Voluntary education standardization in a frame of joint study programs

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Keywords

Efficiency, Education methodology, Education tool

Abstract

The extension of mobility opportunities foreseen in Erasmus plus from European to the international education community has to be supported by standards in the similar study programs. The best practice of curricula voluntary standardization gained during Tempus project implementation in EU and non-EU countries consortia is described. The benefits from extension of novel voluntary standardization approach from one particular project to ordinary practice are analyzed.

Introduction

The largest technical university of Latvia - Riga Technical University (RTU) is a leader in education of electrical engineers in Latvia. The industrial requirements to engineers require having a good level of theoretical knowledge and practical skills.
The education in power engineering covers curricula in energy production and transmission in a study program “Electrical and Power Engineering”, ensures education in energy consumption and control in a study program “Computer Control of Electrical Technologies” and provides education in a field of decreasing the impact on environment in a study program “Environmental Engineering”. Furthermore, students of the study program “Computer Control of Electrical Technologies” obtain practical skills and theoretical knowledge in control, designing and operation of the computerized electric technical devices. For successful students with good knowledge of foreign languages (English or German) RTU provides a possibility of partial training abroad.
There are several education standardization approach exists in RTU. The first one is related to Erasmus/ Erasmus plus students and staff exchanging program. The recognition of study programs between partners allows realizing exchange program. This approach is adequate for Erasmus exchange among European Union countries and the whole Bologna process area.
The number of RTU exchanging partners is impressive: the university has many long-term cooperation agreements; moreover, due to the new Erasmus plus framework the extension of partnership beyond existing partnership is foreseen. The most popular students exchange country is Germany, where RTU found 51 partners. In total, 247 Erasmus partner agreements and 225 another cooperation agreements are in force by end of the actual Erasmus program-planning period in year 2013 (see Fig.1).
The practice of student exchanges exists almost in all training programs. The most “preferable period” when the students are more active in internships, is a time of baccalaureate or master thesis development. Sometimes students prefer to have an internship within a specific partner and they pursue any opportunity to apply for internship in this specified partner.
Growing RTU experience in exchanging students gives possibility to create joint education activities and study programs in collaboration with the partner institutions. For example, collaboration in Erasmus project [1] resulted in a new study program “Master on Logistics and Supply Chain Management (MLSCM)” creation. One of the main goals of this program is education of professionals capable to take decisions considering operational, tactical and strategic aspects of LSCAM in integrated perspective by covering the technological, engineering and business related subjects [1].

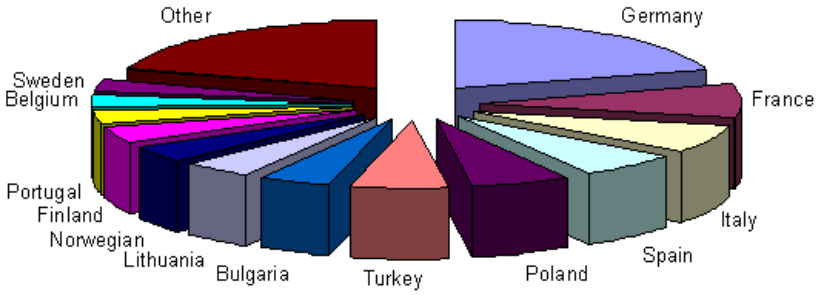

Fig. 1. RTU Erasmus partners in 2013

Bringing together education excellence and best practice by creating and modernizing study programs and through networking activities in the frame of common curricula improving project, exchanging the best practice allows to create compatible and unified curricula for improving education and expertise of the students. Confirmation teaching/ learning approaches for improving the target groups education and expertise allows, using different mobility possibility, to exchange students and to share the best practice among partners. The sufficient contribution into education system towards industry requirements for young engineers is provided by universities, using methodologies, education tools, e-learning platforms etc. The amount of information, which provides sufficient level of knowledge of students in order to have a successful carrier development in industry, is huge and rapidly growing. Sharing of the best practice in teaching methodologies, content and feedback of the students is important for providing excellent quality of the programs and for carrier development of young engineers [2].
The novelty of this paper is the curricula development by topic-based bottom up voluntary standardization approach committed by EU and non-EU universities.

1. Standardization and Bologna process

There is no legal obligation to have common international standardization of education programs. The national standards are mandatory for study programs; however the strong impact of Bologna process allows making real steps towards standardization and mutual recognition of international education. The Bologna Process constitutes an intergovernmental agreement, between both EU and non-EU countries. Therefore, it does not have the status of EU legislation [3]. The Bologna Process targets are mutually recognized as in Europe as in the world. The targets drawn by the process are sufficient for all education areas, for example:

- It is easy to move from one country to the other (within the European Higher Education Area) – for the purpose of further study or employment;
- The attractiveness of European higher education has increased, so that many people from non-European countries also come to study and work in Europe;

In many cases Bologna process gives a background for mutual recognition of study subjects obtained abroad, however it is not guaranteed that the study subjects are assigned in the same way by semesters and content of studies is equivalent in the partner institutions.

2. The case study of voluntary standardization

In the year 2012 the Institute of Industrial Electronics and Electrical Engineering (IEEI) of RTU has been approved as a coordinator of the project "Development of Training Network for Improving Education in Energy Efficiency" (Energy). The project is implemented through cooperation of 14 universities from 9 countries: Belgium, Poland, Romania, Estonia, Lithuania, Byelorussia, Azerbaijan and Kosovo. RTU is the first higher educational establishment in Latvia, which has been approved as a coordinator of the Joint Projects Actions [4].
The main target of the project is to enhance networking among higher education institutions across the Partner Countries and EU Member States for improving the education in the field of the energy efficiency enhancement, energy saving and use of renewable sources of energy. In a frame of the project partners improve existing study programs, as well as develop new study programs for

bachelors and master degree trough sharing training materials, teaching approaches and development of laboratory base in common topics.
Education in the topic of energy efficiency requires knowledge in legal issues, technological aspects, and in applications of energy saving concept. The main themes are:

- Renewable energy sources used for several programs in the areas of mechatronics, environmental protection and engineering in industry, thermal systems and equipment;
- Gas and hydrodynamics in the areas of mechanical engineering, equipment for industrial processes, mechatronics, environmental protection and engineering in industry, thermal systems and equipment, manufacturing engineering;
- Heat pumps at the undergraduate study program in area of thermal systems and equipment;
- Power electronics at the undergraduate study program in the area of Applied electronics;

The high level of IEEI expertise allows to share experience of study program Computerized control of electrical technologies within EU and Partner Countries. The project is focused on the development/modernization of a set of compatible study programs (including lecture courses, laboratory classes and appropriated didactic materials) in 4 declared directions: enhancement of energy efficiency, energy saving, energy effective materials and use of renewable sources.
The benefits from networking and usage of common IT platform among partners allow increasing of study programs quality not only in the project partner countries, but also across EU countries. The benefits for students, achieved thanks to common approach versus traditional national approach, is obvious, because it allows developing international carrier just after graduating.
The voluntary standardization between partners with Bologna and non-Bologna based education programs is a driver of the project team. The two approaches are used in the project: topic based and, related with this common e - study process approach.

3. The topic based approach in voluntary standartization

The experience of Tempus "Energy" project allows concluding that most relevant standardization way is bottom up approach: firstly, development and modernization of training courses, and then modernization of the whole study programs. The voluntary standardization is tested in such courses:

1. "Power electronics"
2. "Effective lightening"
3. "Gas- and Hydrodynamics"
4. "Heat pumps"
5. "Distribution of power energy"
6. "Energy saving technologies"
7. "Energy effective materials"
8. "Solar energy and photovoltaic"
9. "Hydrogen energy"
10. "Wind energy"

The testing of topic based approach foresees, that partners from EU universities will share best practice experience in those courses, and then will build the best curricula for each topic, including lecture material. Simultaneously partners acquire laboratory's equipment for practical training, and develop e – educational environment. The EU and non-EU countries universities now work together to create the best student's books, lecture synopsis and students – teacher interaction e – environment.

4. The analysis of existing partners study programs

The range of existing study programs, where these topics are used is extremely different among partners. European partners apply three stages based study programs. For example in Riga Technical University the study program "Computerized control of electrical technologies", pursues graduating in a field of electrical engineering in four different levels: baccalaureate academic (3 years); baccalaureate professional (4 year); professional, academic masters and PhD study program.

The structure of study programs of non-EU partners differs significantly, for example, non-Bologna education approach of Belarusian State University maintains eight study programs in a field of electrical engineering (see Table 1):

Table 1. Types of Education Plans for the first degree of higher education in BSU

Nr	Education plan (specialty code, directions)
1	G 31 04 01-01 – physics (scientific activity)
2	G 31 04 01-02 – physics (engineering activity)
3	G 31 04 01-01 – physics (teaching activity)
4	G 31 04 01-01 – physics (management activity)
5	1-31 04 01-01 – physics (research activity)
6	1-31 04 01-02 – physics (engineering activity)
7	1-31 04 01-03 – physics (research -teaching activity)
8	1-31 04 01-04 – physics (management activity)

The Belarusian National Technical University has several similar topics as RTU in undergraduate study programs: Specialty: 1-43 01 06 – "Energy Effective Technologies" and "Power Engineering Management"; master program Specialty: 1-43 80 02 "Power Systems and Complexes" and on doctoral level Specialty: 01.04.14 – "Thermophysics" and "Theoretical Heat Engineering".
Analyses of partners study programs revealed rather weak concordance among study programs used in different partner countries. Even partner universities with the similar study programs are not able to ensure students teaching the same courses as their homeland universities.

5. The improving of existing programs and developing of new study programs

The motivation for curricula development differs from partner to partner, however partners' universities share many common priorities. ***Riga Technical University,*** for example, set following targets:

- Improve teaching materials and technical basis involving different additional financial sources;
- Prepare textbooks in the subjects taught at the Department of Industrial Electronics and Electrical Technologies;
- Enlarge co-operation between higher schools realizing similar programs;
- Continue optimization of the educational programs, by integrating new courses that reveal innovative, scientific and technological achievements.
- Develop e-learning environment: ORTUS, Moodle e-library, and „Blackboard", including development of e-learning materials

Rumanian partner "Dunarea de Jos" University of Galati set similar targets:

- Develop and improve teaching materials and technical infrastructure involving different additional financial sources;
- Prepare more textbooks and guidebooks for the design and laboratory works.

For ***Belarusian State University*** the motivation was:

- Improve teaching materials and technical basis involving different financial sources;

- Prepare textbooks, acquire new teaching laboratory equipment and create laboratory works descriptions (guides) in the subjects taught at the Chair of Energy Physics;
- Enlarge co-operation between high schools realizing similar programs in the field of Energy effective technologies;
- Continue educational programs optimization, involving modern scientific and technological achievements in courses of „Gas and Hydrodynamics", „Energy Effective Materials", „Energy Effective Technologies", „Effective Lightning" and „Solar energy and photovoltaic".

Belarusian National Technical University pursues following priorities:

- Improve teaching materials and technical basis involving different additional financial sources;
- Prepare more textbooks in the subjects;
- Enlarge co-operation between higher schools realizing similar Engineer programs in the direction of technologies using of fluids and gases;
- Continue educational programs optimization, involving more modern scientific and technological achievements in the courses of fluids and gases mechanics;
- Organize the position of supervisor the 1st year students mentoring in order to improve relationships between the students and staff and to motivate in the studies;

In conclusion, one of the common priorities is a joint e – learning platform sharing, where the working versions of teaching materials are uploaded and further developed.
Joint e-learning platform (see Fig. 2) is a web-based system for developed and improved compatible training courses and didactic materials needed for transferring experience of EU Universities to Partners Countries Universities. During this TEMPUS project e-learning platform for training courses was created using Moodle platform. This e-learning platform improves information exchange among partners; all training materials become visible for courses development team [4].

Fig. 2: The Moodle based e – learning platform of "Energy" project

Cooperation in the development and modernization study programs allows partner universities to create a Joint Educational Platform as a system of enhanced compatible lecture synopsis (more than 10), laboratory classes (more than 6) and didactic materials. This will encourage academic staff to transfer experience of the Universities of EU Member Countries to the Partners Countries Universities and to exchange experience inside of Sub-Consortia, for example, between three Belarusian leading universities.
Academic staff of the Universities of EU Member Countries is involved into coordination of the modernization and developing of compatible and unified curricula and study programs making them compatible with EU standards. Furthermore, the academic staff of the Universities non-EU countries will be involved into training process in EU Members Countries (mobility), modernization and developing of curricula with appropriated didactic materials, as well as in training of bachelor and master students.

6. The quality control

The quality assurance of topic-based bottom up voluntary standardization approach and newly developed education programs is an integral part of the "Energy" project. Didactic materials, methodological and user guides, created practical and virtual laboratories, all parts of curricula to be tested and evaluated in order to assess benefits of partner's collaboration. All courses materials have been uploaded in Electronic library for common use during testing period, which to be at least one year. All partners produce the Interim evaluation reports, furthermore at the end of the testing period a feedback from student self-governance organizations and from teaching and academic staff will be provided and analyzed.

The project team recognizes a feedback from the students as the main element of the quality assurance system. The standard feedback form of partner's universities differs. The main points of quality evaluation form in Riga Technical University (fig. 3) are quite general:

- The lecturer/professor promoted creative thinking and practical application of theory
- The lecturer/professor covered all curriculum themes required to achieve the defined learning outcomes.
- The lecturer/professor used audiovisual materials efficiently.
- The lecturer/professor's attitude to the students was positive and helpful.

This evaluation list is available directly in e-learning environment (see Fig.3).

Survey on the study subjects implemented in autumn semester of the academic year 2013/14

questionnaire results

Number of students registered at the course: **1**, Submitted questionnaires: **1 (100.00%)**, questionnaires filled in from **25.11.2013** to **05.01.2014**

		Strongly agree	Partially agree	Neutral assessment	Partially disagree	Strongly disagree	No evaluation
1.	At the introductory lecture, the lecturer/professor informed the students on the curriculum and assessment procedures and criteria	1	0	0	0	0	0

Average rating: 5.00, Standard deviation: 0.00

		Strongly agree	Partially agree	Neutral assessment	Partially disagree	Strongly disagree	No evaluation
2.	The lecturer/professor covered all curriculum themes required to achieve the defined learning outcomes	1	0	0	0	0	0

Average rating: 5.00, Standard deviation: 0.00

		Strongly agree	Partially agree	Neutral assessment	Partially disagree	Strongly disagree	No evaluation
3.	The course was well-structured and the themes were explained in a comprehensible manner.	1	0	0	0	0	0

Average rating: 5.00, Standard deviation: 0.00

Fig. 3: Course evaluation template.

7. The case study of students training

In the frame of the project "Development of Training Network for Improving Education in Energy Efficiency" a student's mobility and training event "Training in electro magnetic compatibility" was organized in Electromagnetic Compatibility and Electric Security Research Centre (EMC center of RTU) on 22-24 May, 2014.

The centre offers the most updated and comprehensive electronic and electrical equipment testing facilities in the Baltics. A strong emphasis has been made to extend cooperation with international research organisations and industry based on bilateral research agreements or collaboration within the European Commission's 7th Framework Program on EMC topic. This initiative facilitates the introduction of the industry driven approach into RTU curricula and particularly involving master and PhD students in EMC research topic.

The EMC centre comprises main measurement laboratory and specific measurement equipment for low voltage devices. There is an anechoic measurement chamber (see Fig. 4) with the frequency range

up to 40GHz that ensures testing results of complex electromagnetic compatibility and electric security in accordance with 28 Standards and Directives of the European Union.
During the theoretical course such topics was presented:

- EMC legislation in EU, EU EMC market surveillance, EMC direc-tive EC2004/108/EC, standards EN, CISPR, GOST and Declaration of conformity (DoC).
- Electromagnetic disturbances: Sources of electromagnetic noise, Classification of noise sources, Ambient noise floor in public, house-hold and industrial environment, Environment classification.
- Coupling of electromagnetic disturbances and methods of elimination: Galvanic coupling, Capacitive coupling, Mutual inductance coupling, Radiated fields.
- Cabling: Electric and magnetic field coupling, crosstalk, cable types: coaxial, twisted pair and rib-bon cables; cable shielding.
- Shielding principles, materials used for shielding purposes, electronic equipment shielding, cable shielding, seams, joints, gaskets, slot antennas, and multiple apertures.
- Filtering principles. Filter components. Basic theory of common mode and differential mode filtering. Noise source and load impedance vs filter insertion loss. Single stage filters. Multi stage filters. Inductive chokes vs bypass capacitors in filtering. Proper installation of EMC filter and PCB layout for EMC filter.

Fig. 4: Tempus study training event organized in cooperation with EMC center of RTU.

During the practical part of the course, such skills and knowledge ware trained:

- Physical background of electromagnetic compatibility.
- The modern approach of electromagnetic compatibility mitigation.
- The evaluation methodology of electromagnetic compatibility.
- The testing equipment of electromagnetic compatibility.
- The solutions for electromagnetic protection and its applications.

The participants of this training course were the students with different background from 3 partner's universities: Riga Technical University, Qafqaz University, University of Pristina in Kosovska Mitrovica. The student's feedback related the course was positive.

8. Development perspectives

After comparison of study programm "Computer Control of Electrical Technologies" with similar study programs in Tempus consortia the three key steps of development where considered: the 1st step is adaptation of Moodle system for daily use, during the first year testing period. The second step will be development a study topic of Energy saving technologies for international study students. Furthermore, the third step envisages development a study topic for local students – embedded systems for control of electrical technologies.

The study program development is planned taking into account the research area of Institute of Industrial Electronics and Electrical Engineering: electronic components of mechatronic, embedded systems as well as energy saving technologies.
The development of specific study program for international students requires adaptation of study subjects, because different background of foreign students requires having additional introduction equalization course. The differences and variety of existing power supply and other infrastructure systems used in EU and non-EU countries should be taken into account; therefore, the examples of equipment should be used from international practice across EU.

9. Discussions and conclusions

The topic-based bottom up voluntary standardization approach is a good background, which could to be used for the next Erasmus plus planning period. The standardization of different topics allows creating on the best practice based training materials and lecturing notes. This approach is already partially used in Riga Technical University for foreign students training. For example, a study course "Elements of automation" have been taught to the students of three different study programs.
The usage of joined e-learning platform allows standardizing 'de facto' lecturers, practical training, testing and other virtual laboratory based study activities. The joined e-learning platform opens huge perspectives in the voluntary curricula standardization.
Analyses of partners study programs revealed rather weak concordance among study programs used in different partner countries, moreover even partner universities with the similar study programs are not able to ensure students teaching the same courses as their homeland universities. Therefore, partner universities foreseen sharing joined e-learning platform that helps a student, which takes a course in the partner university, to feel more comfortable and to have easier adaptation after returning to a homeland university.

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Voluntary Education Standardization in a Frame of Joint Study Programs / N.Kunicina, A.Zabasta, L.Ribickis, A.Zhiravecka, A.Patlins // 2014 16th European Conference on Power Electronics and Applications (EPE '14 - ECCE Europe) : Lappeenranta, Finland, 26-28 August 2014. Piscataway, NJ : IEEE, 2014. P.227-234. ISBN 978-1-4799-3016-6. http://dx.doi.org/10.1109/EPE.2014.6910708.