

FUNCTIONING OF THE KNOWLEDGE TRIANGLE IN THE EXAMPLE OF IT EDUCATION

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Abstract

The analysis of the interactions between knowledge triangle components in IT-education in the Republic of Belarus is described. This paper describes the results of research in the framework of the program of the European Union Tempus IV «Fostering the Knowledge Triangle in Belarus, Ukraine and Moldova» - «FKTBUM». The analysis of the obstacles to the effective integration of higher education, research and innovation is performed.

Keywords: knowledge triangle, information technologies, research and development, innovation

1. Introduction: Knowledge Triangle (in IT education)

Belarusian State University of Informatics and Radio electronics is a major educational and scientific complex. BSUIR scientific schools of thought are recognized leaders among national and international computer science and radio electronics centers, which allows us to offer state-of-the-art postgraduate programmers and to successfully promote fundamental and applied research. BSUIR offers state-of-the-art laboratories and training facilities, enabling to implement scientific research in all relevant areas.

Commitment to innovative education and development technologies, state-of-the-art training and research facilities, experienced faculty - all this is what makes us train highly qualified specialists with innovative thinking, ready to contribute to the high technologies and who are highly sought after by employers.

Today the University includes 10 faculties, 40 departments, the Institute for Information Technologies, the Research and Development Department comprising 56 scientific laboratories and research groups, 7 centers, including 2 multiple-access centers and a Research and Development Centre for Industrial Energetics and Automation.

The University personnel is 2193 persons. The faculty consists of 750 full-time lecturers, including 350 conferees. The student body exceeded the number of 15,000.

2010 saw the introduction of the first national IT Business Incubator.

On December 24, 2010 the University quality management system was certified for the international quality management standard ISO 9001-2009 and for the German TGA quality management system DIN EN ISO 9001:2008.

On May 26, 2011 the University was certified as a Scientific Organization by the National Committee for Science and Technologies and the National Academy of Sciences.

BSUIR graduates are not only highly skilled specialists, but also polymaths and active society members, intellectuals and patriots ready to contribute to development of Belarus.

Education. There are 54 higher educational institutions in the Republic of Belarus, where 46 are the state ones and 8 are private. According to the Nation-wide qualifier of the Republic of Belarus by OKRB-011-2009 "Specialties and Qualifications", 22 HEIs are specialized in «Equipment and Technologies" (educational codes are 32 - 68). 15 HEIs are specialized in IT "Informatics and Computers" (educational code 40).

BSUIR is a leader in training of IT specialists and has all courses in "Informatics and Computers" (educational code 40).

Education is provided in cooperation with research organizations and also with leading industrial enterprises. Research work at the universities is performed according to agreements with regional enterprises with involving students into such work. Scientific developments of the teachers and researchers of the universities are used in educational process as well in solution of applied problems of the enterprises.

Interaction schemes of interaction between knowledge triangle participants:

university + enterprise = joint laboratory

university + enterprise = branch of department

university + enterprise = education center

university + research institution = branch of department

university + research institution = joint laboratory

Researches. There are several scientific and research organizations, where BSUIR graduates can work, including The National Academy of Sciences of Belarus organizations (The United Institute of Informatics Problems, Institute of Applied Physics, Institute of Mathematics, Institute of Heat and Mass Transfer, Institute of Physics). Besides, some HEIs have their own research laboratories, which also need IT graduates.

Innovations. There are two sectors of enterprises, which can be employers for BSUIR IT-graduates:

- public sector (OJSC "AGAT – Control Systems", JSC "MPOVT", JSC "INTEGRAL", JSC "Peleng", "Horizont", Scientific Research Institute of Computers, Minsk Electrotechnical Plant named after V.I.Kozlov, JSC "KBTM-OMO", JSC "Amkodor-Belvar", etc.);
- private sector (EPAM Systems, iTechArt Group, Itransition JSC, Qulix Systems, ABA IT Park, Samsolutions, ISoft Solutions, Softech Flesh Solutions, Numerical Methods, etc.).

The ideal knowledge triangle in IT education is presented in figure 1.

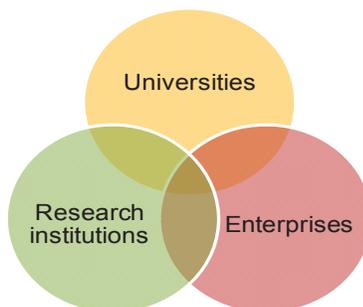


Figure 1. The ideal knowledge triangle in IT education

2. Situation in the Republic of Belarus (in IT sector)

2.1. General information about the existing Knowledge Triangle

There is a lack of time to adapt all innovations, which IT companies require to the IT graduates, into educational programs. So, education sector sets a task to give fundamental knowledge of a number of basic disciplines and to give opportunities for studying of actual technologies in cooperation with Hi Tech Park. Creating of joint laboratories with the real sector of economy companies allows studying students according to the actual directions in the IT industry.

Nowadays BSUIR, with a grate number of the IT graduates, is closely cooperating with Hi Tech Park. BSUIR rector is a member of Hi Tech Park Supervision Council, which selects the residents and projects and coordinates the main activities in Hi Tech Park.

Regular round tables are organized with participation of education and Ministry of Education representatives to show the interest in cooperation between the IT industry and profile IT faculties of Belarusian higher education institutions. Within these actions the current problems of student`s education for IT sector and possible ways of these solving are discussed. Such round tables help to generalize the cooperation experience between companies and HEIs, to discuss ways of further joint actions.

The researches, conducted in 2014, showed that over the last 10 years export of computer services considerably grew in Belarus. And if the companies don't have difficulties in finding new customers, there is a question of providing these services with qualified personnel. The demand of IT specialists with different skill level exceeds supply three times more.

Close cooperation with the IT companies bridge theoretical students' knowledge, university graduates and practical skills.

2.2. Short description of the existing most significant legal, organizational, financial and personnel frame conditions Knowledge Triangle

In 2014, 1076 graduates of the Belarusian higher education institutions were employed by Hi Tech Park companies (which is 18% more, than in 2013). 78% of young specialists studied free, which raised a question of graduate placement. Traditionally about 40% of young specialists employed by Hi Tech Park come from Belarusian State University of Informatics

and Radioelectronics (faculty of computer systems and networks, faculty of information technologies and control) and from Belarusian State University (faculty of applied mathematics and informatics).

Graduate placement is organized according to Regulation on distribution, redistribution, and job referral, graduate placement after finishing undergraduate and graduate programs, specialized secondary education and vocational studies. New term "basic organization" appeared in Regulation in 2011. The basic organization has the privilege when higher education specialists, specialists of specialized secondary and vocational education are assigned. Commission for the Distribution had to distribute graduates to the state organizations and the organizations with the state share of property in authorized capitals earlier, now "basic organization" is a wider concept, it can be both joint-stock companies, and residents of Hi Tech Park, and the same budget companies. If there are several basic organizations, their needs of experts are provided one by one, depend on the dates when Cooperation Agreements were signed.

Very important issue (High Tech Park proposal) is to work out new requirements to some positions. This moment, requirements by the current legislation are stated in the classification reference book of positions "Service positions of any kind of activity" and consist of general information. New requirements are planned to systematize specialist requirements depending on concrete knowledge area and level. The reason is the increasing problem of qualification confirmation in labor market for citizens of the Republic of Belarus. After development of the qualifications description, higher education institutions will be able to correct training process to know precisely what students need to study.

3. Target concept of Knowledge Triangle functioning in the Republic of Belarus (in IT education)

Knowledge Triangle in IT education includes University, as the organization, which prepares specialists, the IT company, as the organization for which specialists are intended and the joint research laboratories. There are two main tasks of joint laboratory activity: conduct the researches/appropriate new technologies in various areas of information technologies, embed the results in university educational process and also embed research laboratory results in business processes of software development in the company.

Successful example is joint laboratory BSUIR-IBA, which won prestigious award of IBM company – IBM Faculty Awards in 2012. BSUIR was one of three higher education institutions among the CIS countries which won this award.

4. The existing conditions of educational, scientific and innovative activity integration in the Republic of Belarus

Belarus is creating the acceptable conditions to implement the closest educational, scientific and innovative activity integration between three directions.

The following tendency is observed in IT: curricula become outdated quickly, and higher education institutions can't train the graduates, who can start develop software immediately,

without additional preparation. Therefore education sets task to study fundamental disciplines firstly (algorithmization and data structures, mathematical disciplines, etc.) and to give various opportunities for studying the most relevant technologies in cooperation with Hi Tech Park.

Nowadays BSUIR, with a grate number of the IT graduates, is closely cooperating with Hi Tech Park. BSUIR rector is a member of Hi Tech Park Supervision Council, which selects the residents and projects and coordinates the main activities in Hi Tech Park.

According to the dev.by research, BSUIR is the main provider of the IT graduates (40 % of employees).

Hi Tech Park tries to support IT faculties of Belarusian higher education institutions to improve the quality of education in the sphere of information technologies. Regular round tables are organized with participation of education and Ministry of Education representatives to show the interest in cooperation between the IT industry and profile IT faculties of Belarusian higher education institutions. Within these actions the current problems of student`s education for IT sector and possible ways of these solving are discussed. Such round tables help to generalize the cooperation experience between companies and HEIs, to discuss ways of further joint actions. It is evident that the issues are very serious and, it is a challenge that can only be met by us all together.

Hi Tech Park pays special attention to staff development, who are involved in the process of training in higher education institutions, and, as a result, holds the training seminars regularly. But there is still a problem of lecturer`s shortage, who have not only fundamental theoretical knowledge, but also practical skills. The reasons are the lack of prestige and small salary.

Belarus started long and difficult process of qualifications national system development last year. The main project is to create the professional standard in IT which coordinates Hi Tech Park.

Sectorial council, which included the leading IT companies, Ministry of Labor and profile higher education institutions, coordinates professional standards and qualifications. Hi Tech Park resident companies are interested in professional standards and qualifications development. First of all, each IT company has its own requirements for qualification of employees and they are significantly different from each other. If education institutions will have qualifications requirements, they will be able to correct training process. Sectorial council is developing qualification requirements for two most famous professions in IT sector now; it is software developer and tester.

5. Performance requirements for triangle knowledge in the Republic of Belarus

5.1. Functional requirements: description of specific requirements for particular organizations needed to meet the goals set in section 3

Organizations are subject to the following functional requirements necessary to meet the goals:

1. Legislation and regulatory system should at least not impede the functioning of triangle education – research – innovation, and at most create favorable conditions for active cooperation between its members.

2. Heads of educational institutions and managers of enterprises should be aware of the importance of creating favorable conditions for the functioning of triangle knowledge and understand its internal organization and mechanisms needed.

3. The enhancement of synergies between members of triangle knowledge requires enough financial support and information resources, especially at first, when cooperation has just launched. The implementation of innovative projects also requires enough support.

4. Teaching burdens should be reduced to 400 – 600 hours/year to ensure full involvement of the university academic staff into innovative projects.

5. A sufficient number of business analysts in scientific and innovation research is required, which leads to the necessity of creating retraining opportunities in this sphere.

6. The pay gap between educational and industrial sectors (according to the economic sector) should be reduced. The pay should at least be no more than 1.2 times higher in industry than in education. Salaries paid in the educational sector should ideally even exceed those paid in the respective branch of industry.

7. A significantly greater flexibility in the creation of study programs (educational standards, curricula of specializations and disciplines), as well as much simpler procedures of their inspection and approval, are required.

5.2. Non-functional requirements: ways to meet the goals set in section 3 for particular organizations of triangle knowledge

1. In the sphere of education, research and innovations, a special milieu should be created to make it economically beneficial for organizations to participate in the functioning of triangle knowledge.

2. Both tangible and intangible incentives should be created for managers, who take active part in the system education – research – innovation.

3. The discussed issue should arouse sustained interest and important events should have a wider coverage in mass media and other information sources.

6. Requirements to the future conditions of integration of educational, research and innovation activity in the Republic of Belarus

Personnel and financial conditions: The university, as well as the academic and research structures on its base (joint laboratories and educational centers) should be more attractive for the top professionals in this sphere.

Therefore, it is reasonable to reduce the workload of the academic staff to 500-600 academic hours in order to stimulate them to conduct research in the IT sphere.

Besides, top professionals of IT companies should be engaged to work part-time in joint laboratories.

Reasonable is also to explore the possibility of granting more autonomy to universities following the experience of western European universities and providing a number of tax

advantages, for instance extending the benefits enjoyed by residents of the High-Tech Park to universities so as to allocate funding for scientific research projects and higher salaries of high-qualified teachers.

The academic staff should also have a wider range of opportunities for internships in foreign IT companies, research centers and universities.

Equally important is to engage students in the work of joint laboratories, especially for fulfilling study projects, following the example of MIT Media Lab (Massachusetts Institute of Technology).

Legal conditions

In order to ensure the successful cooperation of triangle knowledge, the legal framework should be created/expanded both at the local level of the university or an IT company, and at the national level.

The legal framework should deal with the following subject matters:

- 1) greater autonomy of universities (national legal acts).
- 2) tax advantages for universities (national legal acts).
- 3) regulations of work of innovation business incubators at universities, tech parks (national, local legal acts).
- 4) motivation of academic staff of the university to conduct research (local legal acts).
- 5) motivation of staff in IT companies to conduct research in joint laboratories at universities (local legal acts).
- 6) integration of the university's research outputs into business processes of IT companies to raise the efficiency of an enterprise.

7. Challenges and risks

There are the following challenges and risks, which hinder to implement goals and requirements.

1. There are difficulties to amend legislative acts (Codes, laws, etc.). When you want to amend legislative documents, you will face with the serious limitations, including the amendment procedure, where large number of organizations and officials are involved (generating and submitting proposals; consideration; decision-making according to proposals; development of amendment project; consideration the project in legislative authority) and amendment terms. For example, 2 years have passed from the moment of amendment proposal submission and process isn't finished yet.

2. Heads of state organizations misunderstand the importance of innovative processes, technologies transfer, science, innovations and education integration. There are no initiatives in many state organizations, which help to introduce innovative technologies in all areas of activity, including technologies transfer and higher education institutions involvement. State organizations heads have really wary attitude to any new methods and technologies, and oriented not on enterprises development, but follow safe and proven method.

Private organizations misunderstand the importance of innovations because of limited development of business, and don't need innovative development yet. At the same time large

private companies understand the importance of these processes, because its development closely connects with innovations.

3. Lack of funding. Now state organizations aren't ready to invest in technologies transfer.

4. Increased requirements to safety and issue of commercial confidentiality, which became a problem for HEIs to conduct researches for companies. Private IT companies usually control as developers as the place where it is fulfilled. As a result, numbers of projects which can be fulfilled in cooperation with HEIs with scientific laboratories are unrealized.

5. Higher education institutions employees are not ready for technologies transfer. Many higher education institutions employees should be advertised. Marketing strategies are really undeveloped. So, HEIs potential is unknown abroad.

6. Lecturers are busy with their academic activity. Annual volume of academic hours is 700-1000. Some part of these academic hours doesn't include (second part of the working day). So, there is no time for research activity.

7. Top managers are not able to give work correctly. These risks can be minimized by developed system of business analysis. There isn't enough knowledge in subject area. The competent analysis is possible only with in the serious scientific training of the analyst. This training can't be fulfilled in short-term period. Usually, business analysts are not trained enough in IT companies, and they are not competent enough in HEIs.

8. Decrease in personnel capacity of higher education institutions, because the most successful and talented specialists work in private companies. It is shown evidently that in the IT sphere, where salary in private company is 2.5-3 times more than in education, moreover, it can be even 10-15 times more. The issues, which are solved by such specialists, are not high tech and creative, but boring and routine. As a result, the potential is lost.

References

1. Education Code of the Republic of Belarus
 2. Decree of the President of the Republic of Belarus #300 of 1.07.2005
 3. Labour Code of the Republic Belarus
 4. Law of the Republic of Belarus #708-XIII of 21.10.1996 "On Scientific Work"
<http://www.bsuir.by/>și Perspective pentru cercetare. Revista de Știință, Inovare, Cultură și Artă "ȘTIINȚĂ ȘI INOVARE" (AKADEMOS), Nr. 1 (24), Chisinau, ASM, pp. 64-69; ISSN 1857-0461.
- Porta Optica Study project, (2008) [Online], Available from: <http://www.porta-optica.org/> [Accessed: 16th January 2015].
- POCOTILENCO, V., ALTUHOV, A., BOGATENCOV, P. and SIDORENCO, V. (2009). MD-Grid CA: New security service in Moldovian grid infrastructure. "Networking in Education and Research", Proceedings of RoEduNet International Conference, 8th Edition, Romania, Galati, December 3-4, 2009, pp. 44-46.