilastele käsitletud teemades tugeva sisendi, nii et nad suudavad aktiivselt osaleda õppeprotsessis ja mäletavad vajalikku materjali.

Käesolev uuring kinnitab hüpoteesi:

Õpetamine mitmekülgse intellekti tegevuste alusel LAK-õppe klassi inglisekeelses matemaatika tunnis – arvestades kõiki MI õpilaste tüüpe – suurendab õpilaste kaasamist õppeprotsessi nii sisu kui ka keelelise õppe puhul ja mõjutab positiivselt õpilaste õpitulemusi. Käesolev töö ja tulemused tõendavad MI tegevuste positiivset mõju õpilaste kaasamisele õppeprotsessi gümnaasiumiastme inglisekeelses matemaatika tunnis, samuti positiivset mõju õpilaste õpitulemustele.

APPENDIX 1

Multiple Intelligence detailed descriptions, including preferred learning styles, roles and activities for in-class work.

VERBAL-LINGUISTIC Intelligence			
Learning style and preferences	**Description**	**Roles**	**Tasks, activities and assessment**
Words and language	- written and spoken words - interpretation and explanation of ideas and information via language - understands relationship between communication and meaning	- copywriters - editors - historians - journalists - lawyers - linguists - poets - PR and media consultants - speakers - teachers professors - trainers - translators - TV and radio presenters - voice-over artists - writer	- edit a peer's paper - give an oral presentation - list the strengths and weakness of a product - write a eulogy - write directions to accompany a map

LOGICAL-MATHEMATICAL Intelligence			
Learning style and preferences	**Description**	**Roles**	**Tasks, activities and assessment**
Logic and numbers	- analyse problems - detecting patterns - perform mathematical calculations - scientific reasoning and deduction - understands relationship between cause and effect toward a tangible outcome or result	- analysts - arbitrators - bankers - certified public accountants - computer programmers accountants - engineers - insurance brokers negotiators - researchers - scientists - statisticians - traders	- analyse how a computer works - assess the value of a business or a proposition - create a process - devise a strategy to achieve an aim - perform a mental mathematical calculation, create a process to measure something

VISUAL-SPATIAL Intelligence			
Learning style and preferences	**Description**	**Roles**	**Tasks, activities and assessment**

Visual-spatial images and space	- interpretation and creation of visual images, pictorial imagination and expression - understands relationships between images and meanings and between space and effect	- architects - artists - cartographers - city-planners - engineers - graphic designers - inventors - landscape architects - photographers - sculptors	- compose a photograph - create an organizational logo - design a building - design a historic costume - design a landscape - interpret a painting - organize a storage room - pack an automobile trunk - paint a landscape

INTERPERSONAL Intelligence			
Learning style and preferences	**Description**	**Roles**	**Tasks, activities and assessment**
Other people's feelings	- ability to relate to others - interpretations of behaviour and communications - understands the relationships between people and their situations, including other people	- advertising professionals - care givers - coaches and mentors - counsellors - educators - health providers - HR professional - mediators - politicians - psychologists - sales-people - teachers - therapists - trainers	- affect the feelings of other in a planned way - coach or council another person - demonstrate feelings through body language - interpret moods from facial expressions - mentor a new faculty member

INTRAPERSONAL Intelligence			
Learning style and preferences	**Description**	**Roles**	**Tasks, activities and assessment**
Self-awareness	- one's own needs for and reaction to change, ability to deal with change in the workplace - one's relationship to others and the world - personal cognizance - personal objectivity - the capability to understand oneself	- one who is self-aware and involved in the process of changing personal thoughts, beliefs, and behaviour in relation to their situation - other people, their purpose and aims	- consider and decide one's own aims and personal changes required to achieve them (not necessarily reveal this to others) - consider and decide one's own position in relation to the Emotional Intelligence Model

BODILY-KINAESTHETIC Intelligence			
Learning style and preferences	**Description**	**Roles**	**Tasks, activities and assessment**

Body movement control	- eye and body coordination - manual dexterity - physical agility and balance	- anthropologists - athletes - biologists - dancers - geologists - instrumentalists - nurses - physical education teachers - physical therapists - physicians actors - sign-language interpreters	- arrange workplace furniture - demonstrate a sports technique - design a window display - interpret a speech using American sign language - prepare samples for magnification and testing - put together a piece of modular furniture - ride a horse - stack books on a shelf

NATURALIST Intelligence			
Learning style and preferences	**Description**	**Roles**	**Tasks, activities and assessment**
Observing, comparing environment and process in the world of nature	- ability to recognize and categorize plants, animals and other objects in nature - understands the relationships between nature and human	- gardener - farmer - scientist - botanist - geologist - zookeeper - veterinarian - ecologist - conservationist - animal trainer	- collect natural organisms – feathers, leaves, flowers - Use microscope and magnifying glass for your research - explain scientific concept related to nature - organize the collection of natural organisms

MUSICAL-RHYTHMICAL Intelligence			
Learning style and preferences	**Description**	**Roles**	**Tasks, activities and assessment**
Music, sound, rhythm	- awareness, appreciation and use of sound - recognition of tonal and rhythmic patterns - understands the relationships between sound and feeling	- acoustic engineers - composers - DJs - entertainers - environment and noise analysis - music producers - musical instrument repair specialists - musical performers - singers - voice coaches	- coach someone to play a musical instrument - compose media jingles - identify music for malls and retail stores - lead a choir - perform a musical piece - review a musical play - whistle a tune

APPENDIX 2

The MI class profile questionnaire.

*1. At school I was good at mathematics, physics or chemistry.

*2. I am good at singing or playing an instrument.

*3. I often think about my own feelings and sentiments and seek reasons for them.

4. I enjoy hunting and fishing.

*5. Writing is a natural way for me to express myself.

*6. At school, geometry and various kinds of assignments involving spatial perception were easier for me than solving equations.

7. I have a talent to form a mental picture of objects by touching them.

*8. I am very good at tasks that require good coordination.

9. It is easy for me to repeat correctly a musical theme from TV, or some other tune.

10. I enjoy reading demanding novels or classics.

11. Other people say that I am good with colours.

12. I enjoy being with animals.

*13. One of my strengths is problem solving together with other people.

*14. When walking outside, I am good at finding words on signs and posters and making them rhyme.

*15. When I think, I can see clear visual images in my mind.

*16. After hearing a tune once or twice I am able to sing or whistle it quite accurately.

*17. When listening to music, I am able to discern instruments or recognise melodies.

18. I am able to analyse my own motives and ways of action.

*19. I spend time regularly reflecting on the important issues in life.

20. I am able to see objects or events that I would like to document on camera or video.

21. The world of plants and animals is important to me.

22. I can write little songs or instrumental pieces.

*23. I usually find my way, even in unfamiliar places.

*24. It is easy for me to use abstract concepts.

25. Even in strange company, I easily find someone to talk to.

*26. I get along easily with different types of people.

*27. I have opinions of my own and dare to disagree with others.

28. I like being outdoors, enjoy the change in seasons, and look forward to different physical activities each season.

* 29. I have good coordination.

30. I have a good singing voice.
31. I enjoy exploring the nature.
32. I can easily measure, classify, analyse or calculate things.
33. I have a realistic idea of my strengths and weaknesses.
34. I am handy.
35. I can work with and solve complex problems.
36. I am good at entertaining myself and others with wordplay and jokes.
37. I make contact easily with other people.
*38. I can easily do something concrete with my hands (e.g. knitting and woodwork)
*39. It is easy for me to play with word games, for example crossword puzzles.
40. I am good at teaching others something I know myself.
41. I have the strength to participate in extreme physical experiences (e.g. shooting the rabbits, parachuting and mountain climbing).
42. I easily notice lapses of logic in other people's everyday speech or actions.
*43. I am good at jigsaw puzzles, picture puzzles and various kinds of labyrinth puzzles.
*44. I am good at games and problem solving, which require logical thinking
45. I have recently written something that I am especially proud of, or for which I have received recognition.
46. I am able to handle criticism directed against me.
47. I like to read psychological or philosophical literature to increase my self-knowledge.
*48. I am the kind of person that neighbours, colleagues or fellow students turn to for advice and instructions.
49. I tend to look for consistency, models and logical series in things.
*50. I am good at showing how to do something in practise.
51. I easily recognise other peoples' motives.
52. It is easy for me to imitate other peoples' gestures, facial expressions and ways of moving.
53. It is easy for me to conceptualise complex and multidimensional patterns.
*54. It is easy for me to understand other peoples' feelings and moods.
*55. I consider myself a leader (or have been called one by other people).
*56. I keep a diary or note down happenings of my inner life.
*57. I often "talk with my hands" and/or otherwise use body language when talking to someone
58. I can easily imagine how a landscape looks from a bird's-eye view.
*59. Mental arithmetic is easy for me.
*60. I can easily keep the rhythm when drumming a melody.
*61. Metaphors and vivid verbal expressions help me learn efficiently.

62. I am good at making decisions or predictions from new scientific discoveries.

*63. I play a musical instrument or otherwise take part in musical activities.

64. In negotiations and groupwork, I am able to support the group to find a consensus.

65. I have a talent to use concepts or expressions, which are not very typical in other people's everyday talk.

66. I quickly recognise a song or piece of music.

67. I notice immediately if a melody is out of tune.

68. I’m good at drawing and designing various kinds of figures.

*69. When necessary, I am able to motivate myself, even for unpleasant tasks.

*70. When I read, I form illustrative pictures or designs in my mind.

*71. I want to present things as logically as possible and give reasons for them.

72. I was good at handicrafts at school.

73. I can handle the emotions caused by serious setbacks.

*74. In conversation, I often refer to things that I have read or heard about.

75. At school studies in native language or social studies were easier for me than mathematics, physics and chemistry. (Note new wording: At school, studies in native language were easy for me.)

Item Selection Process

Multiple Intelligences	Original version	Initial version	Final version
1. Verbal-linguistic	05, 10, 14, 36, 39, 45, 61, 65, 74, 75	05, 10, 14, 39, 74	05, 14, 39, 61, 74
2. Logical-mathematical	01, 24, 32, 35, 42, 44, 59, 62, 71	01, 24, 32, 44, 62	01, 24, 44, 59, 71
3. Visual-Spatial	06, 11, 15, 20, 23, 43, 53, 58, 68, 70	06, 11, 15, 23, 53	06, 15, 23, 43, 70
4. Interpersonal	13, 25, 26, 37, 40, 48, 51, 54, 55, 64	13, 25, 26, 48, 54	13, 26, 48, 54, 55
5. Intrapersonal	03, 18, 19, 27, 33, 46, 47, 56, 69, 73	03, 18, 19, 27, 69	03, 19, 27, 56, 69

6. Bodily-kinaesthetic	07, 08, 29, 34, 38, 41, 50, 52, 57, 72	08, 29, 38, 41, 50	08, 29, 38, 50, 57
7. Naturalist	04, 12, 21, 31, 28	04, 12, 21, 31, 28	04, 12, 21, 31, 28
8. Musical-rhythmical	02, 09, 16, 17, 22, 30, 60, 63, 66, 67	02, 09, 16, 22, 60	02, 16, 17, 60, 63

APPENDIX 3

Tests on knowledge of the topic of Mathematics “Types of numbers”

PRE-TEST ONE

1. Name all nine types of numbers:
2. Give at least one example for every type of a Number:
3. Write the Vieta’s theorem. What is it used for?
4. Solve the equation: $3x^2 + 4x - 3 = 0$; Find the roots.
5. Find the roots of: -4; 3i; e; 121; $\frac{128}{256}$; π

<u>Assessment:</u>
5 right answers – “5”
4 right answers – “4”
3 right answers – “3”
2 right answers – “2”
1 or no right answers – “1”

POST-TEST ONE

Topic “Types of Numbers” Date: Name:	Score
1. What types of Numbers do you know? Name them: ____________________________________ 2. What is Imaginary number? Explain the term: ____________________________________ 3. Show the formula for the solution of an easy polynomial equation: $2x^2 - 4x + 2 = 0$; Find the roots. ____________________________________ ____________________________________ 4. What is Square root of -4? Show the solution: ____________________________________ 5. Give an examples of transcendental numbers and their approximate equality (only two expressions):	

6. Which one of the following is **not** a rational number?
a) ½
b) 22/7
c) -2
d) π

7. Which one of the following is **not** a complex number?
a) -3
b) 2+5i
c) i√2
d) They are all complex numbers

8. Which one of the following is **not** real?
a) i
b) ∞
c) √4
d) They are all real

9. The product of two imaginary numbers is always:
a) A real number
b) A rational number
c) An irrational number
d) An imaginary number

10. The product of two complex numbers is always:
a) Always real
b) Always complex
c) Always irrational
d) Always imaginary

Match the definitions with their examples:

11. Real numbers ________________________________

12. Natural numbers________________________________

13. Transcendental numbers_________________________

14. Imaginary numbers ____________________________

15. Algebraic numbers ____________________________

a) $4x^2 - 5x + 10 = 0$;
e) 1.5+(-12.3) + √4=-8.8
e) 3 π+ 2e
b) -3i
c) 123+453+1875

<u>Assessment:</u>
14-15 right answers – “5”
11-13 right answers – “4”
8-10 right answers – “3”
4-7 right answers – “2”
1-3 right answers – “1” or “Fail”

Test of knowledge of the topic of Mathematics “Vector and its coordinates”

PRE-TEST TWO

1. What is a vector?
2. How vector differs from line, parabola and circumference?
3. Write the Pythagoras’s theorem. What is it used for?
4. Solve the equation: $|a| = \sqrt{}(128 + 16\left(2\frac{1}{4}\right) - 20)$
5. Find the |b|, if $|c|^2 = |a|^2 - 15|b|^3$ and |c|= 11

Assessment:
5 right answers – “5”
4 right answers – “4”
3 right answers – “3”
2 right answers – “2”
1 or no right answers – “1”

POST-TEST TWO

Topic “Vector and its coordinates” Date: Name:	Score
1. Name two distinctive features of a vector: ____ 2. What is parabola? ____ 3. Explain the term circumference: ____	

4. Does vector have the beginning and end? Explain:

____

5. Give an examples of vector in our life:

____

6. If we reverse the direction of the vector and add it
2. we add
3. we subtract
4. we multiply
5. we divide

7. The vector can be
e) one dimensional
f) two dimensional
g) three dimensional
h) all of the above

8. To calculate the magnitude of a vector we use
f) Archimedes' theorem
g) Pythagoras's theorem
h) Euclid's theorem
i) Vieta's theorem

9. Scalar changes the vector's
e) direction
f) size
g) longitude
h) angle

10. The vector has
e) only x coordinates
f) only y coordinates
g) no coordinates
h) x and y coordinates

Match the definitions with their examples:

11. Vector____

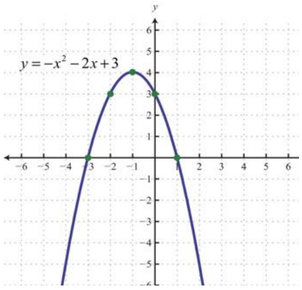
12. Parabola____*

13. Scalar____

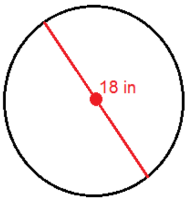
14. Circumference__________________________________

15. Magnitude of a vector____________________________*

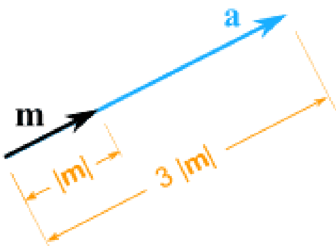
a)



b)



c)



d) $|\mathbf{b}| = \sqrt{(6^2 + 8^2)} = \sqrt{(36+64)} = \sqrt{100} = 10$

e)

<u>Assessment:</u>
14-15 right answers – “5”
11-13 right answers – “4”
8-10 right answers – “3”
4-7 right answers – “2”
1-3 right answers – “1” or “Fail”

Test of knowledge of the topic of Mathematics “Random, certain and impossible events”

PRE-TEST THREE

1. Explain the term “Probability of the event”:

2. Name three kinds of events. What are their difference?

3. How do you calculate the probability? What formula?

4. Toss the coin five times. What is the probability of getting all “heads”?

5. Give an example of impossible event:

Assessment:
5 right answers – “5”
4 right answers – “4”
3 right answers – “3”
2 right answers – “2”
1 or no right answers – “1”

POST-TEST THREE

Topic “Random, certain and impossible events” Date: Name:	Score
6. What is the formula for calculating the probability of the event? ____ 16. What is/are the difference(s) between dependent and independent events? ____ 17. Why is Probability called chance? Explain: ____ 18. What are the numbers probability takes place between? ____ 19. Give an example of dependent event: ____ 20. What are the opportunities to show probability? a) via decimals b) via fractions c) via percentage d) all of the above 21. A coin is tossed three times. Find the probability to get one “tail” and two “heads” a) 1/3	

b) 1/2
c) 3/8
d) 5/8

22. A dice is thrown twice. What is the probability that both numbers are prime?
a) 1/9
b) 1/4
c) 2/9
d) 1/2

23. On a probability line the number showing that event is certain is:
i) 100
j) 2
k) 51
l) 1

24. Impossible event is shown via the number of
i) 0.5
j) 1/1
k) 0
l) 1x1

Match the definitions with their examples:

25. Dependent event_____________________________

26. Random event________________________________

27. Statistics__________________________________

28. Mutually exclusive___________________________

29. Impossible event______________________________

a) Tossing a coin
b) Picking up red and blue marbles from a bag
c) Difference between the lowest and highest values
d) Tossing a coin with the aim to get both “tail” and “heads”
e) Picking up blue marbles from a bag with red marbles

Assessment:
14-15 right answers – “5”
11-13 right answers – “4”
8-10 right answers – “3”
4-7 right answers – “2”
1-3 right answers – “1” or “Fail”

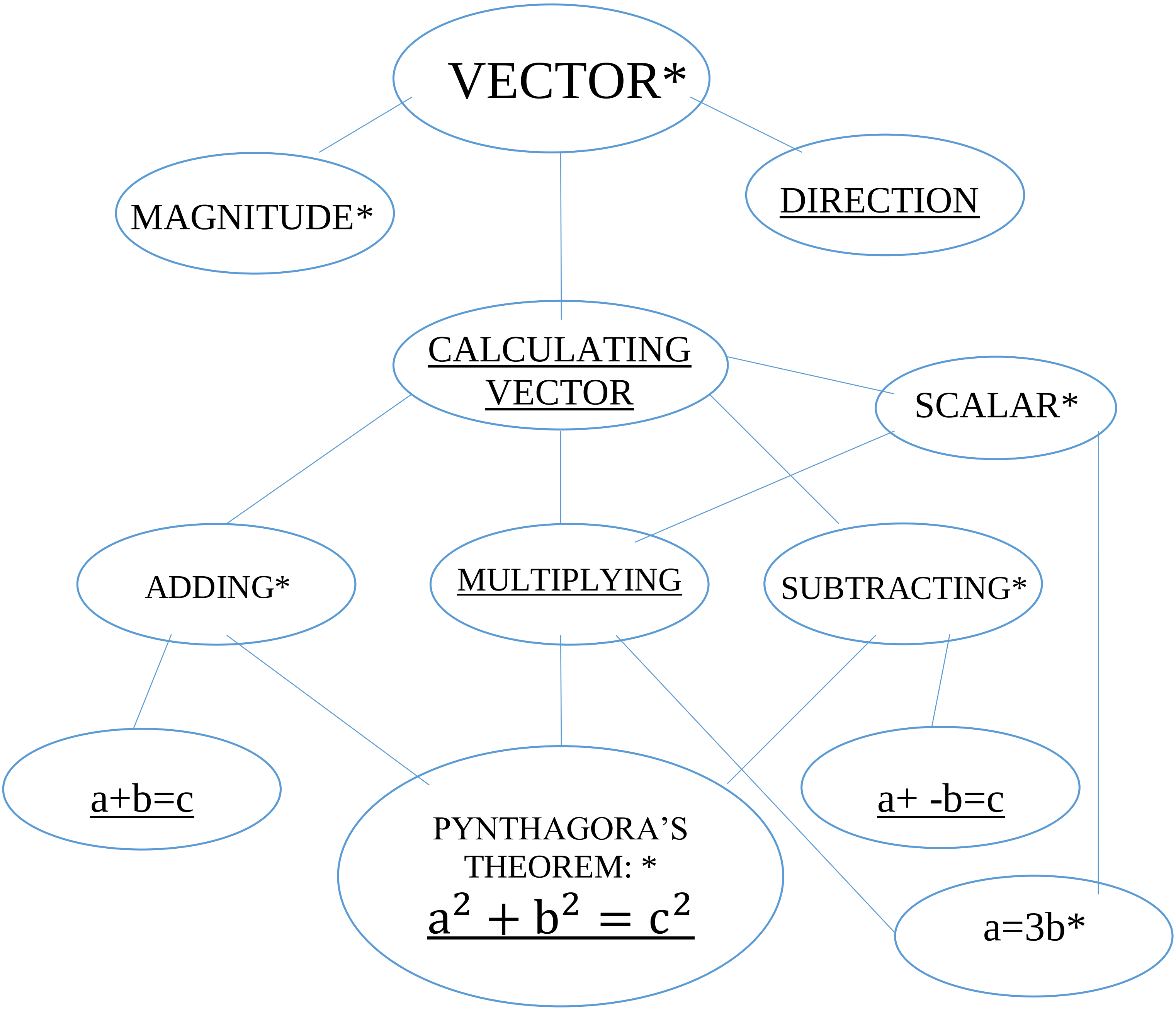
APPENDIX 4

List of terms, examples and formulae for activity "Mathematical Charades"

Real numbers	**Natural numbers**	**Integers**	**Rational numbers**
Irrational numbers	**Transcendental numbers**	**Algebraic numbers**	**Imaginary numbers**
Complex numbers	**{1, 2, 3…}**	**{…-3, -2, -1, 0, 1, 2, 3…}**	**3/2, 8/4, -1/1000**
√2, √3	**π, e**	$\boldsymbol{x^2, y^2, z^2}$	**1.5, -12.3**
$\boldsymbol{i^2}$	**1+i**	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	**Vieta's theorem**
Pythagoras' theorem	$a^2 + b^2 = c^2$	$\boldsymbol{x_1 + x_2 = -\frac{b}{a}}$ $\boldsymbol{x_1 x_2 = \frac{c}{a}}$	$\boldsymbol{x^2 - 2x + 4 = 0}$

APPENDIX 5

Visual-Spatial Activity "Information gaps"
Student 1: Terms that only this student has, are marked with asterisk "*"
Student 2: Terms that only this student has, are underlined
The teacher's list has no terms at all



APPENDIX 6

Group's answer sheet:

Group 1 **Members' names:**
Adding Station 1. Problem: Solution: Name of the student: 2. Problem: Solution: Name of the student: 3. Problem: Solution: Name of the student:
Subtracting Station 1. Problem: Solution: Name of the student: 2. Problem: Solution: Name of the student: 3. Problem: Solution: Name of the student:
Multiplying Station 1. Problem: Solution: Name of the student: 2. Problem: Solution: Name of the student: 3. Problem: Solution: Name of the student:

Matching Station

1. Term:
   Definition:
   Name of the student:

2. Term:
   Definition:
   Name of the student:

3. Term:
   Definition:
   Name of the student:

Real Life Examples Station

1. Example and explanation:
   Name of the student:

1. Example and explanation:
   Name of the student:

2. Example and explanation:
   Name of the student:

Five Stations

Adding Station:

1. Vector a=$\frac{28}{36}$; vector b=-$\sqrt[3]{27}$
2. Vector a=12,65; vector b=$4^2 + \frac{1}{2}$
3. Vector a=8,15; vector b=c=$x^2(a^3 - b)$; x=1^5
4. Vector a=2/3 ; vector b=$\sqrt{25}$
5. Vector a=$\frac{\pi}{2}$; vector b=12,56
6. Vector a=b+c; vector b=34; vector c=2
7. Vector a=$\sqrt{c^2 - b^2}$; vector b=1; vector c=1
8. Vector a=4,5; vector b=$\frac{3}{2}$
9. Vector a=12,25; vector b=a-4,5
10. Vector a=$\sqrt{121}$; vector b=14
11. Vector a=8,45; vector b=12,34
12. Vector a=$\frac{b}{2}$; vector b=16
13. Vector a=$x^3 + 45$; x=2; vector b=1/2
14. Vector a=$a^2 - 8{,}4$; vector b=$b^2 - 8{,}4$
15. Vector a=-7,45; vector b=-1/2
16. Vector a= $\frac{\sqrt{25}}{2}$; vector b=0

17. Vector a=(2;3); vector b=-1

Subtracting Station:

1. Vector a=45; vector b=-(3/4-1/2)
2. Vector a=23,3; vector b=4,5-3,2
3. Vector a=$\sqrt{25-4}$; vector b=0
4. Vector a=-b; vector b=-23
5. Vector a=$\frac{\sqrt{49}}{7}$; vector b=-8,34
6. Vector a=12,5; vector b=$\frac{1}{2}$
7. Vector a=$\frac{b}{3}$; b=$\sqrt[3]{19683}$
8. Vector a=18$\frac{1}{2}$; vector b=a
9. Vector a=32; vector b=-(-a+4,5)
10. Vector a=$\sqrt[3]{8}$; vector b=3/4
11. Vector a=c-28; vector b=2; vector c=-2
12. Vector a=$(x+b)^2$; vector b=-4; x=1/2
13. Vector a=$\frac{81}{b}$; vector b=7
14. Vector a=($\frac{3}{2}+\sqrt{25}$); vector b=0
15. Vector a=-456; vector b=-(23x); x=-1
16. Vector a=2,34; vector b=$\sqrt{4}$
17. Vector a=0.2; vector b=-123

Multiplying Station:

1. Vector a=4,5 ; scalar d=$\frac{3}{4}$
2. Vector a=1,2; scalar d=$\sqrt{4}+\sqrt[3]{8}$
3. Vector a=0; scalar d=$\frac{(\sqrt{2^2+48^2})}{3x^2}$; x=1
4. Vector a=12,34; scalar d=4,002
5. Vector a=$\frac{49}{35}$; scalar d=2
6. Vector a=|a|; scalar d=-10
7. Vector a=$\sqrt[3]{64}$; scalar d=-2
8. Vector a=1,256; scalar d=-$\frac{2}{3}$
9. Vector a=1/2; scalar d=4/2
10. Vector a=3x; scalar d=1/2; x=-1
11. Vector a=2$\frac{\pi}{2}$; scalar d=3π
12. Vector a=(b^2+3b); scalar d=-1/2; b=$\frac{3}{9}$
13. Vector a=$3^{1/2}$; scalar d=12/6
14. Vector a=$1^{3/4}$; scalar d=3/4
15. Vector a=-(-4.5); scalar d=12+6
16. Vector a=$\frac{90}{45}$; scalar = -(-3)
17. Vector a=x^2+3x-1; scalar d=1,2

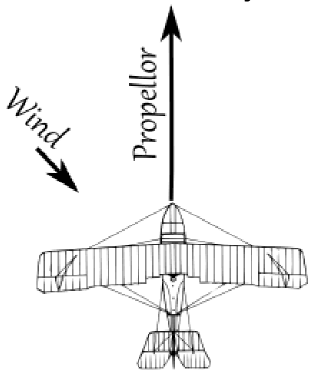
Matching Station:

1. Vector
2. Vector's coordinates
3. Magnitude
4. Direction
5. Size
6. Scalar
7. Parabola
8. Line
9. Circumference
10. Velocity
11. Acceleration
12. Force
13. Pythagoras's theorem
14. x and y axis
15. Length
16. Head of vector
17. Tail of vector

a) A line that has the beginning but no end
b) The line's exact positions on the plain
c) The length of a vector
d) A course of a vector
e) The extend of a vector
f) The quantity of a vector
g) Symmetrical open plane curve of a line
h) A long, narrow mark
i) A curved geometric figure (a circle)
j) The speed of an item
k) The capacity to gain speed of an item
l) The strength
m) the square on the hypotenuse of a right-angled triangle is equal in area to the sum of the squares on the other two sides.
n) Positions of the head of the vector and its tail
o) The extent of a vector from head to tail
p) An arrow pointing vector's direction
q) A starting point of a vector

Real Life Examples Station:

Here you can see a plane. The wind can be seen in a form of vector, as well as the plain's flight's direction.
Write and/or draw your own examples in the answer sheet.



APPENDIX 7

Paradox

Statements: (Marked with T for True and F for False for teacher's convenience)

1. Independent event is never affected by any other events (T)
2. Probability is often called "chance" (T)
3. Dependent event is only affected by previous event(s) (T)
4. Rolling a die is an independent event (T)
5. All statements in this part are true
6. Only one statement in this part is true
7. Only one statement in this part is false
8. All statements in this part are false
9. Tossing a coin is an independent event (T)
10. Mutually exclusive events can happen on a specific condition (F)
11. Winning a lottery is an independent event (F)
12. Possible event is shown with at least 51% (F)
13. Dependent event is affected by any other event (F)
14. Drawing a "King" from a deck of cards is a dependent event (T)
15. The formula for calculating the probability is P(event)=$\frac{number\ of\ ways\ it\ can\ happen}{total\ number\ of\ outcomes}$ (T)

16. Probability of multiple events happening one by one can be calculated by multiplying the results of those events (T)
17. Probability must be calculated in percentage only (F)
18. In the formula, P(A) stands for “Probability of an Action” (F)
19. Probability of dependent event can be calculated by formula P(A+B)=P(A)+P(AB) (F)
20. Each event has only three outcomes (F)

APPENDIX 8

Answer sheet "Probability"

Topic: Probability of events Name:	*Heads or Tails?*
1. Toss the coin 5 times and write your results – how many "Heads" and "Tails" have you got?	
2. Find someone in the class who has the same results as you. How many people could you find? Write their names:	
3. What is the chance of getting the same results as somebody else from your class? (calculate in decimals, fractions and percentage)	
4. Calculate the probability of getting these results. What formula will you use? Use the space below for calculations (in fractions, decimals and percentage):	
5. What kind of event was that?	

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