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Diploma Thesis

Links between business and education sectors

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DIPLOMA THESIS ASSIGNMENT

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Thesis title

Links between business and education sectors

Objectives of thesis

Analyze the role of education in the national economy.
Introduce present incentives and trends in the education system aiming at securing competitiveness of the economy.
Analyze current situation in promoting and supporting MST through cooperation between schools and businesses.

Methodology

Introduction of key factors
Theoretical background
Clarification of objectives of the work
Analytical part
Practical proposals
Summary and Conclusion

Schedule for processing

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70

Keywords

Partnership between schools and businesses, projects supporting attractiveness of MST, crucial role of education in maintaing competitivness of the economy

Recommended information sources

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Declaration

I declare that I worked on my diploma thesis “Links between business and education sectors” by myself and I used only the resources mentioned at the relevant part of the thesis.

In Prague 28 March, 2013 _____

Petra Kundeliusová

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Links between business and education sectors

Vazby mezi podnikatelským a vzdělávacím sektorem

Summary

The aim of the diploma thesis is to show the links between business and education sectors within the issue of promoting Mathematics, Science and Technology (MST). The importance of the support of these subjects is currently considered as crucial in order to maintain the sustainable economic growth. There are held various projects and initiatives promoting the attractiveness of the MST aiming to enhance the number of young people proceeding their studies in MST based fields. The thesis introduces current trends and incentives within the agenda on the European and national levels. The examples of strategies implemented by member states of European Union are provided. In the practical part of the thesis is introduced situation of the MST support in the Czech Republic. Recommendations based on the findings and review described in the theoretical and practical parts are included in the final part of the thesis.

Key words

crucial role of education in maintaining the competitiveness of the economy, projects supporting attractiveness of MST, stakeholders of the partnership between schools and businesses

Souhrn

Cílem této diplomové práce je ukázat vazby mezi podnikatelským a vzdělávacím sektorem v oblasti podpory matematiky a přírodních a technických věd (vzhledem k anglickému překladu Mathematics, Science and Technology se pro tuto skupinu předmětů všeobecně ustálila zkratka MST). Podpora těchto předmětů je v současné době považována za jednu z klíčových oblastí vzdělávání z pohledu zajištění konkurenceschopnosti ekonomiky. Za účelem získat studenty pro absolvování vysokoškolského studia na přírodovědných a technických fakultách je vyvíjeno velké množství aktivit v rámci různých projektů. Práce představuje současné evropské trendy v oblasti podpory matematiky, přírodních a technických věd. V praktické části práce je popsána současná situace v České republice, na jejímž základě je v závěru práce navrženo vlastní řešení, které by podpořilo příznivý vývoj v počtu studentů přírodovědných a technických oborů.

Klíčová slova

zásadní role vzdělávání při udržování konkurenceschopnosti ekonomiky, projekty na podporu zvýšení atraktivity matematiky a přírodních a technických věd, zájmové skupiny v oblasti spolupráce škol a firem

1. Introduction

There is a general belief that schools should be a well functioning and highly participating part of the community. They were founded with the aim to fulfil various needs, particularly to enrich the social environment through cooperation with city government, parents, other institutions and presently, also with businesses. Under certain circumstances, in the cases when such cooperation occurs in insufficient way, the education process may not follow the actual needs of the community and just exists somehow in parallel with real life. This unfortunate situation might cause countless problems and negatively affects progress of the whole community. On the other hand, if there exists educational conception aspiring to provide students (graduates) with the knowledge and skills which are crucial for the successful involvement on the labour market, the profits go not only to the graduates and employers, but to the whole society.

The issue of school's successful integration into the community as a centre of lifelong learning process is a very broad subject with many different viewpoints. The purpose of this thesis is to focus particularly on the topic of making from educational institutions effective providers of knowledge and skills which are needed to maintain the competitiveness of the economy. Current discussions of this issue are concentrated on the necessity of support the attractiveness of Mathematics, Science and Technology (MST or also can be used the abbreviation STEM - Science, Technology, Engineering and Math)[1].

Policy makers, educational experts, representatives of business and other relevant stakeholders on national and European levels are focused on preventing the inconvenient situation of skills gap at the labour market. The are several strategies how to avoid future possible scarcity of graduates equipped with appropriate skills and knowledge considered as desirable on the labour market. Each of the strategies requires involvement of various parties and during the implementation is focused on collaboration with different target

1 For the purpose of this thesis will be used the abbreviation MST. Cited materials will follow the originally used abbreviation.

groups. This thesis focuses particularly on monitoring the initiatives promoting close cooperation of the business and education sectors where students are in the centre of attention.

Students aimed to be addressed by these initiatives can be divided basically into two groups. In the first one would be students who are actually at the final stage of formal educational process, just about to enter the labour market - students at the universities, tertiary professional schools and also students of secondary schools (mostly vocational schools but can be also from other types of institutions). The main challenge there is to provide the graduates with the skills and knowledge meeting the requirements of the labour market. The second group to deal with within the process of raising attractiveness of MST study fields are students at the primary and secondary level of education. There emerges a clear goal to persuade them to proceed their studies into the MST based fields - to show them how perspective, interesting and fulfilling the career of the scientist or engineer can be.

2. Objectives and methodology

2.1. Objectives

The main objective of the work is to show the importance of the support of MST based fields. At the first part is the topic promoted mostly based on the review of different reports, communications and studies held within the area. The second part is focused on the situation in the Czech Republic.

Research questions

Why there is an urge need to support MST based fields?

Who are the relevant stakeholders in that process and what is their role?

What is the current situation in the field of promoting attractiveness of MST subjects in the Czech Republic?

At the very beginning of the theoretical part of the thesis there is a description of the role of education in the national economy. Following section is devoted to policy trends, incentives and examples of a good practice within the education systems aiming at the securing the competitiveness of the economy among the member states of the European Union.

The practical part of the thesis is focused on monitoring the situation of promotion and support of Mathematics, Science and Technology on different educational levels and by various organisations in the Czech Republic. At the closing part of the thesis is paid attention to subsequent comparison of the theoretical base with the findings at practical part in order to provide recommendations and suggestions what might be improved in the Czech approach.

There are many projects and actions undertaken in this area and purpose of this thesis is not to make a list of them covering all possibilities but to bring several examples

to illustrate what support of attractiveness of Science, Technology, Engineering and Mathematics actually means. And how such support can be provided.

2.2. Methodology

In the theoretical part of the thesis is used description to determine current directions and trends within the issue of promoting the attractiveness of MST subjects, as well as explanation of the importance of key factors.

The methodology of the theoretical part was predominantly built on studies of accessible materials and they were used, subsequently, for extractions, inductions and deductions. Qualitative methods as comparison and evaluation are reflected in the whole thesis.

An introduction of current situation within the area in the Czech Republic following at the practical part of the thesis includes description of system of formal education in the country and presents various initiatives held in the are of promotion of MST based subjects.

At the final part of the thesis is made comparison of observed data with information base provided in the theoretical part. Special attention is devoted to the problem of cooperation between education and business sectors.

As data source were used different kinds of information publicly available in reports, communications and webpages of projects or initiatives. The collection of data was also carried out during student's internship at the Ministry of Education, Youth and Sports within the years 2010 and 2013. All sources used for theoretical part of the thesis, as well as for gathering the information about projects and initiatives held in the area of promotion of MST based subjects in the Czech Republic, are listed in the reference section at the particular part of the thesis.

There is provided additional section explaining the abbreviations used throughout the text within the Annexes. At the same part of the thesis is also overview of the figures and graphs provided in the thesis. The figures and graphs are labeled according to chapter where are situated.

3. Theoretical background

The chapter reviews the importance of the education for economy and maintaining its competitiveness followed by current issues within the agenda of support of MST based subjects on the European level.

The outline of key issues and their consequences is presented and then there are reviewed national policies of European countries' showing how can be dealt with the promotion of Mathematics, Science and Technology in order to secure sufficient high skilled labour force.

3.1. The role of education in the national economy

The role of education is projected into economic reality through the theory of human capital. The term of human capital was introduced by Milton Friedman and the theory as a whole originates in the 1960's at the work of Chicago School of economists. [12] The principle of the theory is based on assumption that investments into the human resources increase human capital productivity. [Mac] Education is considered as such investment and as any other investment has to have certain appreciation.

The main task for economists who investigate the role of education in the process of raising the production potential of human capital, is to determine if the rate of return on investments into education is sufficient enough to justify the expenditures in comparison with another possible utilisation of given resources. [12] In other words, to determine, if opportunity costs of education are not too high. Education is considered as an input and as such is measured according to its effectiveness. However, estimation of the actual impact is very hard and although there were taken several researches in order to provide reasonable explanation of the importance of education in the process of raising value of the human capital, there are number of key issues why there is not available clear answer.

Among other concerns there is a question of missing straightforward characteristic of the quality of education and its determination on particular results of the education process. The two main approaches which might be used to asses the effectiveness of education are quantitative and qualitative measurements. Nevertheless, there is a drawback of the quantitative measurement of the impacts of schooling in the assumption that year of schooling delivers the same increase of knowledge and skills no matter of the education system, which neglects the cross-country differences in quality of education. [W] Therefore there is a valuable presumption that the quality of education reflected in knowledge students gained, measured by cognitive tests, provide much more revealing information than the number of years students spent in the classrooms. [7]

Although the basic assumptions based on length of the schooling and quality of education system might not be considered as highly influential for the economic growth, there are numbers of models which emphasize the importance of the scientists and engineers, highly skilled, technically trained graduates who are able to contribute to development of new products and therefore function as a special element to the growth equation. [7] Skills and knowledge of average worker are in great extent considered as key elements of the competitiveness of the economy and its growth. Nowadays, the problem of getting new technologies is much less challenging than to maintain the skills needed to control and effectively use knowledge and information and therefore there is a intention to create knowledge based economy in order to achieve its sustainable competitiveness.

There might be further discussions of the causality in the relation of economic growth and education. It is obvious that countries growing rapidly have the added resources to invest into education system and consequently to increase its quality and to ensure better performance of students. In other words, this would mean that better education system might be the result of growth, not its cause. [7]

Anyhow, the quality of labour force determined by education is not a single sufficient engine of the growth rate of the national economy. It is clearly built up from various

factors such as appropriate market conditions, functioning legal and governmental institutions which support modern economy and are able to overcome possible deficits in the quality of education. [7]

Additionally, the development of education brings the benefits for both economic and non-economic environment. The non-economic point of view considers education as an engine for change in social structure, inter and intra relations of differentiated social groups and behaviour of each individual. [12] Education has a valuable affect on forming personality but it is just one of the many influences. But the determination of the extent of its impact on individual is not the purpose of this work.

3.2. Current situation of MST support at the European level

During the Czech Presidency of the Council of the European Union in the year 2009 was adopted the Strategic framework for European cooperation in education and training (ET 2020) setting a strategic goals towards which should member states direct themselves within the agenda of education and training. Under the strategic objective number 2 - Improving the quality and efficiency of education and training - is strengthened also the need to make the mathematics, science and technology more attractive. [4]

The maintenance of the high-level skills in the MST fields is considered as crucial for the economic sustainable development. Majority of the European countries should consider the aim of high proportion of the MST graduates as an important objective of its national education program. That arises significant challenges in promoting the attractiveness of MST related studies for further education and potential career path. [5]

In the year 2001 was in the European Union, on average, the proportion of MST fields graduates 24.4%, compared to the total number of graduates. In less than ten years,

to the year 2010, the number declined to 21.4% which shows significant decrease in the share of MST graduates in majority of European countries. [5]

There can be taken several actions to reverse the situation. There is certainly a need to work with teachers and to create and persuade the implementation of innovative teaching methods. Strengthening various partnerships with science centres and engaging professionals to act as positive role models and providing information about reality of science career contributes to emphasise the employment opportunities available in the MST areas. The effort has to be reinforced by sensitive career guidance and campaigns aiming at raising general awareness of the issue. [5]

Large-scale initiatives covering all education levels are not very common among European countries. They usually focus on improvement of students' motivation to learn MST subjects through extra-curricular activities provided by individual projects or partnerships among schools and businesses but the incentives are not covered in well-organized strategic system. [5]

Mathematical competence and basic competences in science and technology are one of eight key competences defined at the EU level as a *"combination of knowledge, skills and attitudes that are considered necessary for personal fulfilment and development; active citizenship; social inclusion; and employment"* [5, p. 7]. The other competences are:

- *"communication in the mother tongue;*
- *communication in foreign languages;*
- *digital competence;*
- *learning to learn;*
- *social and civic competences;*
- *sense of initiative and entrepreneurship;*
- *cultural awareness and expression"*.

And it is not actually just promotion of MST, where education and business sectors meets. The support of the 'sense of initiative and entrepreneurship' has most commonly form

of *"developing small business projects, setting up model mini-enterprises, and encouraging cooperation between schools and businesses to develop the entrepreneurial spirit of students as well as to familiarise them with the world of business"* [5, p. 18].

3.2.1. Key issues

The issue of graduates shortage in the MST based fields compared to all university graduates concerns not only policy makers but also representatives of business who find insufficient number of prospective employees with required adequate skills and knowledge as a problem which needs to be focused on.

In the year 2011 the European lobby group BUSINESSEUROPE enrolled the study analyzing the situation in the field of Science, Technology, Engineering and Math (STEM) graduates. The BUSINESSEUROPE is association of 41 member federations from 35 countries, the main horizontal business organisation at the European level with tradition going back to choatic times of economic reconstruction after World War II. According to its mission, the main goal of the organisation is to cooperate to strengthen the corporate competitiveness of European companies and support smooth functioning of labour markets. [15]

The study called "Plugging the skills gap - clock is ticking" wanted to contribute to raise the awareness of the problem of shortage of the STEM graduates at the labour market. It highlighted several aspect of the problem:

Demographic change

In the United Kingdom, for example, will be up to 70% of high-skilled employees in the nuclear industry retired by the year 2025. The similar situation is with the teachers of physics at tertiary level of education. That means there is a need to take action to avoid the possible future scarcity of the stock of science and technical skills in the workforce

and to prevent the situation when there would not be enough experts to pass the knowledge on next generation. [1]

Lack of attractiveness for incoming workers

Highly qualified third-country nationals seeking for a job within the STEM fields rather choose Australia, the USA or Canada than Europe which is unfortunate particularly because Europe is left out from the so called brain circulation. [1]

The theory of brain circulation explains the migration of highly skilled human capital as one of key elements contributing to economy progress of the country.[3]

So when Europe loses its attractiveness as working destination for well educated labour force, it misses the opportunity to be endowed by world-leading specialists.

Mismatches

Structural mismatches between supply and demand on European labour market occurs when graduates (potentially skilled at STEM fields) do not match the requirements on the specialisation which are desired by companies. Therefore it is important to assess the shortages of STEM graduates in nuanced way, to differentiate between STEM subgroups.

Missing lifelong learning programs for teachers

The cooperation between schools and businesses can be focused also on providing teachers with valuable insights into current environment of companies. That would enable lecturers to provide students with accurate information about the functioning of real scientific world, meaning that teachers would be able to bring students closer to more precise imagination what selecting the career in MST based fields actually mean. The system of the further education of teachers is in the main responsibility of their employees (e.g. regional governments or other state institutions according to particular national system). The issue of teachers' training and lifelong education is mainly connected with the topic of school

leadership and therefore will not be further developed in this thesis (unless as a part of the specific project).

3.2.2. Consequences of shortage of MST graduates

The risk of the European economy being left behind is getting bigger as the number of appropriate STEM graduates decreases. Loss of domestic market share, deficiency in international trade share and overall lower productivity levels are examples of the consequences that shortage of scientists and engineers can bring. In connection to brain circulation theory, when the high skilled scientifically and technically educated labour force is outside Europe, the allocation of resources on company level might be influenced as well. For example, as a result of lack of qualified engineers in France, Germany and UK, the Airbus company, the world leading aeroplane producer has recently decided to carry out a bigger part of its engineering work in India. [1] To name few more, we do not have to look to the sky but just around us. Everyday life in modern society is surrounded by products of scientists, technologists, engineers and mathematicians. Challenges ahead us in health care, infrastructure, climate change and many other fields will require further technological development which can be provided only by well educated scientist, technicians and engineers. [1]

3.2.3. Governments' approaches to education

The prioritising the resource allocation within state budgets should be made with the intention to secure sustainable economic growth. Education is such priority area although in current situation of urgent need to reduce public debts there are legitimate concerns of setting long-term investments aside in favour of current demand conditions (and investments into education as such are long-term investments). Anyhow, distribution of scarce resources allocated to education systems should be held in highly efficient ways, focus on training future work force with economically viable skills. [1]

The responsibility for education lies in hands of governments (possibly local municipalities) and therefore it is necessary for them to deal with the agenda of imminent lack of high-skilled workers educated in the MST fields. [1]

Bureaucracy obstacles preventing the school-business cooperation should be immediately removed, as well as negative attitudes among involved parties. Businesses are well-suited to provide the level of expertise and practical context needed to increase the attractiveness of MST classes and to arise actual interest among students into science careers. And that should be actively supported. [1]

Modernisation of teaching methods with giving greater liberty to teachers which would enable them to choose their lecturing materials and methods (as far as they are in accordance to national educational standards) and focusing on learning outcomes while providing students with the flexibility to learn via different approaches is the way how to equip graduates with valuable tools and make them prepared for ongoing lifelong learning. This goes hand in hand with changes of school management which is certainly the responsibility of national bodies. [1] Although one enlightened teacher might cause a great progress, the importance of proactive approach needs to be encouraged on the decision-making level.

The national governments are obligated to introduce suitable framework in order to stimulate the focus of educational institutions to produce highly skilled graduates appropriately equipped with knowledge which would enable them to contribute in maintaining sustainable economic growth. For that purpose the cooperation between education and business sectors serves as priceless instrument. There can be several ways how to appreciate the level of cooperation of particular school, for example allocation of resources could be possibly a very powerful tool, if correctly adjusted. Anyway, the main issue for governments remain in re-orienting resources to raise the attractiveness of MST subjects by increasing quality and relevance of learned content. The importance of incorporation in EU and global brain circulation has been already emphasised above. [1]

3.2.3.1. Strategies of MST support across EU

The awareness of the importance of support MST based subjects is spread across the member states of the European union. Although there are shared common stimuli and encouragement, the applied national policies differ according to specific cultural, business and educational background. This subchapter outlines the examples of implemented strategies.

For the purpose of this thesis was selected only the strategies aiming at support of MST based subjects and promoting cooperation between business and education sectors.

The strategies are listed alphabetically according to state they are implemented in. There is no intention to order them in any kind of ranking (of its possible impact or extension of the policy - none of that is used). The objective of this part is to show the explicit possibilities how to deal with the issue of promoting the importance of the MST study fields.

Austria

In Austria is implemented national strategy aiming to improve the situation within several key competences, namely Mathematics, Science, Information Technology, German language and related subjects. The national programme IMST (Innovations Bring Schools to the Top) started in 1998 and in the year 2013 would be extended for three more years. *"The programme helps teachers to put innovative instructional projects into practice and to receive support in terms of organisation and finance. It involves about 7 000 teachers who participate in projects, conferences or cooperate in regional and thematic networks."* [5, p. 58]

Belgium

The action plan focused on raising awareness of the science importance among general public was launched in Belgium. It provides information about scientific development

and promotes the cooperation of education and business sector to increase the number of students interested in science and technology. [5]

Estonia

In Estonia also went the way of rising public awareness of the importance of research and development for the maintenance of the competitiveness of the economy. Although that is just one of the objectives of the Programme TeaMe under which is the initiative implemented. Among others belong popularisation of science-related professions and dissemination of scientific thinking. The results of the programme activities are the increase of scientific discussions in media and the production of learning materials for young people interested in MST subjects. The programme is funded by European Structural Funds and will run until the year 2015. [5]

There were also founded AHAA Science Centre[2] by the Estonian Ministry of Education and Research, the city of Tartu and the University of Tartu in the year 1998 which develops new teaching methods and provides various promotional activities such as science theatre shows, interactive educational exhibitions, fun laboratory experiments and planetarium lectures. The purpose is again to bring science and technology to the public and young people, in particular. The running of the Centre is co-financed by European Structural Funds, state budget and money contribution is also provided by private sector. [5]

Finland

In Finland was developed an umbrella organisation (LUMA) coordinated by Faculty of Science of the University of Helsinki which supports and promotes the cooperation between schools, universities, business and industry in teaching and learning at all levels of education. The centre provides training and workshops for teachers as well as activities for pupils, for whom arranges a MST camps, for example. It also produces various materials for teaching and learning Maths. [5]

2 The website of the AHAA Science Centre: http://www.ahhaa.ee/en/

Germany

In Germany was the High-Tech Strategy launched in 2006 by Federal Ministry of Education and Research. The aim of the strategy is to attract young people to courses of the so-called MINT subjects (Mathematics, Information Technology, Natural sciences and Technology). One of the objectives is also to ensure better usage of the potential of women in science.

In the year 2009 was issued the list of recommendations for reinforcing MST education. The list includes the aim to improve the image of science in society, to support the science education already in early childhood education level and strengthens the need to change curricula and teaching approaches at primary and secondary education levels. And to create opportunities for continuing professional development for science teachers. [5]

Malta

In Malta chose the way of promotion by introducing "role playing" initiatives. Students try to set up cooperatives and also have an opportunity of job shadowing in various industries. There was launched subject called Personal and Social Development which aims to develop effective communication, problem solving and decision-making skills along with abilities for effective teamwork.

After the publication of new science education strategy consultative document in May 2011, there were held consultations and meetings with science educators and interested stakeholders until December 2011 in order to get the relevant assessments and remarks before the final version of the document is published. It should give greater importance of science education at primary level schools and new approach to science education at the secondary schools. It also predicts the needs of the implementation of the strategy in terms of resources, logistical and training demands as well as time frames. [5]

The Netherlands

In the Netherlands introduced the Platform Bèta Techniek towards preventing skills shortages in MST fields. The platform was commissioned by the government, education and business sectors. *"The objective is not only to make careers in science more appealing, but also to introduce educational innovations that improve motivation and challenge young people. There are specific programme lines for primary and secondary education, vocational and higher education. Activities target schools, universities, businesses, ministries, municipalities, regions and economic sectors. The main objective is to ensure that the future supply of knowledge workers will meet future demand, but the programme also seeks to make certain that talented professionals already in the job market are more effectively deployed. Particular attention is paid to girls/women and ethnic minorities."* [5, p. 16]

There were held a major national events as the Jet-Net Career Day, one especially for teachers, another aimed at involvement of girls and plenty of a smaller programmes, such as mentoring, research assisted by company, guest lectures, workshops for teachers and expert meetings. [5]

There was also an intention to apply the scheme which integrates entrepreneurship eduction into curricula with the objective to increase the number of students with entrepreneurial aspiration to start own business within the five years period following the completion of their studies. The aim is to provide graduates equipped with knowledge, skills and enthusiasms which would force them to establish their own business. [5]

Norway

In Norway was implemented nationwide motivation programme called ENT3R[3]. The programme is based on cooperation of students in the age from 15 to 18 on one side, and university or college students who act as role models and mentors, on the other side. The purpose of mentoring is in inspiring teenagers and attracting them to scientific

[3] http://www.renatesenteret.no/ent3r/h

or technological education. On the website connected to the programme is published database of “Role Models” which brings profiles of variety of people with scientific or technological background. Another action taken under the programme is organizing presentations by science and technology based enterprises to students once a month. The presentations should provide the students with a possibility to meet future employers and promote the relevance and importance of Science and Math. [5]

Poland

In Poland took the initiative in hand the institutions providing higher education, which organize promotional activities for students at secondary education level in order to attract them to science related fields. [5]

Portugal

In Portugal exists an action plan especially focused on Mathematics, which has four key points. The aim is generalisation of the mathematics curriculum connected to development of a database of educational resources for Mathematics which arises the need for specific evaluation of Mathematics textbooks. And the fourth area is the development of school projects focused on the improvement of Mathematics learning for students at primary level of education. [5]

Romania

In Romania the government has launched initiative promoting an entrepreneurship culture which targets at the development of specific modules within the school curriculum which would accommodate students with practical skills and knowledge majorly focused on entrepreneurship environment. To enable the successful implementation of the curricula is needed to provide teachers with relevant training and to support the partnerships between education and businesses which can provide practical observations of the curricula and to facilitate students to gather the experience within the actual company setting. [5]

Slovakia

In Slovakia acts the non-governmental organisation 'Schola Ludus'. Its focused on promotion of science and research in friendly way to wide public as well as to children from pre-primary to lower secondary education level. The organisation works in cooperation with universities, museums, science centres and also private companies to support development of educational science subjects' programmes, on organizing exhibitions and non-formal educational activities at summer camps. On top of the work with children, it also provides professional development for teachers. [5]

Spain

In Spain is established the National Strategy for Science and Technology which provides a framework for territorial cooperation and promotes increasing the interest in science and technology as well as development of skills for problem solving from an early age. [5]

There are also organized summer camps for talented children where they can experience the real scientific research guided by academics in cooperation with secondary school teachers. [5]

Another project called Scientific Routes is designed for students of upper secondary level who has the possibility to participate in one-week internships in laboratories, technology industries, research centres, science museums or natural parks. "*The objective is to complement the scientific knowledge acquired in the classroom by discovering its application and usefulness in everyday life."* [5, p. 48]

United Kingdom

In the United Kingdom began in the year 2004 STEM programme which was scheduled to run for ten years and was implemented through the whole country. The programme was focused on increase of students' STEM skills in order to fulfil the needs of labour market, to help secure the UK's global competitiveness and to make the country a world-leader

in science-based research and development. The programme has eleven action programmes focused on

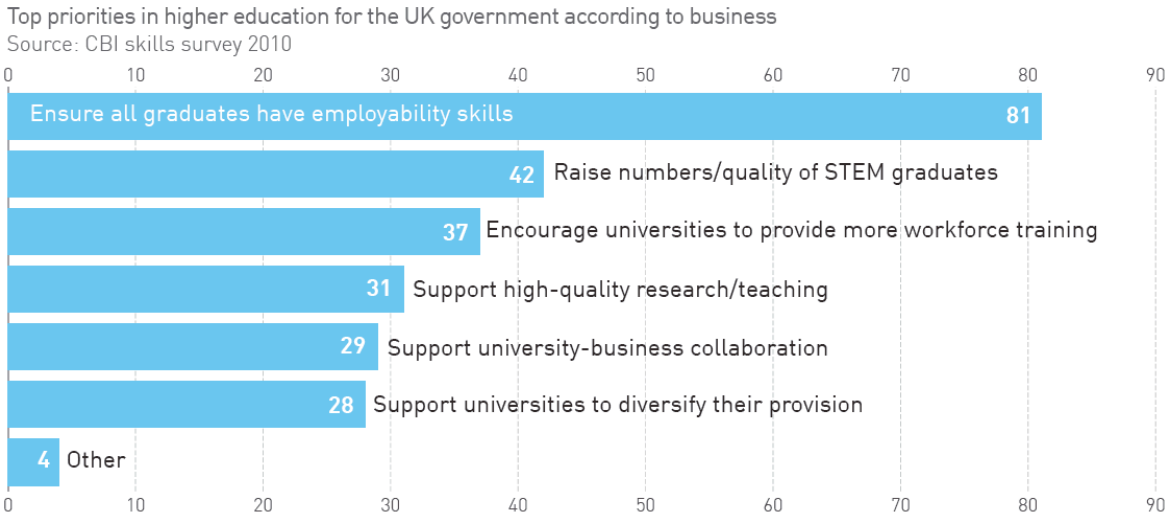
- *"teacher recruitment,*
- *continuing professional development,*
- *enhancement and enrichment activity,*
- *curriculum development,*
- *and infrastructure"*

In the year 2009 was opened the National STEM Centre which not only collaborate with organisations led by specialist to drive forward particular area of the programme but also bring together partners with a shared mission of STEM support. The Centre overall serves as storage of UK's largest collection of STEM teaching and learning resources providing teachers of subjects in question with access to a wide range of materials. [5]

In the Northern Ireland was in the year 2008 launched programme for improvement of young people's knowledge and understanding of starting career in field which require a background in STEM subjects. Work of this programme is focused on development of informative materials for young people about STEM related careers and benefits of employment in these areas. [5]

In the year 2010 was in United Kingdom held surveys analysing current needs of business to be solved by government at the tertiary level of education. Results of the survey are presented in the Graph 3.1: Top priorities in higher education for the UK government according to business.

Graph 3.1: Top priorities in higher education for the UK government according to business



Source: BUSINESSEUROPE, 2011, p. 12

The programmes of countries mentioned above does not make a complete list of policies implemented across the European Union but should give an idea that there exist plenty of ways how to support the attractiveness of the MST/STEM based fields on different educational levels and implemented by different organisations. And also the purpose of this subchapter was to show that it is considered as very important topic and as an issue that has been currently dealt with.

The maintenance of the highly skilled workforce is strongly connected with the availability of a cross-border transfer of the workers within the European Single Market which in the year 2012 actually celebrated 20 years in function. Because only the openness towards global development will help European Union achieve its objective to become a world leading knowledge-based economy. Therefore there is a need to shift approach of rewarding the studies according to actual outputs rather then inputs measured by duration of studies in order to ensure that "*...skills and competencies will become more easily transferrable between education systems, regardless of where they were acquired...By the end of the day, being able to apply theoretical knowledge to solve real-world problems is the main objective of such educations."* [1, p. 14]

3.2.4. Business interventions

The role of businesses in the support of the MST fields can be vital in several areas. In this chapter is made an overview of the interventions based on the review of the publication "Plugging the skills gap - clock is ticking" published by the BUSINESSEUROPE initiative.

One of the key problems in the area of lack of students choosing career in STEM subjects is the absence of picture about real scientist's life - what does it actually mean to be a scientist and what they really do when they work? And this is the sphere which offers great opportunity for businesses interventions.

Among programmes introduced by different states were mentioned steps which can be undertaken - mentoring, career days, story telling, killing myths and giving positive role modelling, inviting classes to see the everyday reality of workers in science and technology, providing them with the context of their tasks. These are actions which allow to work with practically any age group of children, particular activity just has to be properly adapted.

Young people are often concerned with the conditions of the world - the environment, health care, social problems and by showing them how science is used to solve these real-world problems and societal challenges might persuade them that the career in the science makes sense.

Concerns of other type might be influenced by one's desire to be successful, able to provide high living standards for oneself and his or her family. The job status is something what is considered as highly evaluated by peers, friends, family and after all society as a whole. The students has to be shown that careers in science, technology and engineering fields are well rewarded and publicly acknowledged.

There is a challenge for educational institutions to create programmes which ensure the relevance of the studies for the current needs of labour market. That might be much easier if there would be well communicated employers' future skills needs. The forecast of skills could be useful but the cooperation with businesses as consultants should be done on real-time basis will designing course structure within MST based programmes. In Germany, for example, one out of three university board members comes from the business world which allows much more flexible process of implementing current labour market needs into education process. The communication should not be viewed as a one-way flow of advantages, after all the situation should be seen as win-win, as opportunity for companies to influence the content of courses for their favour and at the same time providing real-life context for students. [1]

The costs of training high skilled workers might be beyond the possibilities of the resources such institutions have. The solution could be in mutual cooperation with specific companies. *"Although the responsibility for providing the necessary equipment lies with the university, performing laboratory work or research projects at the companies that actually develop the instruments enables the student to acquire skills for which there is a direct demand among local companies."* That enables the company to share the costs for the equipment with the university and students of the university has the opportunity to enforce the theoretical knowledge to real-world scientific tasks. [1] Such exchange, above all, fulfil plenty of issue mentioned above such meeting the reality and context of scientist work, for example.

Anyway, there might be fears about how the cooperation between business and educational institution will really work. The key point at the very beginning of the cooperation is the clear definition of roles and the extent of business's interventions. For example the regulation of direct and indirect promotion of products and services is essential. [1] There must be clearly stated who is in charge (the school) and how influential can business in decision-making process.

3.3. Theoretical basis for the solution

"International surveys and research confirm the link between motivation, attitudes and selfconfidence, on the one hand, and achievement and career choices, on the other. Motivation to learn mathematics and science is not only important for performing well at school, but is also necessary if students are to choose careers vital for the competitiveness of our economies." [5, p. 11]

The survey held in the Netherlands under the initiative "Bèta Techniek" showed strong connection between experiences from the exposure and involvement in science and positive reinforcement from the young age and future motivation to choose career in science. [1]

The work with children at schools should not be focused just on gathering hard skills and knowledge but also on so-called soft skills such as flexibility, creativity, time management and responsibility for the result which are nowadays one of key competences demanded on the labour market.

Another highly needed ability is adaptability, the capability to make a shift from one professional background to another. Therefore it is important to make the skills and knowledge for students "connected" - to show them the links of applicability of one particular piece of knowledge in different study fields. [1]

The importance of mathematics for real life is given by its ability to develop logical and systematical way of thinking which is strongly reflected in many other competences required on the labour market. In effort to work on forming students' own thinking procedures it is very important to let children find the solution of exercises by themselves. The enlightened way of teaching should not be focused on number of solved examples but in centre of attention should be the understanding of learnt operations. [13]

There is a clear need to evolve educational concepts focused on occupations, career, development of entrepreneurial skills and include them as standard part of primary education. [6]

So far has been mentioned mostly what can be done to raise the attractiveness of MST study fields while working with students. The group which should not be excluded from the debate are the ones who lead the children through educational process - teachers. What can be done for them in order to make them better equipped so they would be able to show children that MST fields are fun, perspective and, above all, important? As mentioned above there is need to create a sufficient lifelong learning process for teachers (and make them aware of the need to persuade it, from their attendance of pedagogical faculties) in order to ensure they are provided with right skills and competencies.

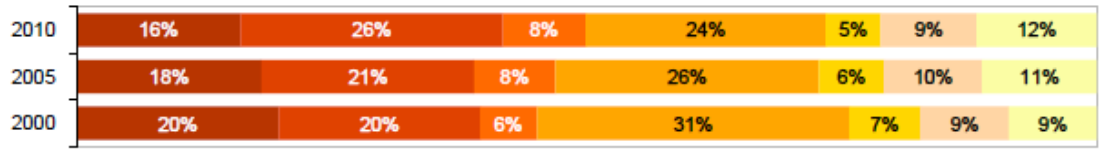
4. Practical part

The practical part of the thesis is focused on monitoring current situation of support of MST based subjects in the Czech Republic.

With effort to provide an integrated picture of the environment and conditions the projects and initiatives of support are implemented in, the chapter begins with the description of the Czech education system. Following part introduces the results of Czech students in international survey of mathematical and natural science education TIMSS[4] 2011. The chapter then continues with the information about projects and initiatives and at the final section of the chapter is provided the comparison of findings with theoretical base settled in previous parts of the thesis.

At the very beginning is useful to reveal current state. In the Czech Republic comes currently just 8% of all tertiary educated graduates from studies based on Natural Sciences and 24% from Technical Sciences based fields. This number is actually decreasing which is trend that should be reversed as soon as possible. The current situation of structure of graduates is for better imagination showed in the graph 4.1.

Graph 4.1: The structure of university graduates in the Czech Republic



Zdroj: Český statistický úřad, Výběrové šetření pracovních sil, 2011

Source: Czech Statistical Office

Colours description:

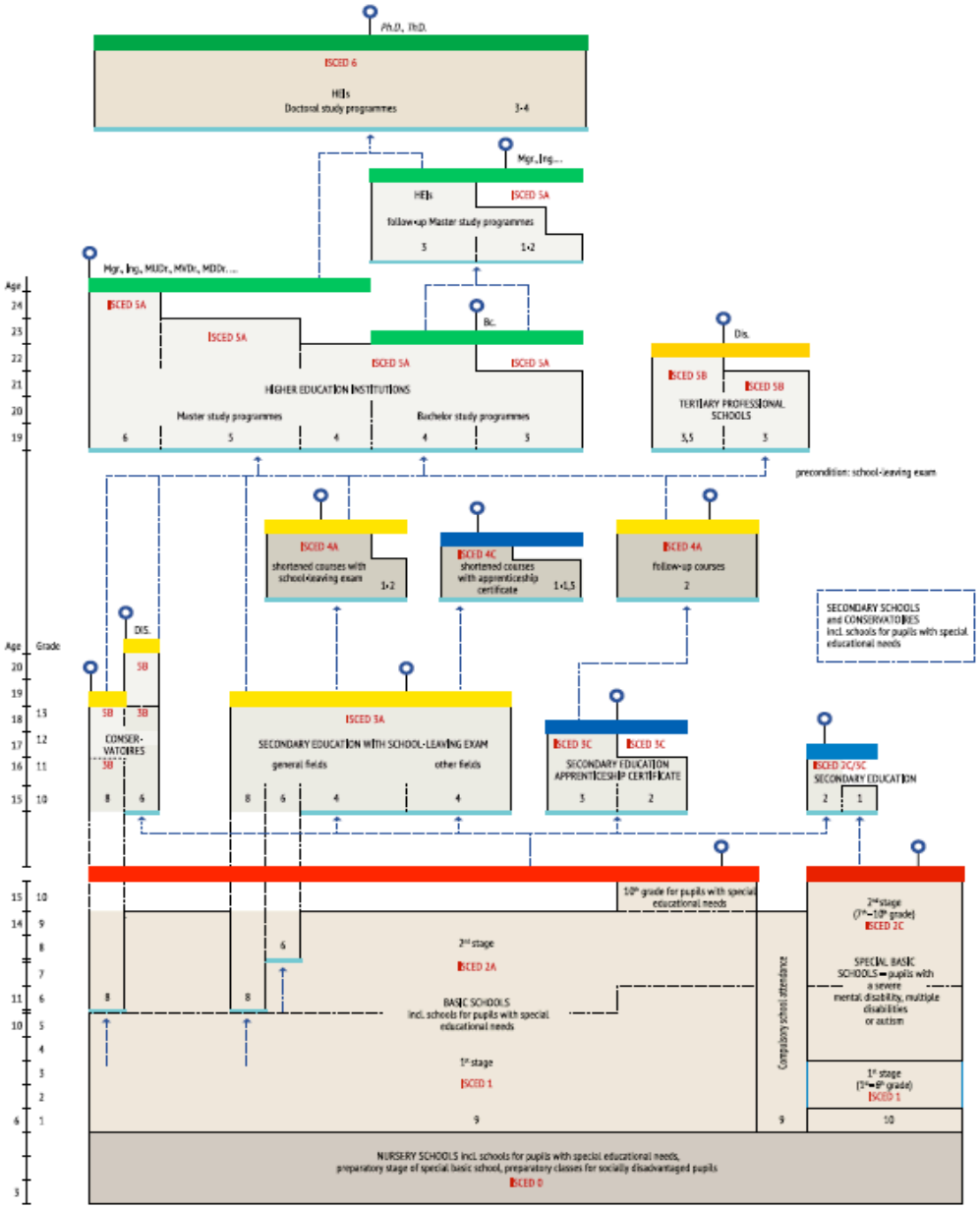
Education and Training Sciences
Social Sciences and Law
Natural Sciences
Technical Sciences
Agricultural Sciences
Medical Sciences
Human Sciences and Services

4 Trends in International Mathematics and Science Study

4.1. The Education system in the Czech Republic

The outline of the education system in the Czech Republic is showed by the figure 4.1. Each of the stages is closely described further in this chapter.

Figure 4.1: Organization of the System in the Czech Republic



Source: The Ministry of Education, Youth and Sports of the Czech Republic, 2012, p. 5

4.1.1. Pre-primary education

The education system in the Czech Republic starts with the pre-premiry education. It is provided by nursery schools which are designed for children of the age from 3 years up to 6 (7) years of age. Approximately 84% (raising to 91% in the pre-school year) of the total children of the age group is attending the pre-primary education institutions although the attendance is not obligatory. The year before the compulsory primary education is free of charge and children have a legal right to attend it. Although there might arise the need to cover up to maximum 50% of running costs (not educational). [9]

The nursery schools compose a traditional part of the Czech education system. The Education Act of 1869 already mentions pre-primary schools establishments, however the beginnings of pre-school institutions goes back to 1832. After the Victorious February in the 1948 when communist took over the control of the state, the pre-primary education became a full component of the education system but primarily with the intention to weaken the influence of the family on children's education. After the Velvet revolution in 1989 was again encouraged the debate of function of pre-primary institutions in personality-oriented model of education. [9]

The establishment of the nursery school is usually in the competence of the municipality (or groups of municipalities). Only 2,6% of nursery schools are maintained by private institutions or church (data from the school year 2010/2011). [9]

4.1.2. Compulsory education

The compulsory education in the Czech Republic takes nine years (from 6, respective 7 until 15 years old). The primary education is organized into two parts - first five years spend all pupils on the basic schools. Then there arise a possibility of choice among three options - continue at the basic school or switch either to multi-year secondary general school or conservatoire. The majority of pupils finishes their compulsory education at the basic school. Multi-year secondary general school (gymnázium) is a secondary

school providing a general education in order to develop key competences across various study fields counted as base for gaining so-called general knowledge. This option is chosen by 11% of pupils. Conservatoires are special type of schools providing artistic education in dance, music, singing and musical-dramatic art courses. The candidates are required to demonstrate their talent in the form of aptitude test. Only 0,07% of pupils decides to complete the basic education at the eight-year conservatoire. [9]

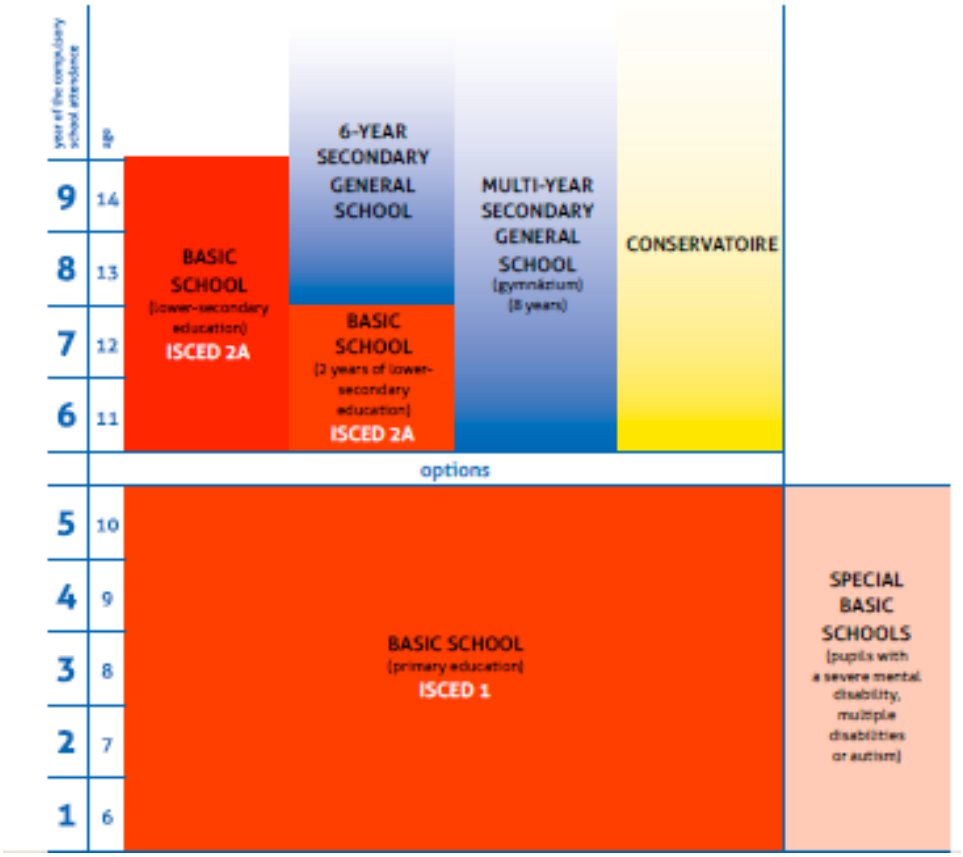
Pupils with a severe mental disability or autism can attend a special basic school.

At the first part of the basic education are all subjects usually taught by a generalist teacher, whilst at the second part (sixth to ninth grade), teachers have particular specializations (mostly in two subjects) and therefore almost each subject is taught by different teacher.

Due to the even density of basic schools distribution the number of schools is connected to number of municipalities in the Czech Republic which is considerably high. About 35% are therefore small-sized schools (with fewer than 50 pupils). Number of pupils in class is usually between 17 and 30 (in the school year 2010/2011 was average size of class 20.0). There are defined catchment areas according to child's domicile but the choice of school is free. [9]

The overview of the compulsary education structure is clearly recognizable in the figure 4.2.

Figure 4.2: Compulsory education and its options



Source: The Ministry of Education, Youth and Sports of the Czech Republic, 2012, p. 18

4.1.3. Upper secondary and post-secondary education

The post-compulsory general and vocational educational is usually provided free of charge by public schools, generally established by regions. There is also the possibility to choose private or denominational private school where fees are paid.

Teaching takes place in co-educational classes with one exception - physical education lessons.

Figure 4.3 shows the overview of the possibilities of secondary education.

Figure 4.3: Types of upper-secondary education

Secondary education according to the acquired education/qualification	Levels of education & their characteristics	Type of school	Length (years)	Theoretical age
Secondary education completed with school-leaving examination *(maturitní zkouška)* ISCED 3A	Upper secondary general education	**Secondary general school** *(gymnázium)*	4	15–19
	Upper secondary education with several specialization: pedagogical, economical, technical, etc.	**Lyceum**		
	Upper secondary technical education	**Secondary technical school** *(střední odborná škola)*		
	Art education[1]	Conservatoire		
Secondary education leading to apprenticeship certificate ISCED 3C	Upper secondary vocational education; very practically oriented	**Secondary vocational school** *(střední odborné učiliště)*	2/3	15–17–18
Secondary education ISCED 2C/3C	Upper secondary general and vocational education acquired through completion of an educational programme lasting 1-2 years	**Secondary vocational school or practical school**	1–2	15–16/17

[1] Minor exceptions may occur.
[2] Nevertheless, studies at conservatoires are usually completed by an absolutorium at conservatoires (ISCED B).

Source: The Ministry of Education, Youth and Sports of the Czech Republic, 2012, p. 22

The education at the secondary general school (gymnázium) can have three versions:

- 8-year courses for pupils who have completed the 5th year of basic education (already mentioned above)
- 6-year courses for pupils who have completed the 7th year of basic education
- 4-year courses for pupils who have completed the compulsory school attandance.

Although not all secondary general schools provides all these types, it can even vary year to year at the same school. The opening of the particular type of class depends on the current situation of the number of pupils (need to follow the socio-demographic development) in order to keep higher standards of the education level than provided at basic schools. While the pupils gather the general education in various fields of study

(e.g. languages, humanities, science, mathematics, physical education) they do not become specialists in any of the area and therefore there is a presumption of children studying secondary general school to continue to higher education.

On the other hand the graduates of the secondary technical and vocational schools are educated with an intermediate level of qualifications connected with the common assumption that these students would move directly into the labour market. The education provided at these types of school is aimed at developing practical applications of technical skills and knowledge. [9]

Graduates from upper secondary education has the option to continue to on three different types of post-secondary non-tertiary educational programmes. [9] They can choose either between two-year technical follow-up study or two types of technical or vocational shortened study.

4.1.4. Tertiary level of education

In the Figure 4.4 below are showed the possibilities of institutions students might proceed in order to gather reconglizable degree.

Figure 4.4: Types of institutions and qualification acquired

Institution	ISCED level	Length (years)	Type of examination	Degree awarded
Conservatoire (art education)	5B	**2**	Absolutorium	
Tertiary professional school	5B	**3 (3.5)**	Absolutorium	**DiS.** (specialist with a diploma)
Higher education institution - university and non-university type (Bachelor and Master's studies)	5A	1st cycle **3-4 (180-240 ECTS)**	State examination and defence of a thesis	**Bc./BcA** (Bachelor/Bachelor of Art)
		2nd cycle **1-3** (or 4-6 in case of "long" non-structured courses)	State examination and defence of a thesis	**Mgr./MgA.** (Master/Master of Art) **Ing./Ing. arch.** (for technical and economic branches/ in architecture)
			Specific state examination ("rigorózní zkouška") and defence of a thesis	**MUDr.** (doctor of medicine), **MDDr.** (dentist), **MVDr.** (doctor of veterinary medicine) For Master degree holders after taking this type of examination: **JUDr.** (in law), **PhDr.** (in humanities, education and social sciences), **RNDr.** (in sciences), **PharmDr.** (in pharmacy), **ThDr.** (in theology)
Higher education institution – university type (Doctoral studies)	6	**3-4**	State doctoral examination and defence of a thesis	**Ph.D.** **Th.D.** (theology)

Source: The Ministry of Education, Youth and Sports of the Czech Republic, 2012, p. 26

The purpose and idea behind conservatoires has been already described in the part 4.1.2. concerning the compulsory part of education.

Tertiary professional schools have been mostly attached to secondary technical schools and until nowadays still form a single legal entity with them. Their purpose was in filling the gap in qualification needs between secondary and tertiary education for students who

might not be able or do not want to attend higher education. In the school year 2011/2012 there were 180 tertiary professional schools with 29 335 students. [9]

The higher education institutions (HIEs) provide various accredited study programmes at ISCED[5] 5A and 6 level. The programmes are fully organised and prepared by the institution (or its part, e.g. faculty) and approved by the Ministry of Education, Youth and Sports after discussion with Accreditation Commission. [9]

There are university and non-university types of facilities. There are 24 public, 2 state and 3 private institutions of university type and 2 public and 42 private institutions of non-university type. The functioning of private institutions depends on approval of MYES which is based on recommendations of the Accreditation Commission which was established from the prominent professors and scientists by the government. [9]

The common requirement for admission to any of the institutions providing higher education is certificate of successful pass of the school leaving examination. Other than this common rule the admission criteria and content of entrance examination are set by each organization individually, as well as number of enrolled students. [9]

The higher education is currently free of charge, except for few administrative payments such as fees of admission procedures, for extending the duration of study beyond a set limited and for study of an additional programme. The private institutions can charge any fees with no law limitation of the amount. [9]

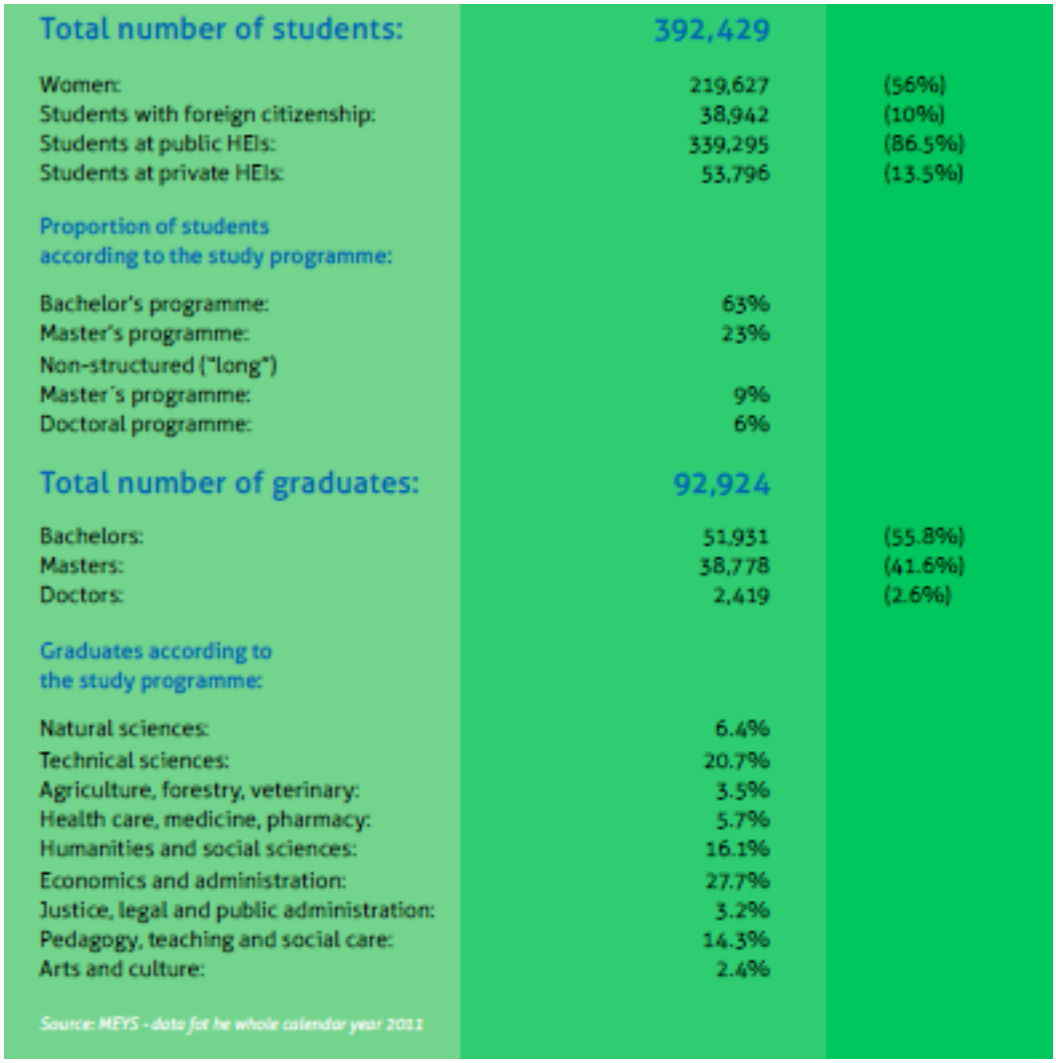
The institutions of higher education provide study programmes at Bachelor's, Master's and Doctoral levels. The fields of study are given by traditional classification of academic fields. Besides providing education concluded with recognizable degree, higher education institutions carry out other activities such as research, development, artistic work

5 Table of ISCED levels is provided in Annexes section of this work.

and possibly other creative activities, as well as organising lifelong learning programmes. [9]

The overview of students proceeding the higher education is described in the figure 4.5.

Figure 4.5: Number of students at HEIs and graduates



Total number of students:	**392,429**	
Women:	219,627	(56%)
Students with foreign citizenship:	38,942	(10%)
Students at public HEIs:	339,295	(86.5%)
Students at private HEIs:	53,796	(13.5%)
Proportion of students according to the study programme:		
Bachelor's programme:	63%	
Master's programme:	23%	
Non-structured ("long") Master´s programme:	9%	
Doctoral programme:	6%	
Total number of graduates:	**92,924**	
Bachelors:	51,931	(55.8%)
Masters:	38,778	(41.6%)
Doctors:	2,419	(2.6%)
Graduates according to the study programme:		
Natural sciences:	6.4%	
Technical sciences:	20.7%	
Agriculture, forestry, veterinary:	3.5%	
Health care, medicine, pharmacy:	5.7%	
Humanities and social sciences:	16.1%	
Economics and administration:	27.7%	
Justice, legal and public administration:	3.2%	
Pedagogy, teaching and social care:	14.3%	
Arts and culture:	2.4%	

Source: The Ministry of Education, Youth and Sports of the Czech Republic, 2012, p. 28

4.2. Results of TIMSS 2011

According to National Report TIMMS 2011 [TI] is the Czech Republic participating in the international survey TIMSS since the year 1995. The survey is organized

by International Association for the Evaluation of Educational Achievement and takes place every four years. Content of the survey is made based on the mathematic and science curricula of participating countries and is aimed at pupils of age 9 and 13 (usually pupils of the fourth and the eight grade of basic school). In the year 2011 participated only pupils of fourth grade in the Czech Republic.

The aim of the survey is to provide countries with data of how well are their pupils educated in Maths and Science compared to other countries all over the world. There are also made statistics of the progress in particular field. [14]

Although pupils in the Czech Republic gathered in Mathematics score above the European and OECD[6] average, in the long term prospective (since 1995) their results decreased the most of all the countries which participated in the survey. That is a result which should turn on all red lights. Also, the Czech Republic is one of the only six countries where boys has regularly better average results in Math than girls. [14]

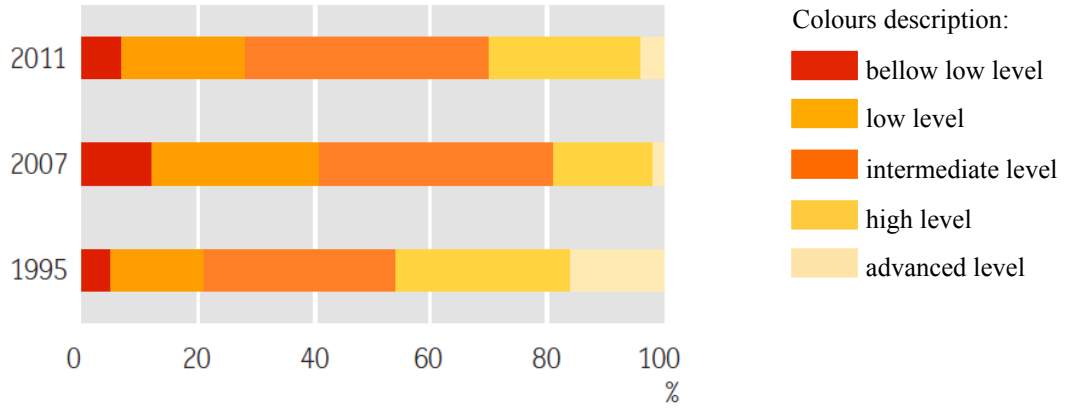
In the case of Science, the Czech pupils are also above average and better results had pupils just from five European or OECD countries involved in the survey. But there is also significant decline since the year 1995 and, in case of science, the Czech Republic has the highest difference in results between boys and girls from all the countries. [14]

The results of the knowledge in particular area are distinguished in four levels: low, intermediate, high and advanced [16]. In the Czech Republic has only four percent of pupils advanced knowledge level in Maths. The percentage of students is measured as accumulated share which means that all students achieving certain level are automatically counted in lower levels. The Czech Republic is the only country involved in the survey which showed decline of accumulated share in all levels since the year 1995. Even worse message is the biggest decline occurred in the two highest knowledge levels (high and advanced). In the year 1995 was the accumulate share for high knowledge level

6 OECD - Organisation for Economic Co-operation and Development

30% and for advanced level 16%, in the year 2011 were these two levels accommodated by 30% altogether. For better imagination see the graph 4.1. [14]

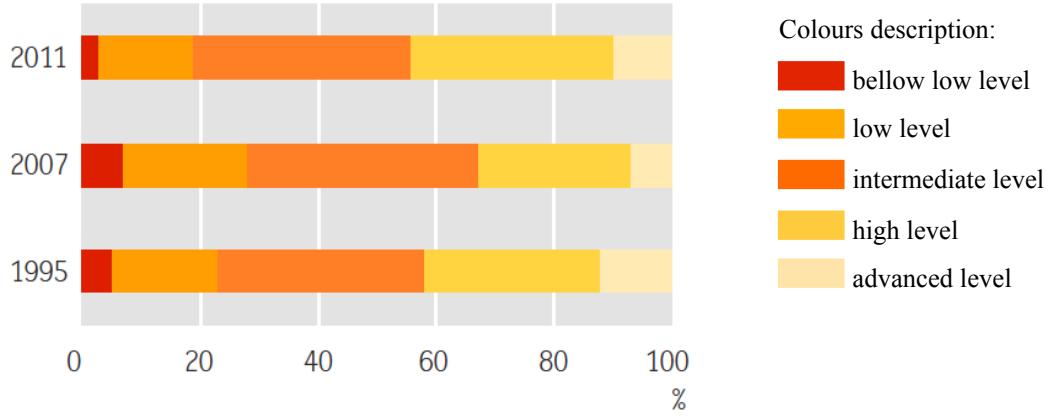
Graph 4.1: Representation of Czech pupils in Math knowledge levels in the years 2011, 2007 and 1995



Source: Tomášek, V. a kol., 2012, p. 10

The situation within the Science is according to results in much better shape. Ten percent of pupils reached the advanced knowledge level and that place the Czech Republic among the most successful European countries. Just about 3% of pupils did not cross the line of low knowledge level. Overall, since 1995 to 2011 there was increase of pupils reaching at least intermediate level of science knowledge. The graphic representation of the results is showed in the graph 4.2. [14]

Graph 4.2: Representation of Czech pupils in Science knowledge levels in the years 2011, 2007 and 1995



Source: Tomášek, V. a kol., 2012, p. 13

4.3. Approach of the Ministry of Education, Youth and Sports

The Ministry of Education, Youth and Sports (further "The Ministry") of the Czech Republic introduced on the January 10th 2013 to the Government of the Czech Republic material where was highlighted the importance of development of vocational education and training, practical applicability of graduates and strengthening the position of secondary vocational education in the years 2013 - 2016. Minister of the Education, Youth and Sports, Petr Fiala, mentioned as one of key area of the field of vocational education and training, the cooperation between schools and businesses, which needs to be continually and systematically supported.

Not only the Ministry of Education, Youth and Sports but also representatives from the Ministry of Industry and Trade, the Ministry of Labour and Social Affairs, the Ministry of Agriculture, the Ministry of Health of the Czech Republic, the Ministry of Regional Development, the Ministry of Transport, the Ministry of Culture, the Czech Chamber of Commerce, the Czech Agrarian Chamber, the Confederation of Industry of Czech Republic, the Czech Confederation of Commerce and Tourism, the Czech-Moravian

Confederation of Trade Unions, also representatives of regions and associations of schools providing secondary education are involved due to the effort to provide the complex solution of the problem.[27]

Under the Education for Competitiveness Operational Programme (ECOP)[7] was in February 2013 announced the call for proposals for grants for investments in science and technology education.The Ministry of Education, Youth and Sports has 1.8 billion Czech crowns to cover demands of all high schools except for the ones based in Prague. According to Minister Fiala, the amount of money should contribute to modernisation of classrooms and laboratories and to support the interest of young students in science education. The granted money should be also used for implementation of innovative approaches within the cooperation between schools and actors on the labour market. Creation of open workshops for the pupils from primary level enables to gather detailed picture about the technical of scientific fields through personal experience. One of the aims is promotion of foreigner language learning, increase of language skills particularly in connection to MST subjects. [25]

The Ministry contributes to the topic of promotion of MST subjects and cooperation between schools and businesses also thought the projects aimed at dissemination of results of European cooperation in education and training (ET2020) held under the grants from the European Commission.

In the year 2011 was organized an international conference called “Partnership for MST: support for teaching of Mathematics, Science and Technologies through cooperation between schools and businesses” where were presented projects from both the Czech Republic and abroad aimed at supporting the attractiveness of MST subjects. This major event was followed by seminar “MST - Mathematics, Science and Technology:

7 The Education for Competitiveness Operational Programme (ECOP) is a multi-year thematic programme under the jurisdiction of the Ministry of Education, Youth and Sports of the CR (MEYS), within which it is possible to draw financial means from the European Social Fund (ESF), one of the structural funds of the European Union (EU), in the programming period 2007–2013. Its focus is at the area of the development of human resources through education in all its various forms with an emphasis on the comprehensive system of lifelong learning, creation of an appropriate environment for research, development and innovative activities and stimulation for cooperation among the entities involved.

an opportunity for future career" held in the year 2012 in Brno to broadened the fact of importance of dealing with the topic not just on national level but also that it is considered as crucial even within regions.

The audience of events were put together from representatives of teachers and teachers´ trainers, school leadership and administrative governance, experts, representatives of businesses and research institutions, non-governmental organizations, associations connected with the education or labour market, chambers of professionals and other relevant stakeholders. The events were focused on raising awareness of all current incentives and trends in the field of the education quality, better future for education systems in EU Member States and better preparation of young people for future challenges. One of the main objectives was dissemination of the results and outputs of initiatives that EU is currently undertaking especially in the field where education and labour market meet.

To ensure the applicability of graduates' gathered skills and knowledge on the labour market was in the October 2012 held an international conference "Modernisation of the System on Recognition of Professional Qualifications: EU Internal Market without Barriers". The purpose of the modernisation is aimed at securing the transfer of knowledge across the European countries which is crucial for one of the goals set at the strategic framework for European cooperation in education and training - to become the most competitive and dynamic knowledge-based economy.

4.4. Approach of the Ministry of Industry and Trade

The Ministry of Industry and Trade plans to release 800 millions of Czech crowns under the Operational Programme Enterprise and Innovation to support the education of young technicians. In order to prevent the situation when graduates come from the vocational schools but without the ability to actually control the machinery, the Ministry wants to support companies to ire students as interns during their studies. Due to the fact that

machinery available for students at schools usually do not respond with the one companies are using, the possibility to learn on devices used in real would provide students with very valuable experience. [28]

To encourage companies to accept students as interns, the Ministry wants to introduce change in the law on income tax and involving tax reliefs for business willing to cooperate with the students. The relief would have the form of deductions from the tax base of purchasing the equipment for every intern accepted. Tax deductions would be prepared also for companies which do not purchase new equipment but let students use their older machinery. [28]

4.5. Initiatives of support MST based subjects

This section is devoted to presentation of project and initiatives held to support the attractiveness of MST based subjects in the Czech environment. The structure of the section is structured in alphabetical order according to the name of the project or initiative.

The name of the action is usually quoted in original Czech version at first and than in English translation (authoress's own translation). In cases where there was provided English translation in original materials regarding particular project or initiative, the name is written just in English version.

4.5.1. inGenious

The Czech Republic is joined in the initiative inGenious launched by European Schoolnet[8] and the European Roundtable of Industrialists[9]. InGenious is the European Coordinating body aiming to reinforce the interest of young people in Science, Technology, Engineering and Math education to prevent gaps in the future graduates' skills. It is one of the largest and most strategic projects undertaken in Europe intended to increase the links between science education and careers. [21]

The main aim of the initiative is to recognize and share teaching practices developed by representatives of industry to encourage young people to think about the value of STEM subject and wide range of interesting opportunities that choosing career path within that field can bring them. The other activities are on-line chats with the experts from various companies where can also participate students, and on-line discussion forums. [21]

The duration of the project is three years and each year participate ten teachers from ten different Czech schools (among over 1000 teachers across Europe). In the Czech Republic are teachers coordinated (and chosen) by one of the organisations directed by the Ministry of Education, Youth and Sports, the Centre for International Services. [20]

4.5.2. Matematika s chutí/Math with Passion

The non-governmental organization ISEA[10] introduced the project "Math with Passion" which is aimed at the raising the attractiveness of Mathematics in the primary education. The main aim is to provide students with possibility to connect the knowledge gathered in Math lessons with the practical examples in real life, as well as find the interconnections

8 European Schoolnet is a network of 30 Ministries responsible for education in European countries and beyond aiming at maintaining innovations in teaching and learning in the are of policy, research, school services and learning resources.[19]

9 European Roundtable of Industrialists is a forum joining around 50 Chief Executives and Chairpersons of major European companies operating in industrial and technological sectors. The purpose of the forum is to strengthen and support key conditions for innovations and entrepreneurship in the European economy. [18]

10 Institution for Social and Economic Analyses is one of the leading and politically independent think-tanks in the Czech Republic.

of various subjects. Through collaboration with teachers, the project aims at support of students' active thinking with providing better understanding of basic concepts. Students are enabled to feel involved in the process of finding the solution in environment with cooperative atmosphere, tolerating mistakes which are taken as common part of any innovative approach. The abstractive methods are replaced by real-life examples which makes the learning easier for all groups of students.

4.5.3. Open science

Project "Open science - popularisation of science and technology and communication of research and development with the society" is implemented by Centre of Administration and Operations of the Academy of Sciences of the Czech Republic[11] with the financial support of Education for Competitiveness Operational Programme and state budget of the Czech Republic. Currently is in progress its third implementation period which is under way since July 2012 until June 2014. [v]

The aim of the project is to create a systematic framework of support to ensure the sufficient number of high quality labour force for scientific research and development in the Czech Republic. Among specific actions taken to fulfil that, can be systematic work with students from secondary level of education appointed as the main. There are offered internships by institutes of the Academy of Sciences of the Czech Republic, universities and research laboratory to secondary schools all over the Czech Republic for pupils talented in the science and technology subjects with the aim to improve and grow human potential in the long-term weakened scientific fields, to motivate them to proceed university education in these fields as well as their future career. Students are chosen to participate on real research work or even to carry out their own scientific plans which offers them the opportunity to taste also the practical part of the life of a scientist. [v]

11 Centre of Administration and Operations of the Academy of Sciences of the Czech Republic is a public research institution inscribed in the Register of Public Research Institutions administered by the MEYS of the CR. It is an independent legal entity of a not-for-profit character, whose aim is to ensure the infrastructure of research and development and provide supporting activities particularly for the Academy of Sciences of the CR and its workplaces.

One of the other objectives of the project, creation of the net of propagators among workers of research institutions all over the Czech Republic is connected with further development of skills of research workers to communicate the science in the persuasive and fascinating way to attract the interest of broader society. [26]

4.5.4. Podpora technických a přírodovědných oborů/ Support of technical and scientific fields

National individual project "Support of technical and scientific fields" is implemented by the Ministry of Education, Youth and Sports within the Education for Competitiveness Operational Programme.

The aim of the project was to design and verify methods of support the interest of young generation to continue their studies in scientific and technical fields in order to provide the society with exactly focused, critically thinking labour force.

For that purpose was created net of regional coordinators (institutions) which contributed on fulfilling the goals of the project.

Key activities of the project

The project had three key activities: teaching support, motivational activities and communication of science.

Teaching support

Research-oriented teaching. That was the main idea underling this project activity - to introduce teachers new ways how they can improve their lessons through implementation of research-oriented teaching concept. The idea of research-oriented teaching is based on process when students are encouraged to reveal part of the problem by themselves. They are forced to formulate hypothesis, confirm or refuse them

on the basis of facts, experiments, and scientific reasoning which not only provides students with more permanent knowledge but it actually let them feel really involved in the process and make them more interested in the subject.

Motivational activities

These activities were focused on raising the interest in technical and scientific fields through strengthening the fact that content of the subject does not have to be just simple formula memorising but that the are real practical impacts of the work of technicians and scientists.

The key idea of the motivational activities is that it is crucial to target desirable group and go to attract them. There is no space to expect that the unmotivated people will come by themselves. The attraction of target group might be done by one major event but that needs to be followed by ongoing systematic work with the target group.

The activities organised during the project were, for instance, summer camps, children scientific conferences, outdoor events, seminars, “Universities for children” and others.

Communication of science

The objective of this activity was to work on popularisation of science. The effort was to enrich various methods how to popularise scientific work through modern communication channels - webpages, social media and road shows which can bring science to general public. And it actually did, brought science to unexpected places such as one of major summer music festivals in the Czech Republic - Rock for people.

As a outcome of the project also serves the website www.generacey.cz which is focused on promoting news within the science and technology.

4.5.5. Přírodovědci/Scientists

As an example of the effort of higher education institution to raise the attractiveness of the MST based subjects and attract more students to choose their future career in these fields might be used the communication initiative presented by website www.prirodovedci.cz.

The aim of the project is to enable children closer insight to four sections of Faculty of Science at the Charles University in Prague. Registered users are given materials and opportunities to visit lectures, to meet experts from the faculty and to participate at all kinds of science competitions and thematic excursions. The value of gathered experiences is in the opportunity to get the feeling of university environment - to sit down at lecture rooms and see the experiments.

The initiative also offers various workshops, weekends for children focused on particular field and summer camps for pupils of primary level of education who are interested in science. There are also available materials and seminars for teachers of science subjects.

4.5.6. Stáže pro mladé/Internships for young people

Fund for further education, organisation under the Ministry of Labour and Social Affairs of the Czech Republic is currently implementing the project for students of last year at secondary education level or students of last semester at higher education institution or at tertiary professional school (see section 4.1.4.). The purpose of the project is to provide students with work experience through which they should be able of much more easier adaptation on labour market when they graduate. [31]

The duration of the project is three years and should provide internships for 840 students from the educational institutions all over the Czech Republic. [31]

The database of the internships are provided on the website www.stazepromlade.cz, where are available also information for businesses willing to contribute as an internship provider. The cooperation with the company should be guided by mentor (employer of the company) whose salary will be compensate from the project resources. [31]

The students will be rewarded by 60 CZK per hour but the internship will take place in their free time and would not change their school routine in any way. [31]

4.5.7. Věda má budoucnost/Science has future

The project "Science has future" is coordinated by the civic association AISIS with the auspices of the Ministry of Education, Youth and Sports. Project follows the example of successful initiative Schools'Business Partnership implemented in Ireland where nowadays is connected 125 large companies and over 170 schools. [30]

The purpose of the project is to raise the attractiveness of science, mathematics and technology among young people through cooperation of schools with businesses. The key feature of the project is connection of MST subjects with career guidance at schools. This is the element which differentiate the project from others, it does not focus just on raising the attractiveness of the MST study fields but works on promoting the career possibilities in the science and technology fields which young people usually do not see while thinking over the future prospectives. [30]

The project allows close cooperation between education and business sectors which provides both sides with possibility of experiences exchange.

There are number of ways how company can cooperate with school and it is up to their mutual agreement to what extent the cooperation will take place. The common routine is one company-one class (or classes on the same grade within one school) cooperation

going on for one school year. The coordination of partnership establishment is provided by the AISIS which lowers the administration demands on participating parties.

Modules of cooperation

The basic module of cooperation is called “Work skills” and is aimed at students of both basic and secondary education levels. It is a one school year programme of well structured visits and workshops exposing students to various processes of the company. The cooperation is based on meetings scheduled through the school year. At the meetings, students are provided with the information about everyday reality of the work life in the company, the recruitment process, they are forced to actually prepare the CV which is then assessed by the responsible employee of the company and they have to prepare themselves for the interview which is also part of the workshops. [30]

The other modules are Mentoring, Further professional development for teachers and school leaders and module called Summer jobs.

Mentoring is designed for talented students (both from basic and secondary level of education). It is one-year programme focused on very close regular cooperation of volunteers from the company with small groups of students to stimulate their interest in future career in MST fields. [30]

The module providing further education for teachers and school leaders (also available for basic and secondary schools) includes series of educational activities organised based on the cooperation with the company and focused on development within the MST area. [30]

Summer jobs are accessible only for students on the secondary level and it basically allows them to work for the company during the summer holidays. [30]

Companies Bayer and IBM have cooperated on the project from its very beginning and they have actually collaborated on creation of conditions which allow involvement of other companies and therefore also higher number of schools.

5. Recommendations

In the practical part of the thesis were brought examples of initiatives aimed at support of the attractiveness of MST based fields which are applied in the Czech Republic. The initiatives are organized and implemented by various institutions - universities, institutions of state administration, civic associations and representatives of businesses. The overview clearly shows that the awareness of the importance of MST based subjects support is unquestionably recognized and shared by various parties involved. Which is a good first step needed for the execution of shift in current development.

In this part of the thesis is commented the current situation in the Czech Republic with remarks on issues which should be, according to authoress's opinion, further addressed. There is developed in broader concept the idea of MST DataBank (described below).

The strategy of raising the number of students graduated from institutions of higher education is definitely important to ensure the high-skilled labor force. Although there must be taken actions to adopt measures to influence the structure of graduates. Whilst nowadays the majority of students graduate from human sciences based faculties, the intention should be to shift the higher number of students into MST based fields.

There is a wide range of ways how the support of MST study fields might be carried out. Representatives of the public administration institutions show that they are aware of the need to deal with the issue on national level and are prepared to reveal significant amounts of money to encourage the initiatives which are aimed at the support of MST based fields. Nevertheless there can be also taken steps which require none or just minimum added resources on one hand, but offer a great possibility of influence on the other. Such approach might be accomplished, for example, by maintaining contacts with own graduates who have become successful professionals and might be helpful as role models, or by broader collaboration with parents who can tell students about their professions. The important aspect of all initiatives is the contact with real life which brings children inspiration and encouragement.

The shortage of many projects might be in target group they address. Many projects are focused on talented children which is great, definitely is needed to further develop their potential, to take care about their interest in Science, Math or Technology and to sensitively guide them into studies of MST based subjects. However, these students are already attracted, there is need to attract more children to avoid the possible future scarcity. The key element of that goal should be to arouse the interest in MST subjects among the children who would not have ever think about it.

Another challenge in the area of MST support is certainly to bring girls, women and disadvantage groups of students to MST study fields. For that purpose there has to be firstly addressed the importance of bringing MST subjects to them - to attract them. Within strategies aimed to solve the possible future gap at the labour market, these might be groups with great potential to work with.

Projects co-financed from European Structural Funds (which most of them is) cannot be implemented in Prague which means exclusion of all students of schools based in Prague which can lead to missing the potential of almost 150,000 students [17] at primary and secondary level of education. That is reason for maintaining also projects which are funded solo from state budget or other resources.

The successful implementation of any initiative is based on involvement of all relevant parties. In the case of MST support are these parties school leaders, teachers, students, institutions providing education at any level, parents, students, civic associations, media and above all institutions of state administration. All the parties should actively contribute to effective ongoing of the actions, which could also mean reduction of bureaucracy and voices of skeptical attitudes among authorities. In the Czech Republic is widespread the viewpoint of the exceptionality of academics which might cause suspicious reactions towards the possibilities of cooperation with commerce sphere. That surely arises a certain challenge to work on changes of that attitude in order to encourage the creation

of constructive partnerships. The experiences gathered in environment outside school, including from business should be highly appreciated and encouraged, not prevented. The higher the level of recognition of the value of education acquired outside school would be adopted, the better prospects it would bring for the society.

MST DataBank

The evident shortage of the actions taken in order to prevent possible future problem sees the authoress in the lack of coordination of the operations. There are valuable projects and initiatives but they miss the overall covering strategy which would state clear mission and vision. There is missing strategy which would clearly define roles of the particular players in the field and which would define the desirable state and more importantly, the ways how can that be achieved and who would take care about it.

It seems like there is shared feeling "something has to be done, let's try this (or that)" but if the effort was used in more coordinated way, the results might be more beneficial for all parties involved.

The idea is to create a place (institution or department within existing institution) where would be held centralised information about the MST agenda (for the purpose of the clear distinction of the proposed institution was chosen the name MST DataBank which does not describe anything else within the thesis, the name is fictional and does not refer to any existing institution).

The division of the activities executed by the MST Databank might be divided according to relevant stakeholders it would serve for.

Schools

- supporting creation of individual schools-business partnerships - providing information about companies willing to cooperate with schools (in form of database)
- guidance in the area of MST support

- database of projects which are undertaken in the MST area
- storage of teaching materials (products of projects)
- offering of the space where they can share their concerns/ideas/comments/observations

Businesses

- providing information about the possibilities how to contribute
- explaining the situation - why it is important to support the MST based subjects, and what advantages would such cooperation have for them (work on attracting them)
- offering of the space where they can share their concerns/ideas/comments/observations

Students

- information about the fields of MST based studies
- information about career prospects in the MST based fields
- overview of the projects
- offering of the space where they can share their concerns/ideas/comments/observations

General public

- PR of the MST subjects
- PR of the importance to support the MST based subjects (explanation of how the number of MST graduates influences the development of economy)
- offering of the space where they can share their concerns/ideas/comments/observations

Institutions of state administration

- overview of the area of MST support
- monitoring of the trends and incentives introduced abroad
- providing guidance at the field of dissemination and exploitation of MST support
- providing information for international reports/surveys
- offering of the space where they can share their concerns/ideas/comments/observations

Horizontal Activities

- monitoring of the situation in the Czech Republic and abroad
- surveys covering the area of MST support
- maintenance of informative website
- providing information for relevant decision makers
- PR of the MST DataBank
- sharing examples of good practice and valuable experiences
- assessment/ranking of the projects and initiatives

In order to cover all the activities listed above, the MST DataBank would have to be respected as an important part of decision making process within the area of the MST. It would have to attract stakeholders to actually share the information.

The important factor is that the MST DataBank would not manage projects by itself, although as might be clear from the list of activities, there would be a significant amount of work needed to cover all demands. For example, in the case of creating the database of companies willing to contribute with schools, there arises the need of communication with companies to find out the possibilities of cooperation they are willing to offer for schools, but that would be the extent of intervention. The cooperation as such would be under the administration of particular school or company.

The centralisation of the information would allow to easily determine the weak spots within the system of the MST support and enable to take actions to solve them. It would also help to avoid doubling the projects or initiatives.

Other great opportunity is seen in providing the guidance for stakeholders. The methodologies explaining how to deal with particular situation would offer the possibility for schools, municipalities or whoever would want to do contribute, simply take ideas from the examples of what was successfully implemented before. That would

decrease the barriers of the unknown and encourage to take action. This organ would work as an advisor in the area.

The importance of the communication with general public is taken into account because when there is an intention to prosecute something to students there must not be abandoned the influence of others on students' decisions - parents, peers, role models and influence of media and social media.

6. Conclusion

The choice of the diploma thesis topic was based on the experiences gathered during the internship at the Ministry of Education, Youth and Sports. With regard to my study field, Economics and Management, I have decided to drive the choice of the topic according to availability to use insights from both fields, meaning education and business sectors.

The links between education and business were through the thesis strengthened mainly with the intention to enhance the importance of applicability of knowledge and skills obtained during the education process in actual business environment.

The challenge in that field for the Czech education system is to make the shift from traditional viewpoint at the education as a process which finishes with the end of formal education. The ongoing development and enhancement of skills and knowledge during lifelong learning process is the only perception which can remain viable in the effort to maintain sustainable economic growth.

It is impossible to develop effective policies without clear understanding of the process which would be required to achieve the aim. The support of the MST based fields could be divided into to basic phases. The first step is to increase the attractiveness of this subjects for the students of primary and secondary level of education. In other words, to encourage them to persuade them to study MST fields on tertiary level. And there comes the second phase where the key challenge is to provide students with relevant skills and knowledge, which would fulfil the requirements of the companies on the labour market.

The structure of the thesis was adapted to the objective of introducing the facts explaining the importance of the urge need to support MST based fields and to show who are the key players and relevant stakeholders at that field. Although there are differences caused by the diversity of education systems and cultural and economical environment among countries, there is a belief that examples of good practice and specific recommendations

might be transferable and applicable into the Czech policies concerning the situation of cooperation between schools and business and supporting the attractiveness of MST (STEM) study fields.

In the practical part were showed examples of initiatives and projects implemented in the Czech Republic which should have provide the basic orientation in the area in order to evaluate the current state and to recommend effective solution. The proposal of the coordination centre is, however, just one of the possibilities how to contribute to successful cooperation in the field of MST support.

The determination of costs of implementing particular projects or initiative was not included in this thesis due to the fact that such analysis would be beyond the possibilities of authoress as well as measurements of actual impact of the policies. Reforms, especially within the education sector are implemented with long-term prospective. The impact is not recognizable in the society until at least 15 years period (in cases of the changes introduced at the basic education level) when can be held the evaluation of statistics of number of students who were involved in particular project or initiative and how it influenced their definite choice of study field. There is certainly great space for further research in many areas presented within the thesis.

7. Resources

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8. Annexes

8.1. Abbreviations used in the thesis

- ESF - European Structural Funds
- HEI - Higher education institutions
- MST - Mathematics, Science, Technology
- MYES - Ministry of Education, Youth and Sports
- NGO - Non-governmental organization
- OECD - Organisation for Economic Co-operation and Development
- STEM - Science, Technology, Engineering, Mathematics
- TIMMS - Trends in International Mathematics and Science Study

8.2. Figures and graphs used in the thesis