Development of Human Capital via Modern Informatics Education

L. Révészová
Faculty of Economics Technical University of Košice
Department of Applied Mathematics and Business Informatics, Košice, Slovakia
libusa.reveszova@tuke.sk

Abstract - In the new digital world, information is available anywhere at any time, computer power is ubiquitous, communication of vast amounts of information is almost instantaneous, and storage capacities seem infinite. But these powerful possibilities are beneficial only for those who have learned to use them effectively. Educational system should be able to react appropriately to the development and trends. We educate our students for the future. They will face many changes in their future careers and lives. Their school knowledge and skills become obsolete within a short time. That is why they must be robust enough to meet the challenges of the rapidly changing world, and also enable the students to cope with the changes. It is important to consider that the knowledge and skills for today must be adaptable to serve future needs. The core of education must be independent of the changes in tools and technologies. Nowadays, not only classical literacy (reading, writing, counting) is needed, but also the high level of digital literacy, creative, logical and critical thinking, and last but not least, the potential for permanent development of human capital. The article summarizes the experience in teaching Informatics at the Faculty of Economics, Technical University, Košice.

Keywords – informatics education, human capital

I. INTRODUCTION

Since we work at the Faculty of Economics, Technical University in Košice (TUKE), we try to look at the education in the field of Informatics from the perspectives of both economists and managers which, it is not only interesting but many times very useful as well.

The widening discrepancies between market value of companies and reported tangible book value is considered to be an indication of the significance of intangible resources in the modern knowledge economy, which forces managers to visualize the value of intellectual assets in their organization [9].

The greatest power of companies, firms, organizations, and institutions is nowadays recognized in its non-visible and intangible assets derived from knowledge creation, which involves knowledge sharing, knowledge distribution and social interaction within a company. At this point, there is a question of what is considered to be „intellectual capital” within a company and how it contributes to the higher performance and better competitiveness arises [24].

Nowadays, employees are faced with the task to meet requirements of the company to do more brainwork and implement their personal knowledge into new applications and innovative products.

Knowledge and intellectual capital are now considered to be the main drivers in value creation, due to its unique capability to be utilized again and again without being consumed unlike tangible assets [4].

Understanding of intellectual capital concept enables us to understand how knowledge can be profitably transformed into the valuable activity outputs within enterprises. Intellectual capital has acquired an unprecedented role in contemporary society, since it has become an important factor for economic growth and business development. We can find a characteristic of intellectual capital as intellectual assets that can create value, drive the development of business and provide economic growth [13].

A simplified model of intellectual capital consists of two dominant components: human capital and intellectual assets. According to most of theoretical approaches, for example [11], [12], [25], the following main components of the intellectual capital can be commonly identified:

- human capital,
- structural or organizational capital,
- customer or relational capital [6].

As we can read in [21], intellectual capital consists of collective wisdom and energy, which is difficult to be measured and more difficult to be managed. Intellectual capital includes three crucial components: human capital (being the sum of existing status of learning, innovation and mentality, experiences embodied in employees); structural capital (being the sum of existing stock of knowledge effectively tested and organized within a company); and finally, customer capital (being the relationship with the company related persons and parties, which includes customer loyalty and satisfaction).

Due to the latest managers’ practice, human capital is a very important source of value in every company because it is only through humans how the company can gain an ability to create and add value.

Human capital can be defined as:
• Capabilities of employees required to provide value to customers [19].

• A sum of a company’s individual employees, each of whom possesses unique physical and mental qualities, knowledge and skills, as well as capabilities of suppliers, contractors, and other organization related persons to create and deliver value to a customer [22].

The most important parts of the human capital are knowledge, experiences, skills, and know-how of all employees of the company/firm/organization.

II. HOW COULD WE DEVELOP STUDENTS’ HUMAN CAPITAL VIA INFORMATICS EDUCATION?

The system of university education is one of the basic parts of education, culture, teaching, social welfare and economic development in every country. The institutions of university education are capable of training an educated, intelligent and knowledgeable society and raising national intellectual and creative potential. That is why it is necessary for higher education institutions, to search for the new possibilities of improving the potential of human capital development and skills of future specialists and professionals, developing individual abilities and acquiring high level professional competences [10].

Knowledge, experiences, skills, and know-how are the most important parts of our students’ human capital we are focusing on.

A. Knowledge

Business informatics, management of information systems and business process modelling have been chosen as the main topics of Informatics II, in accordance with practice demands. There are some reasons why we consider education in the mentioned fields important:

• The information aspects of the management at all levels have a very important function in increasing competitiveness and management quality of all economic systems.

• Nowadays managers in a higher position are expected to be information managers as well [7]. They have to be involved in analysis, modeling and building of the effective information systems (IS) of the companies and organizations.

• Current business entities are forced to improve their products and services consistently. They have to utilize their IS, ICT application/implementation and modern management methods, as well. This is the only way they can succeed in such competitive environments.

• Based on studies in more than 150 companies, more than a half of the projects of reengineering business processes either failed or was not able to reach even the minimum of the planned results. The typical obstructions and shortcomings are reluctance towards changes in organization, inertia of employees and management, incorrect choice and insufficient preparation of project team, lack of communication, lack of time for a precise planning, not detailed knowledge of essentials of particular problems, estimating of unclear aims, disability to estimate an extent of projects, incorrect choice and preparation of methodology [17].

• On the other hand, for critical factors of success we can consider direct connection of the management, active support of the leading management, support of employees, ensuring a high rate of connected people, match of improving projects with company’s strategy, strict business case study, good methodology, clear understanding of strategic not only technical aspect of changes.

In determining both the content and the method of teaching, we consider an evaluation of the students’ knowledge base in the field of Informatics as a very important step. At the beginning of study at the Faculty of Economics we use a questionnaire as a research tool, administrated on the first seminars of Informatics I Course. We search for both the extent and content of compulsory education in the field of informatics/computer science and ICT at secondary schools. We have created the questionnaire entries based on legislation, pedagogical documentation, and standards of Slovak educational system. Our questionnaire is divided into several parts. Within the first part of the questionnaire our students are asked the questions like: What type of secondary school did you attend? How many obligatory informatics lessons per week did you get over at secondary school in particular school years? In the second part of the questionnaire we focus on students’ knowledge in the field of basic terms of informatics, hardware architecture, operation systems, text editors etc. In the third part we want students to describe their experience in information systems. The questionnaire evaluation results were published in detail in [18].

The sample of our research consists of all secondary school graduates who entered their first year at Faculty of Economics TUKE. Numbers of respondents in the presented period, and type of graduates’ secondary schools are shown in Tab. 1 in detail. Letter “G” stands for Grammar School, “B” for Business School, and “O” for Other/Vocational School. Low number of these graduates in our sample is due to the practical focus of these schools, but as we can see in Tab. 1, it has recently increased.

Based on the questionnaire evaluation, we can say that the education of Informatics at secondary schools is in many cases surprisingly very poor. It is focused on handling with different packages of applications’ programs. There is a lack of understanding of basic terms, of data processing, of modeling (e.g. IS), regardless of the fact, that students work with modeling and different types of IS in some form “every day”.


Table 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Total number</th>
<th>Type of school</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G</td>
<td>B</td>
</tr>
<tr>
<td>2012</td>
<td>144</td>
<td>125</td>
</tr>
<tr>
<td>2013</td>
<td>152</td>
<td>129</td>
</tr>
<tr>
<td>2014</td>
<td>166</td>
<td>137</td>
</tr>
<tr>
<td>2015</td>
<td>136</td>
<td>118</td>
</tr>
<tr>
<td>2016</td>
<td>200</td>
<td>127</td>
</tr>
<tr>
<td>2017</td>
<td>199</td>
<td>111</td>
</tr>
<tr>
<td>2018</td>
<td>204</td>
<td>119</td>
</tr>
</tbody>
</table>

As we have been comparing the questionnaire evaluation for more than ten years, we have to conclude that the algorithmic approach, the using of knowledge for creating “something new”, problem solving abilities, and interdisciplinary relations are often missing in the informatics education, and this situation is not improving.

We also compare evaluation of Informatics II (within the standard scale). As we can see in Fig. 1, the level of students’ knowledge is decreasing, despite the fact that ICT and Informatics applications have penetrated into all areas of life.

Due to negative trends in the education system in Slovakia (decreasing level of knowledge [18]) as well as due to increasing differences in the sample of secondary school graduates entering our faculty, we have to work with a very diverse group of students. That is why at first, it is necessary to integrate level of students’ knowledge of the basics of computer science and using basic applications in the scope and content similar to ECDL standard within the first term - subject Informatics I. Students can learn how to work in text editor environment, spread sheets, presentation software, database systems, and various web-services, which we consider vital for further correct understanding business informatics – the main topic of subject Informatics II.

After that, our effort is focused on designing a modern education system within the Informatics II - knowledge base, skills and activities supporting development of human capital of future advanced users/managers at an area of “understanding and using business informatics and ICT”.

The main question we are dealing with is: How to optimize and personalize education in the subject Informatics II according to individual needs and knowledge base levels of students to maximize development of their human capital?

We developed an innovative manner of teaching to support students’ human capital development - their potential to learn, creativity, logical thinking and problem solving skills. Our education is based on modeling, simulation and on a well-known opinion that “no kind of teaching can replace the personal experience”.

We created two basic studying materials that cover two particular areas:

1. Information systems for economists, divided to the following chapters: Development in the information area, Basics terms and their meaning, Information systems, Specification of user requirements, Modeling using the Unified Modeling Language (UML).


In addition to the mentioned study materials, students can use recommended literature, e-resources and a set of solved examples – all accessible in LMS Moodle.

We have decided for a concept of education in two parallel planes as represented Tab. 2. The first plane is the standard way of teaching via lectures and seminars. The parallel plane, where the business informatics and management of IS are the key themes, seems to be in close relation to modeling of business processes.

The dominant method in this area is problem-oriented project teaching, while we are using the functionality of LMS Moodle environment. We are trying to develop education with a potential to support our students by personalizing learning process to meet the individual characteristics and needs. To achieve this, our system recommends learning materials, project template, learning paths, consultations, teachers’ feedback, activities and optional possibilities, etc. in a Moodle course. We found inspiration for personalization of education for example in sources [5], [8], and [14].

In this innovative way of teaching we are trying to transform the problem solving process into an active process of cognition.
B. Experience and skills

As the most valuable skills we consider problem solving abilities. To gain experience our students are taking part in projects of building IS in one of many types of virtual firms, companies or institutions.

All our students find themselves at a position of a manager of a virtual company – in the role of IT executive such as Chief Information Officer (CIO) in ensuring continuous development and innovation of both IT applications and IT infrastructure. It offers us a possibility for gamification of education that can motivate students to learn new concepts via games.

In project of specifying users’ requirements, they have to think about how to differ from the others, what kind of innovations they should bring into the model of the main process of a chosen company. They have to have by the method of learning-by-doing get knowledge of IS and its management.

Fig. 2 presents an example of the students’ projects. The recommended structure of the project consists of four parts. In part 1 there are questions and answers on theoretical background about modeling and using IS. In the second part, student describes a core business process in words and also by graphical model. On this basis they create requirements on the IS in the third part of the task. They describe the functionality on the project in the fourth part using UML - use case diagram and the basis for the data model is a proposal of classes and their attributes using UML class diagram. The last part which follows is a proposal of tables of relation database in MS Access environment in connection to first plane of teaching.

It is well known that students learn best when they have an opportunity to collaborate, discuss, use knowledge in practice, and interact in a natural and intuitive manner [1]. This has been already implemented in our education as supportive collaborative learning environment. Students can choose their own way and they can reach different level of knowledge.

Our goal is to train students in advanced topics without having them sacrifice quality of life. This can be achieved by improving efficiency of education through technology by maximizing learning at realistic time investments by teachers as well as students [1].

The major part of the mentioned critical factors of success or failure can be tried in practical creation of tasks of IS user requirements projects for supporting main process in the firm. We consider this fact to be the most significant benefit in performed change of the way of teaching.

---

**TABLE II. THE STRUCTURE OF THE SUBJECT INFORMATICS II**

<table>
<thead>
<tr>
<th>The beginning</th>
<th>Second semester - subject Informatics II</th>
<th>The end</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First plane – “classical” way of teaching/learning, face to face lectures and seminars</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MS Excel</td>
<td>MS Access</td>
<td>ARIS Express</td>
</tr>
<tr>
<td><strong>Second (parallel) plane – “new” way of teaching/learning, personalised education, project oriented education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The main aim is development of user requirements project of information system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Face to face teaching and consultation</td>
<td>Project proposals</td>
<td>Project first draft</td>
</tr>
</tbody>
</table>

**Fig. 2. Example of students’ project**
C. Know-how

Recent advances in computer graphics and virtual reality technology, in modeling and visualization tools help people to overcome barriers in communication, understanding each other, learning, systems analysis, programming, process modeling, defining user requirements and so on.

We present to our students very useful environment ARIS Express, because as according to [3] it is:

- free of charge,
- perfect tool for occasional users and beginners in Business Process Management,
- intuitive user interface – modelers can work productively from the start,
- it contains models for organizational structures, processes, application systems, data, and more,
- free training material available in ARIS Community,
- all results can be re-used and enhanced in professional ARIS Platform products.

ARIS Cloud is a full-scale Business Process Analysis-as-a-Service product which is available completely free of charge for research and educational purposes. It powers collaborative process improvement projects around the globe. It allows to design, analyze, share and improve processes within minutes. ARIS Cloud is available in three editions: Basic, Advanced and Enterprise, each providing you with the right features for your current project needs [2]. The web page provides a feature “Universities” – an area for students and faculty members. It is integrated in the larger ARIS Community, but works independently.

Recent decades witnessed a significant increase in the share of jobs that require high levels of problem-solving skills. Our findings (published in [18]) as well as international researches show that the ability of students in problem solving area in ICT rich environment does not reach satisfactory level.

To improve this situation, we implement during the creation of students projects the system approach, as it is presented at Fig. 3. It is a way of identifying and viewing component parts and functions as integral elements of a whole system. We consider it as very important and valuable tool in all kind of problem solving procedure.

![Figure 3. Application of analysis and synthesis in the solution of problems - the systems approach [16], p.21](image-url)
III. CONCLUSION

The paper deals with experience in teaching and it also discusses the body of knowledge and methods which have been implemented into the subject Informatics II at the Faculty of Economics, Technical university of Košice.

The methodology's cognitions achieved by experience in education resulted in the fact that the center of education must be transferred from a teacher to a student. The result of such an approach is the development of personal environment for learning [20]. We are trying to implement these modern trends into our education to support students’ human capital development.

Human capital should be viewed as a very special source of wealth. The benefits of better ICT skilled users and employees for companies and organizations can be found (for example in [15], [23]) as higher productivity and performance of the company/organization, possibility of implementation new organizational forms (e.g. development of business nets, participation in supply chains), increased added value of the product or services, entry to new markets, utilization of new business channels, new products or services, changing business processes, responding to new business activities of competitors.

University education has been accepted as the foundation for public priority, economic prosperity and life quality [10]. By using our system, level of students’ computer literacy, knowledge, skills, creativity and problem solving abilities can be increased.

“A success often comes to those, who are willing to manage their intellectual capital wisely” [21].

REFERENCES