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Informatics education according to the latest trends and ICT development

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Abstract
Applications of knowledge and technologies, especially in the field of Informatics, are critical for success in all areas of human activity, including economic and business spheres. Development and the efficiency of investments into mentioned area depend strongly on users, their motivation, interest and proper education. Presented paper reflects the fact that all of Europe's citizens need to be educated in both digital literacy and informatics and describe the importance of proper informatics education. As we work at the Faculty of Economics Technical University of Košice we are dealing with an innovative manner of informatics education of young managers. In the paper we present results of our research in the field of secondary school graduates informatics education, we also describe our experience in teaching and discuss reasons for the knowledge body and methods which had been implemented into the subject Informatics II at our faculty. We consider knowledge, the implementation of ICT and innovations to be the key factors that can ensure economic growth for individuals, companies even for whole countries.

Key words Informatics education, development of informatics, new trends,

1. INTRODUCTION

To develop a new knowledge society in Europe it is necessary to equip young people in a better way for the labour market, improve all levels of education and training. According to Council conclusions concerning the role of education and training in the implementation of the 'Europe 2020' strategy: Education and training have a fundamental role to play in achieving the 'Europe 2020' objectives of smart, sustainable and inclusive growth, notably by equipping citizens with the skills and competences which the European economy and European society need in order to remain competitive and innovative, but also by helping to promote social cohesion and inclusion. Higher education institutions should be encouraged to improve the quality and relevance of the courses they offer [1].

These days education and training are considered to be investments for states/nations, entrepreneurs and individuals. The educating system cannot just reflect current knowledge but it also has to anticipate the development from the view of contents and quality. An important process is to introduce the achieved knowledge into the real life. The development of human's capital together with social capital is a key factor for building an inclusive, sustainable economic environment [2].

The only thing that is certain in today's world is a permanent change. For a successful existence in this turbulent environment it is very important to learn how to cope with both changes and the quickly transforming world. If anyone wants to compete on the market nowadays, amongst so fast growing competition, the ratio of their change has to be higher than the ratio of changes in the environment around them. A good position can only be the result of a quick adaptation to current needs and trends [3].

2. IMPORTANCE OF INFORMATICS EDUCATION

Informatics, the science behind IT, may be the most important key to the future economic success in Europe. Crucial to that success is the availability of superb informatics education throughout Europe. Guaranteeing and improving this quality is of paramount concern to the informatics community [4].

In this new "digital world", information is available almost anywhere at almost any time, computer power is ubiquitous, communication of vast amounts of information is almost instantaneous, and storage capacities seem infinite. But these powerful capabilities only benefit those who have learned to use them effectively. Any citizen of a modern country needs the skills to use IT and its devices intelligently. These skills, the modern complement to traditional language literacy in language (reading and writing) and basic mathematics, are called digital literacy. Many modern primary and secondary school curricula have started to include digital literacy elements, teaching students to be comfortable with the basic tools of the digital world. The complementary reports describe digital literacy programs in various countries. Digital literacy should indeed be a required part of the education of all Europeans. Digital literacy education, when implemented properly, includes both teaching the technical mastery of digital tools and the rules for using them effectively, safely and ethically. Unfortunately, these rules are not always prominently included in existing programs, even though they are essential to ensure that students learn to use digital resources properly. Digital literacy education must emphasize not only the "what" but also the "how", as well as concepts of right and wrong [5].

Governments and the public all too often satisfy themselves that teaching digital literacy is enough to prepare the citizenry for the "Information Society" that Europe has decided to become. It is not. Digital literacy is a practical skill, not a scientific topic or an adequate intellectual preparation for the challenges of a digital world. For a nation or a group of nations to compete in the race for technology innovation, the general population must in addition to digital literacy understand the basics of the underlying discipline, informatics. On the road to an information society, informatics plays the same enabling role as mathematics and physics in previous industrial revolutions. That is why, according to [5]:

- All of Europe's citizens need to be educated in both digital literacy and informatics.
- Digital literacy covers fluency with computer tools and the Internet.
- Informatics covers the science behind information technology (IT). Informatics is a distinct science, characterized by its own concepts, methods, body of knowledge and open issues. It has emerged, in a role similar to that of mathematics, as a cross-discipline field underlying today's scientific, engineering and economic progress.
- Informatics is a major enabler of technology innovation, the principal resource for Europe's drive to become an information society, and the key to the future of Europe's economy.
- European countries are making good progress in including digital literacy in the curriculum. The teaching of this topic should emphasize the proper use of IT resources and cover matters of ethics such as privacy and plagiarism.
- Informatics education, unlike digital literacy education, is sorely lacking in most European countries. The situation has paradoxically worsened since the 70s and 80s.
- Not offering appropriate informatics education means that Europe is harming its new generation of citizens, educationally and economically.

- Unless Europe takes resolute steps to change that situation, it will turn into a mere consumer of information technology and miss its goal of being a major player.

3. FACTS ABOUT THE REAL STATE OF INFORMATCS EDUCATION

Since the academic year 2003/2004 we have continuously been surveying extent and content of our first grade students' informatics education. Before entering our faculty, these students mostly attended grammar schools or economic high schools. We use a questionnaire administrated in the first semester on the first seminars of subject Informatics I and we search for the real state of compulsory informatics education and students´ information competencies. The questionnaire contains except the closed items (with possibility to choose answer "yes" or "no") also open items concerning information systems (IS), type of IS, life cycle of IS, modelling, working with IS and satisfaction with their informatics education. For us it is very important to know the entrance conditions to set properly the next university informatics education.

The total number of our respondents over the presented period 2003 – 2013 was 1755 graduates of secondary schools. There were 1532 – 87 % grammar school graduates and 223 – 13 % business and other school graduates, mainly from the region of Eastern Slovakia, Faculty of Economics first-year students.

In this paper we present at first the evaluation of the answers "How many compulsory lessons have you had in your secondary school in particular years?" In Figure 1 we can see average number of the compulsory lessons/classes (one lesson is 45 minutes) of informatics on secondary school in period from 2003 to 2013. The former state was 2 lessons of informatics in the first year with the possibility to divide it into next years. This changed in 2012 to 1 lesson in the first, second and third year while the schools still have the possibility to organize it differently. The schools crate their own education programs where they can still add lessons of informatics. Despite this change we still consider the amount of informatics education insufficient these days.

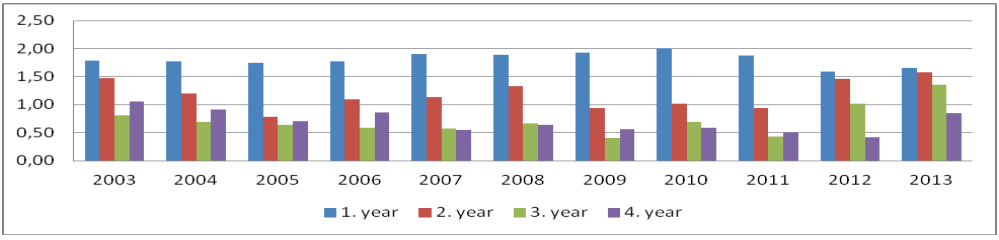

Figure 1. An average number of informatics compulsory lessons on secondary schools in particular years

We also search for the real content of compulsory informatics education. Students answered this question: "Did you work/deal with next applications, programs and concepts?" In Figure 2 we present the average percentage content of informatics education and competencies of secondary school graduates.

As we can see in Figure 2 in the fields of working with text editor, operating systems, using internet services and search machines there are nearly 100 % respondents familiar with these areas. In the field of working with spreadsheet program and software for presentation also in the fields of informatics elementary terms, basics of hardware and architecture of computer, internet protocols programming

languages the percentage is decreasing, in spite of the fact that these fields are a part of compulsory informatics curriculum.

The ability to communicate via computer network also belongs to information competencies. It means using internet services and understanding the basic rules of internet communication. Figure 2 also presents the percentage of the students, who used internet services such as email, www, ICQ and Skype. As we can see almost all secondary school students worked with and used internet services despite of that it is surprising that the number of students who are familiar with basic rules how the Internet works – internet protocols, DNS, etc. is very low.

As we can see the worst situation is in the area of working with IS. The evaluation of the students answers shows that in average less than 20 % of the students had/presented experience with IS and less than 1 % specified working with modelling as a method of simplifying and recognition of real objects. Less than 10 % of students recognized the types of IS and less than 1 % recognized the other terms. Despite the fact the knowledge of IS has been introduced to the teaching plans of obligatory secondary school subject, despite the penetration of the Internet and ICT into every aspect of life - we daily use various IS - libraries, enterprises, offices, entertainment, despite the effort to integrate ICT and computer science into the education.

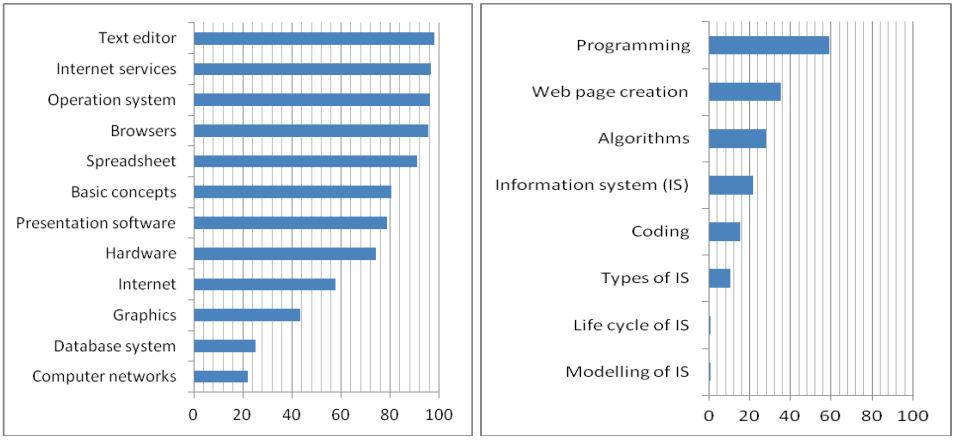

Figure 2. Content of informatics education and competencies of secondary school graduates in average percentage of presented period

We can conclude from students´ answers that secondary school education in the field of informatics/computer science is strictly focused on using different application packages (like MS Office) and work on the Internet. These are parts of digital literacy but it is necessary for students to understand science behind – informatics principles. As we can see only 60 % of secondary schools graduates were familiar with programming despite the fact that it is compulsory part of curriculum. Algorithmic approach, using of knowledge for creating "something new" and interdisciplinary relations are often missing. There is a lack of understanding of basic terms of IS and modelling, regardless of the fact, that they work with IS and modelling in some way every day.

From the year 2008 we also asked students "Are you satisfied with the level and quality of your informatics education in your secondary school?" Students' answers were divided into three categories:

satisfied, partly satisfied and unsatisfied. Figure 3 presents evaluation of students' responses in average percentage in particular years.

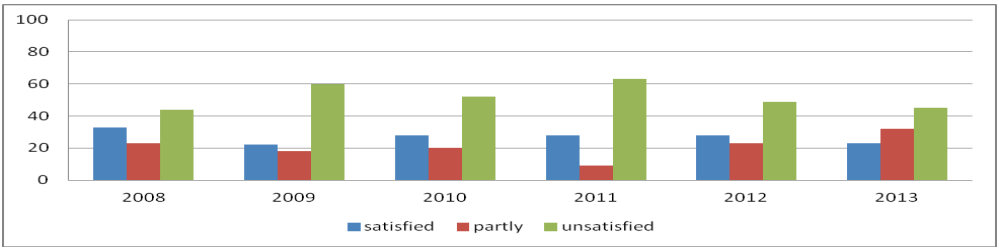

Figure 3. Respondents' view on the adequacy of informatics teaching at their secondary schools

This was an open question. We evaluated it by qualitative analysis of the texts. According to the responses we can conclude that the key factor influencing the level and quality of informatics education is the teacher, his personality and approach and competencies. As we can see in Figure 3, satisfaction from the students' view is stagnating in spite of informatization of all aspects of life and education, in spite of teachers' further education, in spite of projects to increase their ICT competencies. The proportion of unsatisfied answers decreased a little over the years but it still near 50%.

4. INTEGRATION OF NEW TRENDS INTO THE INFORMATICS EDUCATION

To improve students' shortcomings and to set adequate quality of university informatics education we permanently study the accessible sources of literature, the latest knowledge and the trend in the field of informatics. As we work at faculty of economics, especially information management, business process modelling and IS implementation and integration is for us very important. We also use resources such as the experience of experts from the area of theory of teaching, contents of foreign universities curricula, content for educating experts in the field of "business informatics" and software engineering, etc. We naturally use our own experience as participants of various projects, our knowledge and skills as researchers and teachers.

From our annual detail analysis of knowledge level of the students, considering all the mentioned aspects we have decided for a concept of education in two parallel planes. Considering big differences in ICT knowledge/skills of secondary school graduates it was necessary to keep the classic procedure in teaching the subject Informatics I in a structure very similar to ECDL. This seems to be vital for further correct understanding of possible work in the frame of enterprise informatics.

In the subject Informatics II we included a part called Business informatics and Information Systems. In this second parallel plane the key theme is management of IS in the relation with modelling of the business processes. Here we try to innovate the content and introduce the newest trends to our students. We started from the basic theoretical concepts in the Theory of Systems and modelling in general, business processes modelling using ARIS and UML. By solving practical problems as a students´ term projects, students become familiar with the features helping them to work with a lot of available information and create various financial models, as we can find in [6].

To find out "what is new" in the informatics world we use analyses, researches and predictions of Gartner. Gartner, Inc. (NYSE: IT) is the world's leading information technology research and advisory company. It delivers the technology-related insight necessary for all to make the right decisions, every

day. Gartner was founded in 1979, is headquartered in Stamford, Connecticut, USA, and has 6,600 associates, including more than 1,500 research analysts and consultants, and clients in 85 countries.

Figure 4 presents one of the most important analysis of Gartner – Gartner's Hype Cycles for Emerging Technologies. The Hype Cycle for Emerging Technologies report is the longest-running annual Hype Cycle, providing a cross-industry perspective on the technologies and trends that business strategists, chief innovation officers, R&D leaders, entrepreneurs, global market developers and emerging technology teams should consider in developing emerging-technology portfolios [7].

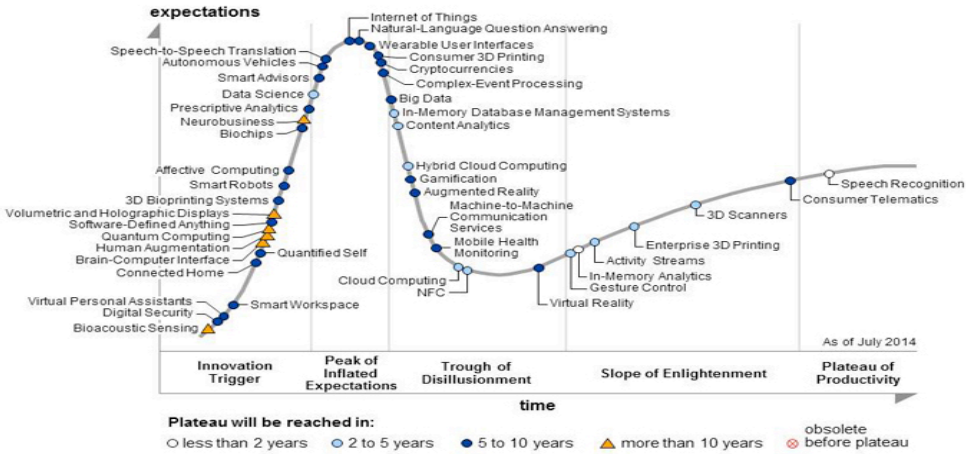

Figure 4. Hype Cycles for Emerging Technologies, source Gartner, August 2014, [7]

Nowadays the central theme is digital business. As enterprises embark on the journey to become digital businesses, they will think about technologies that are considered to be emerging today. Understanding where the enterprise is on this journey and where it needs to go will not only determine the amount of change expected for the enterprise, but also map out which combination of technologies support its progression, said Hung LeHong, vice president and Gartner fellow. Enterprises should use the Hype Cycle to identify which technologies are emerging and use the concept of digital business transformation to identify which business trends may result [7].

It is necessary to set out on the journey to become digital businesses, identifying and employing the right technologies at the right time will be critical. Gartner analysts highlighted the top 10 strategic technology trends. We consider also facts in Figure 4 and we conclude from [7] and [8] that it is necessary for our students to be familiar with following newest fields of informatics knowledge:

- Data science, processing Big Data, online analytics, cost effective open data, citizen managed data;
- Cloud computing and technology, hybrid IT, Internet of things, cross domain interoperability;
- BPM business process management and modelling, case management;
- Mobile technologies, personal mobile workplace, mobile citizen engagement;

Digital business represents a more extreme revolution than previous technology-driven changes. Gartner predicts that a lack of digital business competence will cause 25 % of businesses to lose competitive ranking by 2017 and identified following Six Key Steps to Build a Successful Digital Business in [9]:

- **Create the right mindset and shared understanding.** Digital business is not just about expanding the use of technology. Digital business leaders must think about technology in a fundamentally

different way than in the past. It is not an enabler to be applied to what the business wants to do but a source of innovation and opportunity for what the business could do. This more proactive model focuses on creative disruption and new business models to gain competitive advantage.

- **Put the right leaders in place.** The fast-moving digital world is exposing gaps in digital leadership, especially with regard to front office disciplines (those related to the customer experience) and head-office disciplines (those related to enterprise strategy). Three types of digital business leader have emerged to fill these leadership gaps: the digital strategist, the digital marketing leader and the digital business unit leader.
- **Launch a digital business centre of excellence.** Create a digital business centre of excellence (COE) to provide input, advice and opportunities for the collaborative formation of a digital strategy and the collaborative advice, innovations and capabilities needed for execution.
- **Formulate a digital strategy to respond to opportunities and threats.** Once the necessity of a digital strategy has been established, the following five elements must be addressed: new digitally enabled business models, the product and service portfolio, information as an asset, technology content, media and channels.
- **Find, develop and acquire digital business skills and roles.** Digital business combines the expertise, skills and roles found not just in IT, but across the enterprise. Digital business is not an IT program but an enterprise mindset. While digital business has roots in digital technology, it is ultimately about business.
- **Create new digital business capabilities.** With the expectation that digital business expertise will spread around businesses within two or three years, but the acknowledgment by many that their workforce is unprepared and inadequate, organizations will need to explore the kind of disciplines needed to drive digital business initiatives. Traditional recruitment practices will not suffice. Instead, organizations should consider launching boot camps and other learning programs about digital business across all areas of the business.

Gartner also identified fifteen skills critical to success with business process management in [10]. Figure 5 presents them in a short form. They can be grouped into three types of critical competency: transformational, operational and technical. It is another important view in our new manner of education.

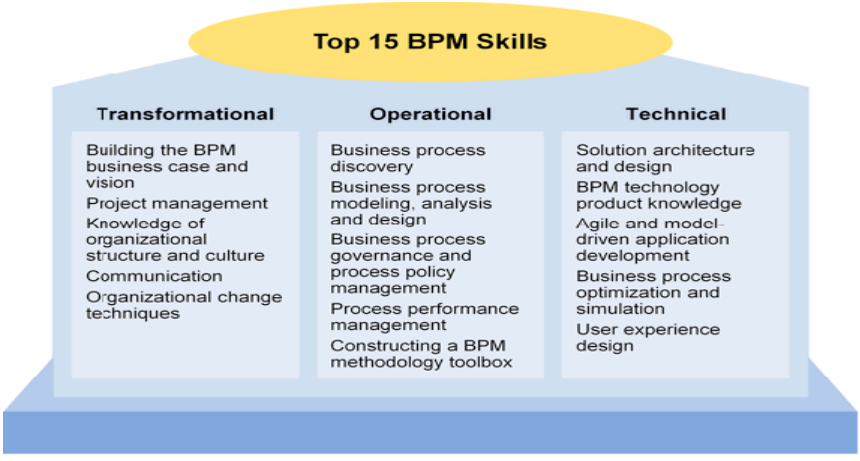

Figure 5. Top 15 Business Process Management Skills, source Gartner, February 2014, [10]

5. CONCLUSION

As well as in the economic sphere also in the school environment it is necessary to count with a minimal stability and certainty. To be familiar with the newest trends in the informatics field and implementations, the ability to work with information and its transformation into knowledge we consider very important, as we can read also in [11]. Based on secondary school informatics education, in order to prepare our graduates for new economic environment and labour market requirements, we decided to include new manner of education into basic informatics course. Except for the traditional content and methods of teaching, as lectures and practices, we use also e-learning, learning-by-doing and project method [12]. Using these modern methods of teaching and learning we try to develop students' logical and critical thinking, we want to support creativity and ability to solve problems by own.

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