

ANALYSIS OF DESIRABLE CHANGES IN ENGINEERING EDUCATION IN THE CONTEXT OF UNIVERSITY EDUCATION REFORM

Dominika Crnjac Milic, Goran Martinovic, Ivanka Fercec

Preliminary notes

This paper analyzes general satisfaction of engineering students in the region of Slavonia with their study programs in the context of the reform at Croatian universities with special stress placed on their importance in the overall academic education of future experts in accordance with modern trends which pave the way for Croatia to the European Union. Special attention is also paid to the implementation of theory into practice, which has always been omnipresent and extremely important.

Keywords: *Bologna process, engineering education, foreign language, knowledge.*

Analiza poželjnih promjena u obrazovanju na tehničkim fakultetima u kontekstu reforme visokog obrazovanja

Prethodno priopćenje

U radu se razmatra opće zadovoljstvo studijem na tehničkim fakultetima slavonske regije u kontekstu reforme sveučilišta u Hrvatskoj s naglasakom na njihovoj važnosti u cjelokupnoj akademskoj naobrazbi budućih stručnjaka u skladu s modernim trendovima koji Hrvatskoj otvaraju put u Europsku uniju. Osobit je naglasak dan na implementaciju teorije u praksi, koja je oduvijek bila sveprisutna i izuzetno važna.

Gljučne riječi: *Bolonjski proces, obrazovanje inženjera, strani jezik, znanje*

1 Introduction Uvod

According to [16] and many other resources, investment into knowledge and encouragement of excellence make sound foundations ensuring future sustainable economic growth and development of the society and also of the Republic of Croatia on a long-term basis.

Introduction of the Bologna process described in [10], [13] and [3] should enable improvement and development of the education system in general, university education and science, application of the aforementioned to economy, as well as enhancement of studying conditions, which would provide students with fair possibilities to gain necessary knowledge and skills, bringing thereby the Republic of Croatia closer to the European Union. Within that context and based upon research and advanced knowledge, scientific institutions must enable both new scientific and technical knowledge, and transfer and implement most recent world achievements onto the Croatian economy, as suggested in [14]. Motivated by [7] investments into science and sports in the last couple of years in the Republic of Croatia are shown in Table 1 and Figure 1.

The most fundamental infrastructure of any competitive knowledge-based society lies in information and communication technologies, as presented in [2], [7] and [15]. According to [19], the proof that it is also the direction Croatia follows might be exemplified by a rapid and expansive IT development and constantly increasing investments into that branch (in comparison to the year 2003, investments have been raised by 41 %).

It can be seen from the given data that the budget for 2007 assumes investments into education and

science 9,3 % greater compared to 2006; thus, since 2003 the overall investments into education and science have increased by 33,7 %, i.e. 2,6 billion kuna.

The aforementioned data point out that there exists awareness referring to the importance of investing into knowledge representing a highly productive national consumption since it contributes to the economic growth of the country.

Chapter 2 shows and analyzes the current situation in university education in the region of Eastern Croatia. In Chapter 3, questionnaire results and desirable changes in higher education that follow from the analysis are discussed. Chapter 4 deals with the role a foreign language should play in engineering education and professional development.

2 Current situation in university education in Eastern Croatia

Trenutno stanje u visokom obrazovanju u istočnoj Hrvatskoj

Social development in general makes an important factor in surveys, analyses and projections of economic development of any region. As a set of factors affecting both social changes and development, it is equally important as other development resources (capital, men power and technology). As discussed in [23], education is probably the most crucial factor affecting not only sources of social behavior, but also development of industrial activities in general. As proposed in [11], the current system of education at the national level should be adjusted to the needs of economy. In the Osijek-Baranya County, and probably in other counties in that part of Croatia, development of industry and the system of education do not match.

Table 1. Ministry of Science, Education and Sports – Expenditure
 Tablica 1. Izdvajanja Ministarstva znanosti, obrazovanja i športa RH

	Year 2003	Year 2004	Year 2005	Plan 2006	Proposal 2007	Difference 07-03	Index 07/03
	1	2	3	4	5	6=5-1	7=5/1
Primary School Education	3,299,803	3,548,719	3,620,560	3,832,299	4,113,155	813,352	124..65
High School Education	1,661,660	1,771,487	1,895,725	1,964,596	2,032,587	370,927	122.32
University Education	1,688,450	1,795,427	2,003,635	2,223,229	2,347,046	658,596	139.01
Science and Research	751,187	698,718	779,438	829,483	840,011	88,824	111.82
ICT, Sports and Int. Co-operation	416,293	447,808	605,993	733,465	1,116,733	700,440	268.26
Total - MSES	7,817,393	8,262,159	8,905,351	9,583,072	10,449,532	2,632,139	133.67

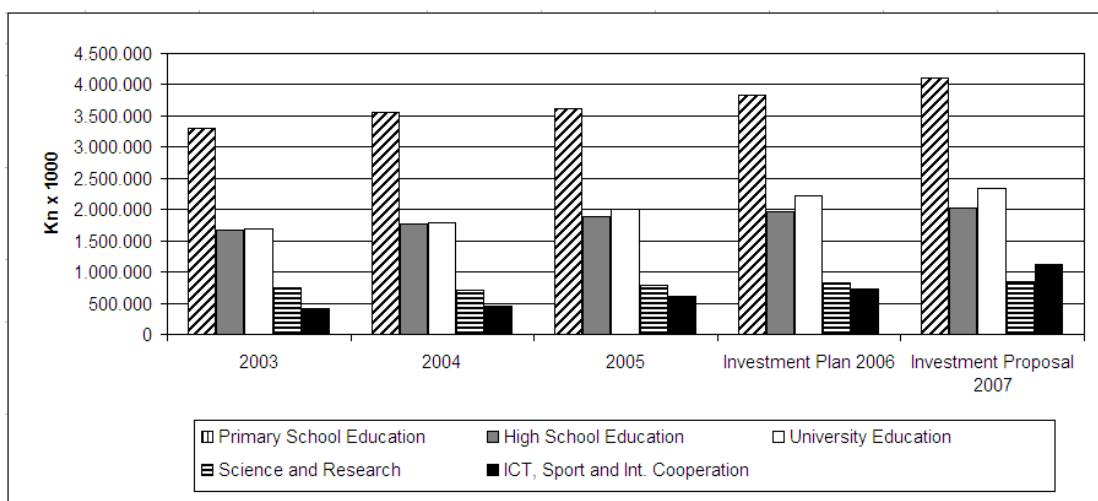


Figure 1. Representation of expenditure of the Ministry of Science, Education and Sports of the Republic of Croatia
 Slika 1. Prikaz izdvajanja Ministarstva znanosti, obrazovanja i športa RH

Secondary schools, colleges/polytechnics and universities educate and train various profiles, which according to the structure do not satisfy the needs of industrial development. High quality management of human resources represents a key issue for development, dynamic activity of companies and a more favorable image of industry.

Well-educated and trained men power creates possibilities for development of knowledge-based industry. A branch which shows great potential for development is the sector of services, since in developed countries many industries are complementary: agriculture, food processing industry, free zones, transport, information and communication technologies and industries, etc.

In companies themselves, investments into R&D activities, human resources, development of ideas and products should increase. In that way, technological lagging behind of industry can be significantly reduced.

From a global point of view, in the whole Republic of Croatia, those purposes currently require at least 2-2,5 % of the GDP. According to [9], Table 2 and Figure 2 show the structure of education in the Osijek-Baranya County according to the level of formal education.

The above data indicate that both in the Osijek-Baranya County and the whole region there are a rather small number of people who graduated from colleges/polytechnics or universities, as well as the ones holding Master's or PhD degrees. Especially worrying is the part of population encompassing the ones with incomplete primary school education and the ones who finished only primary school. Among other factors, insufficient investment and inadequate consultancy and orientation in education cause weak economic development of the region.

Table 2. Portion of formal education levels of the population in the Osijek-Baranya (O-B) County and the Republic of Croatia
 Tablica 2. Udio obrazovnih razina stanovništva u Osječko-baranjskoj županiji i u Republici Hrvatskoj

Formal education	Republic of Croatia %	Osijek-Baranya County %
Total	100	100
Without any formal education	2,8	3,4
Incomplete primary school education	15,7	17,4
Primary school education	22,00	25,5
Secondary school education	47,0	44,1
College/Polytechnics	4,0	2,8
University education	7,3	5,9
Master's degree	0,3	0,2
PhD degree	0,2	0,1
Unknown	0,7	0,6

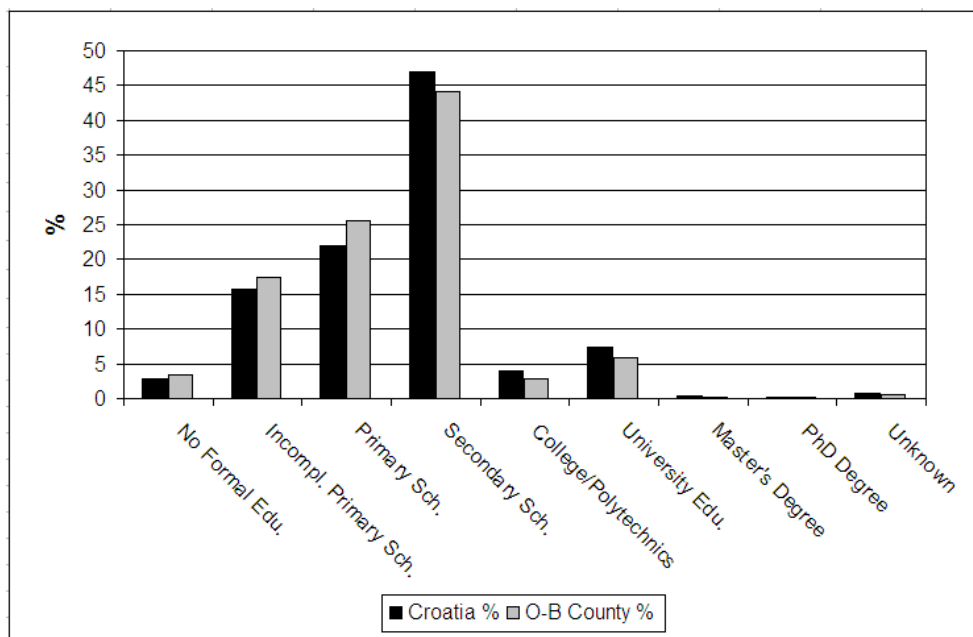


Figure 2. Graphical representation referring to the portion of formal education levels of the population in the Osijek-Baranya County and Croatia
 Slika 2. Grafički prikaz udjela obrazovnih razina stanovništva u Osječko-baranjskoj županiji i u Hrvatskoj

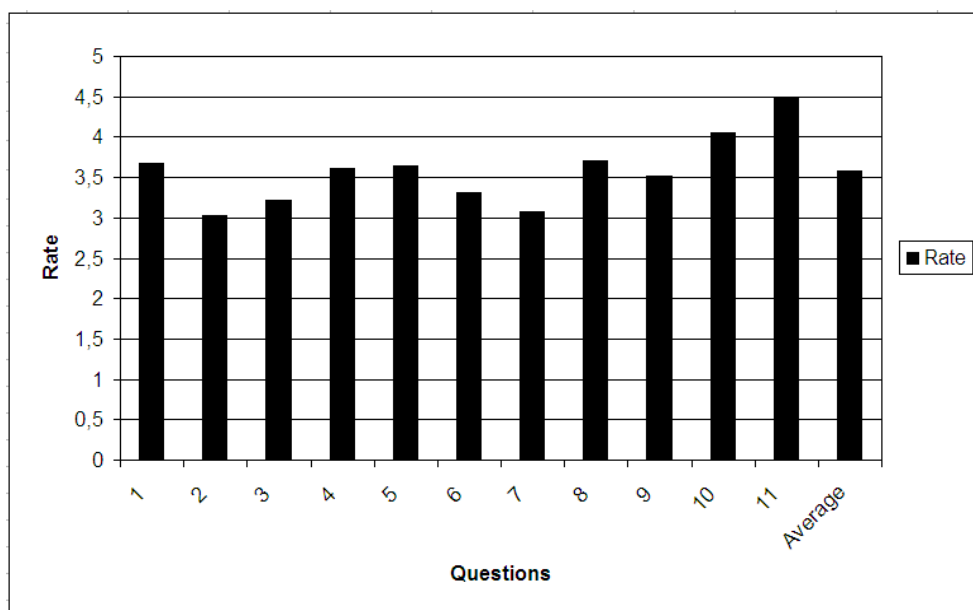


Figure 3. Representation of average rates obtained by the questionnaire
 Slika 3. Prikaz prosječnih ocjena prikupljenih upitnikom

3 Questionnaire results and analysis of desirable changes in university education

Rezultati upitnika i analiza poželjnih promjena u visokom obrazovanju

University education is unquestionably the basic and indispensable *spiritus movens* of development of industry, entrepreneurship, and economy as a whole. For the purpose of obtaining a feeling of desirable changes in university education, senior year students at engineering faculties were asked to voluntarily and anonymously fill in a questionnaire given in Annex 1. The questionnaire relies on ideas provided in [18], [20] and [6]. Those are the students who are to complete their studies according to the curriculum prior to the one harmonized with the Bologna Declaration. Their impressions and experience might indicate desirable guidelines in the development of university education in the Republic of Croatia. However, since the sample is rather limited, i.e. it consists of 150 students, it does not have to represent the viewpoint of the overall students' population. Questionnaire results, i.e. rates referring to satisfaction of students with individual elements of their university education are given in Table 3, i.e. in the diagram given in Figure 3.

Table 3. Average rates obtained by the questionnaire
Tablica 3. Prosječne ocjene prikupljene upitnikom

Question	Rate
1	3,67
2	3,03
3	3,22
4	3,61
5	3,64
6	3,32
7	3,07
8	3,71
9	3,51
10	4,06
11	4,50
Average	3,52

A rather high 3,67 rate shows a general satisfaction of engineering students with their studies. However, a rate of 3,03 referring to their satisfaction with active and cooperative work indicates that certain improvements are necessary, as proposed in [22]. They have already been planned by the Bologna process [17], and can be reached by its practical implementation – reduction of the number of students per teaching assistant, increasing in that way the time of independent active studying in form of homework, assignments, discussions in classes and seminar papers. By the rate of 3,22 students point out that faculties could be equipped better. This primarily refers to computer and other laboratory equipment [24] that requires greater investments. Although not that low, the rate of 3,61 points out that by reducing the number of students per teacher,

academic, personal, social and moral development at faculties should be encouraged and improved. The theoretical part of classes is rated with 3,64, which also provides space for improvement by assessing and evaluating quality of lectures, which is also made more feasible. The rate of 3,32 shows that the execution of laboratory exercises should improve by further reduction of students in a group, and their modernization in terms of contents and equipment. As shown in [1], this is of special importance at engineering faculties.

The connection between the theoretical and practical part of the study program is good (3,07); nevertheless, it should be significantly improved, as in [4]. Among other steps, it can be reached by implementing all measures proposed so far, and especially by additional in-service training of the teaching staff and investment into equipment.

Despite different rates given to the aforementioned elements, the acquired knowledge is considered to be very good (rated with 3,71), although future employers are expected to be impartial regarding this rate. The same holds for implementation of the acquired knowledge and skills in economy, which is also rated with very good 3,51. Students rated their foreign language knowledge with 4,06. The rate of 4,50 stresses the importance of foreign languages at engineering faculties and points out that they should be necessarily included in any engineering curriculum, according to CEL/ELC Executive Committee 2002 [8] and [21].

Although almost very good, the average rate of 3,58 calls upon the needs for improvements in university education. A complete analysis should encompass opinions provided by the teaching staff, business people and graduates who have started to work.

It should be taken into account that all changes indicated are necessary in the period in which Croatia is significantly lagging behind with respect to the total number of population with a degree, wanting to increase that percentage. In addition, university education should be harmonized with the needs expressed by economy, which might significantly contribute to competition and economic growth.

European cooperation should be encouraged and promoted aiming at ensuring quality for the purpose of developing comparable criteria and methodologies. It is of special importance to promote a necessary European dimension in university education, especially for designing curricula, establishing cooperation between institutions, the issues of mobility and integrated study programs, in-service training and research.

4 Importance of foreign language competence Važnost učenja stranoga jezika

Language for specific purposes (LSP) at engineering faculties plays an important role in the overall education supplementing general and specific knowledge,

skills and competences of young experts in their respective fields, contributing at the same time to their competence, know-how and presentation of themselves through their professional and scientific activity [21]. In addition, trends in the world and recent initiatives in the European Union show that a good grasp of at least one foreign language (primarily English, since it has become a *lingua franca* in the whole world) and the so-called working knowledge of another in combination with computer literacy represent a must for any young expert who would like to be involved in most recent professional and scientific trends within their particular fields [12].

The paper gives an assessment of LSP knowledge by students themselves and their opinion regarding the importance of foreign language classes at engineering faculties, as well as the possibility of intensifying the LSP program at those institutions. It has been observed that students have become increasingly aware of the importance of foreign language competence as one of the fundamental principles leading towards European integration.

The results obtained follow a recommendation issued by CESAER (Conference of European Schools for Advanced Engineering Education and Research) [5], which points out the need for teaching current field-related contents within the framework of university engineering education with the purpose of encouraging mobility of both students and teachers and scientists.

5

Conclusion

Zaključak

The analysis of implementation of theory into practice in the system of higher education is based on the data obtained through a questionnaire filled in by senior year students at engineering faculties in the Slavonia region, as well as statistical data encompassing international cooperation of students and the teaching staff compiled in the period between 2003 and 2006. The analysis unquestionably points out an important role of higher education institutions whose major responsibility and purpose is to pass advanced knowledge, skills and competencies to individuals who will be able to apply them practically encouraging thereby constant growth and development of the country. The paper also gives a basic outline of a more efficient scheme referring to the language for specific purposes (LSP) taught at engineering faculties, that would prepare students for specific requests and challenges they will face by the end of their university education and future careers in international environments. Luckily, the processed data show progress in that direction.

6

References

Literatura

- [1] Braskamp, L. A.; Ory J. C. *Assessing Faculty Work: Enhancing Individual and Institutional Performance*, San Francisco, CA, USA, Jossey-Bass, 1994.
- [2] Boisvert, D.; Cohen, R.; Guitierrez, O.; LaTulippe J. *IT Education – Curriculum Development: Achieving a Regional Process for Curriculum Development*, Proc. 7th Conf. on Information Technology Education, SIGITE'06, ACM Press, 2006, pp. 59-64.
- [3] Clausen, T. Guest editorial: Undergraduate Engineering Education Challenged by The Bologna Declaration, *IEEE Transaction on Education*, Vol. 48, No. 2, 2004, pp. 213-215.
- [4] Cassidy, S. *Learning Styles: An Overview of Theories, Models and Measures*, *Educational Psychology*, Vol. 24, No. 4, 2004, pp. 419-444.
- [5] CEL/ELC Executive Committee (2002): *The Bologna Process and the Issue of Languages*, Brussels. http://www.celelc.org/docs/bologna_languages_1.pdf (11 March 2007)
- [6] Cuddihy, E.; Turns, J. *Assessing One Aspect of Design Learning: Quantitative Analysis of Students' Design Rationales*, *Int. Journal of Engineering Education*, Vol. 22, No. 3, 2006, pp. 637-644.
- [7] Diaz-Herrera J. L. *Keynote Addresses: Computing and Information Sciences: the Discipline, Careers, and Future Directions*, Proc. 43rd Annual Southeast Regional Conference, ACM Press, 2005, p. 4.
- [8] European Commission, *The European Commission's Action Plan for Language Learning and Linguistic Diversity Promoting the Diversity of European Languages*, 2001. http://ec.europa.eu/education/policies/lang/policy/index_en.html (4 March 2006)
- [9] Faculty of Economics Osijek: *The Regional Development Strategy of the County Osijek-Baranya as the Process of Cooperation with European Union*, J.J. Strossmayer University of Osijek Report, Osijek, Croatia, 2006.
- [10] Fuller, U.; Pears, A.; Amillo, J.; Avram, C.; Manilla, L. *A Computing Perspective on the Bologna Process*, *ACM SIGCSE Bulletin*, Vol. 38, No. 4, 2006, pp. 142-158.
- [11] Hackelbusch, R. *Handling Heterogeneous Academic Curricula*, Proc. 17th Int. Conf. on Database and Expert Systems Applications, DEXA'06, IEEE Computer Society, 2006, pp. 344-348.
- [12] Havill, J. T.; Ludwig, L. D. *Technically Speaking: Fostering the Communication Skills of Computer Science and Mathematics Students*, *ACM SIGCSE Bulletin*, Vol. 39, No. 1, 2007, pp. 185-189.
- [13] Keeling, R. *The Bologna Process and the Lisbon Research Agenda: The European Commission's Expanding Role in Higher Education Discourse*, *European Journal of Education*, Vol. 41, No. 2, 2006, pp. 203-223.
- [14] Klimeš, C.; Habiballa, H. *Flexible Computer Science Studies*, *ACM SIGCSE Bulletin*, Vol. 38, No. 3, 2006, pp. 338-338.
- [15] Liu, Z. Q., Schönwetter, D. *Teaching Creativity in Engineering*, *Int. Journal of Engineering Education*, Vol. 20, No. 5, 2005, pp. 253-260.

- [16] Meyer, B.; Zwaenepoel, W. The European Report: Europe's Computer Scientists Take Fate into their Own Hands, Communications of the ACM, Vol. 49, No. 3, 2006, pp. 21-24.
- [17] Mondekar, D.; Saucha, T.; Tutiš, S. Pojmovnik Bolonjskog procesa i analiza provedbe reforme visokog školstva u Republici Hrvatskoj, (in Croatian), Zagreb, Croatia, 2005. www.ssu.hr/upload/docs/pojmovnik.pdf (14 January 2007)
- [18] Moody, D. L.; Sindre, G. Incorporating Quality Assurance Processes into Requirements Analysis Education, ACM SIGCSE Bulletin, Vol. 35, No. 3, 2004, pp. 74-78.
- [19] Ministarstvo vanjskih poslova i europskih integracija RH – MVPEI RH: Znanost, obrazovanje i šport' (in Croatian), Zagreb, Croatia, 2005, www.mvpei.hr/ei/default.asp?ru=556 (4 March 2006)
- [20] Shevling, M.; Banyard, P.; Davies, M.; Griffiths, M. The Validity of Student Evaluation of Teaching in Higher Education: Love Me, Love My Lectures?, Assessment & Evaluation in Higher Education, Vol. 25, No. 4, 2000, pp. 397-405.
- [21] Temple, D. J. Going Beyond the Native Speaker in Technical Communication, IEEE Transactions on Professional Communication, Vol. 43, No. 3, 2000, pp. 327-330.
- [22] Thorpe, M. Evaluating the Use of Learning Technologies. In: Burge EJ and Haughey M (Editors), Using Learning Technologies. International Perspectives and Practice, London, UK, Routledge Falmer, 2001, pp. 125-134.
- [23] Tovar, E.; Castro, M. Building Common Spaces in Engineering Education: A Review from ICECE'05', IEEE Transaction on Education, Vol. 50, No. 1, 2007, pp. 79-84.
- [24] Wessels, A.; Fries, S.; Horz, H.; Scheele, N.; Effelsberg, W. Interactive Lectures: Effective Teaching and Learning in Lectures Using Wireless Networks, Computers in Human Behavior, Vol. 23, No. 5, 2007, pp. 2524-2537.

Author's Address (Adresa autora):

Dominika Crnjac Milic, PhD
Faculty of Electrical Engineering
J. J. Strossmayer University of Osijek
Kneza Trpimira 2b, 31000 Osijek, Croatia
Phone: +385 31 224 787
Fax: +385 31 224 605
e-mail: dominika.crnjac@etfos.hr

Goran Martinovic, PhD
Faculty of Electrical Engineering
J. J. Strossmayer University of Osijek
Kneza Trpimira 2b, 31000 Osijek, Croatia
Phone: +385 31 224 766
Fax: +385 31 224 605
e-mail: goran.martinovic@etfos.hr

Ivanka Fercec, BA
Faculty of Electrical Engineering
J. J. Strossmayer University of Osijek
Kneza Trpimira 2b, 31000 Osijek, Croatia
Phone: +385 31 224 683
Fax: +385 31 224 605
e-mail: ivanka.fercec@etfos.hr