

Quality assurance in developing of international electrical engineering study programs

Diana Zalostiba
Institute of Power Systems,
Faculty of Power and Electrical Engineering,
Riga Technical University
Riga, Latvia
Diana.Zalostiba@rtu.lv

Jelena Caiko
Institute of Electrical Engineering and Electronics,
Faculty of Power and Electrical Engineering,
Riga Technical University
Riga, Latvia
Jelena.Caiko@rtu.lv

Anastasija Ziravecka
Institute of Electrical Engineering and Electronics,
Faculty of Power and Electrical Engineering,
Riga Technical University
Riga, Latvia
Anastasija.Ziravecka@rtu.lv

Antons Patlins
Institute of Electrical Engineering and Electronics,
Faculty of Power and Electrical Engineering,
Riga Technical University
Riga, Latvia
Antons.Patlins@rtu.lv

Nadezhda Kunicina
Institute of Electrical Engineering and Electronics,
Faculty of Power and Electrical Engineering,
Riga Technical University
Riga, Latvia
Nadezda.Kunicina@rtu.lv

Leonids Ribickis
Institute of Electrical Engineering and Electronics,
Faculty of Power and Electrical Engineering,
Riga Technical University
Riga, Latvia
Leonids.Ribickis@rtu.lv

Abstract— The quality assurance process for international study programs are developed taking in to account requirements on the national level, Bologna process, as well as international experience of EU partners. The establishment of successful study program in engineering topics is analysed in the article. The quality assurance on international dimension, and development project quality monitoring activity plan for Erasmus plus KA 2 projects are discussed. The internal, external as well as international procedures are discussed. The quality control planning in cooperation with EU neighborhood region e.i. Western Balkan region countries, as well as Russia, Mongolia, Vietnam and Kazakhstan are discussed as examples for new academic programs and double diploma study programs.

Keywords—education, electrical engineering, Erasmus plus capacity building, study program development, Bologna process, double degree, quality assurance, higher education.

I. INTRODUCTION

The developing of study programs, which involves different partners from different cultures and regions in the field of Power and Electrical engineering, Smart city and ect. requires developing common, mutually recognised quality assurance procedures.

The experience, gained during cooperation in international capacity building projects, has been taken into account:

- Establishing Smart Energy System Curriculum at Russian and Vietnamese Universities (ESSENCE) is a curriculum development project initiated by the consortium of 10 universities from European Union, Russia and Vietnam, co-funded by the Erasmus+ Programme of the European Union, Key Action 2, Capacity Building in Higher Education [1];

- Development of master curricula for Electrical Energy Markets and Engineering Education – ELEMEND, co-funded by the Erasmus+ Program of the European Union, Key Action 2, Capacity Building in Higher Education [2];

- The double degree programs development Innovative Approach Towards a Master Program on Smart Cities Technologies SMARTCITY, co-funded by the Erasmus+ Program of the European Union, Key Action 2, Capacity Building in Higher Education [3].

As well as just accepted KA2 project, Development of practically-oriented student-centred education in the field of modelling of Cyber-Physical Systems, which foresees double degree programs. The project addresses to capacity-building objectives of the KA2 by supporting the modernisation, accessibility and internationalisation of the higher education field in the partner countries and promoting voluntary convergence with EU developments in higher education, as it focuses on upgrading Bachelor/Master-level curricula and study programmes according to Bologna practices in

Belarusian and Ukrainian universities in the field of Cyber-Physical Systems modelling and simulation.

The capacity building projects aimed to share experience of European partner universities to EU neighbourhood regions in order to create or update content of study programs. The quality assurance is critical point of new study programs implementation, especially when several international teams are involved in the development of new curricula's content. The national industry and stakeholder's requirements and development priorities are not always the same in the mentioned regions, however the main goals, as working ability in the different market conditions, international requirements, as well as innovation oriented education are priorities for mentioned region. The mutually accepted Bologna process deployment is an important step for mutual understanding of quality baseline in the international cooperation, double or joint diplomas programs as well as the covers of the local stakeholder's interest. The testing period of developed content of study programme, internal and external quality assurance process in bases for development successful study programs on local and joint academic activities level.

II. INTERNATIONAL FRAMEWORKS AND DIMENSIONS

The best practice of already developed international and national frameworks was taking in to account for quality system development, in particular the European Association for Quality Assurance in Higher Education and national experience.

ABET [4] quality assurance is done for accredit study programs, and it is following US academic experience. Other teacher / expert / evaluator base the approach on the evaluation of student performance and progress toward completion of their programs, the monitoring of study performance on place, as well as evaluation and recommendation development. The program must have and enforce procedures to ensure and document that students who graduate meet all graduation requirements.

The (ENQA) [10] is a joint organisation, representing different parties, it is representing education process in different, especially in political decision making processes and in co-operations with associations and individual stakeholders. The main target and task of ENQA is to promotes European co-operation in the field of quality assurance in higher education and disseminating information and expertise among its members and towards stakeholders in order to develop and share good practice and to foster the European dimension of quality assurance.

On national level the accreditation and quality assurance process in Latvia is coordinated by the Quality Agency for Higher Education [11]. According to Law on Institutions of Higher Education (Latvijas Vestnesis 257 (5317)) and the Regulations of the Cabinet of Ministers of 14 July 2015 No. 407, 408 and 409 as they have entered into force, the AIC organizes the accreditation of HEIs and study directions and licensing of study programmes. The specific of Latvian law is, that it is impossible to implement double degree programs, which are very interested and there are announced as national priorities, for example in Ukraine.

The quality assurance process in projects is based on the experience and best practice of the project team members. The working groups for internal quality control activities are created at each Partner countries university consisting of one academic staff, students, and students' organization representatives. The groups are responsible for the internal quality monitoring, prepare all necessary material (questionnaires, forms, etc.), according to the European Association for Quality Assurance in Higher Education (ENQA) guidelines and Quality Assurance Plan (QAP). The university' quality working groups reports regularly the leader of partner team, which prepares progress reports on activities and results and submit them to the MC for approval and decision on corrective actions. The representatives of the Quality working group participate and report at MC meetings.

According to the proposals of the projects, the consortiums have to provide outputs and to submit evidences related project achievements:

1. The number of teaching materials developed: lecture notes/synopses, descriptions/manuals of laboratory works, courses books, etc.;
2. The number and names of Standard master-level programs with ECTS system' application, accredited in the Ministry of Education: the number and names of education courses with ECTS system' application, accredited in the partner's university;
3. The number of study programs for undergraduate/ master-level courses descriptions;
4. The number of teaching/didactic materials uploaded to e-Library;
5. Virtual laboratory for student training, the instruction for its on-line usage.

The aim of developing activities in the projects are to develop and prepare a basis for implementation of new courses, including new teaching equipment purchase. It is the responsibility of QMC from partner countries and university representatives to compile this information and prepare the progress report.

The aim of implementation of new updated program progress report on new curricular testing with feedback from stakeholders is a description of a progress on development and implementation of study programs at partner universities.

According to best practice internal quality reports should elaborate:

- Partners reports with lists of the students studying in the modernized study programs
- Partners reports with feed-back forms from students by subjects
- Partners reports with results of final testing by subjects
- Partners reports with feed-back forms from academic/teacher staff involved in teaching of students by subjects.

The measurement of indicators according is:

- The number of validated / tested courses
- The report should be done by higher education institutions of non-EU partners.

III. THE METHODOLOGY

The international experience and relevant case studies was analyzed, for example paper [4] has demonstrated that the use of blended learning in an electrical machines course has increased student engagement, pass rate, and scores across the GPA spectrum.

Background: Lack of engagement by students in electric machine courses has been reported across the world. However, the interventions usually take the form of laboratory and simulation assignments. There is little information on the use of blended learning and flipped classroom techniques to combat these problems.

Intended Outcomes: Engagement in the course is increased by exam performance. In particular, the students should be able to explain the construction and principle of machines operation, and compute different parameters for various operating conditions.

Application Design: The approach involved online lectures, tutorial submissions, and peer feedback forums followed by face-to-face tutorial sessions. It was chosen because online activities would allow students to access material on devices with which they are accustomed to engaging deeply and because peer feedback has been shown to build community, and increase the quality of discourse for both students and lecturer.

Findings: There was a significant improvement in exam performance when compared to previous years. The pass rate of the course moved from approximately 60% in previous years to 86%. The class average mark also increased from approximately 50% in previous years to 63% [4].

The paper [5] presents ProElec project, which links all the subjects of the electrical engineering field through the academic itinerary of Civil Engineering and Mining and Energy Engineering students at the University of the Basque Country UPV/EHU. Based on Project-Based Learning (PBL), ProElec aims to lead students from 2nd year up to the Bachelor thesis in a dynamic learning process. As preliminary results surveys from students are presented, where it can be observed that the experience has been so far positive [5].

As it is given by [6], - in the engineering career, continuing education is increasingly important. In fact, being updated with new technologies and their usage is mandatory for engineers that want to stay connected with the new trends. In this context, the use of Information and Communication Technologies (ICT) to support online courses mediated through the web is something that can speed up one's continuous education. Therefore, the adoption of Learning Objects (LO) and Open Educational Resources (OER) to support online courses is a reality worldwide. LO follows description standards for ease of storage and retrieval, and OER has by definition the open license for editing and use. Nevertheless, no guarantee about the quality associated with

such digital educational resources is provided. In this work, we present a step for the definition of the main criteria that will serve as a basis to evaluate the technical quality of the DER either automatically or semi-automatically [6].

IV. THE BACKGROUND OF IMPLEMENTATION

With quality assurance we mean internal and external process and criteria to ensure minimum standards (accountability), support quality enhancement, provide reliable and transparent information to users and stakeholders (consumer protection), create trust in the HE system and its components, ensure, fundamentally, that students (can) reach the intended learning outcomes [7], [8]:

– *Standards for QA:*

1. Policy for quality assurance
2. Design and approval of programs
3. Student-centered learning, teaching and assessment
4. Student admission, progression, recognition and certification
5. Teaching staff
6. Learning resources and students support
7. Information management
8. Public information
9. On-going monitoring and periodic review of programs
10. Cyclical external quality assurance

– *Importance of QA:*

The tasks of Quality Assurance are to answer to the questions: what are you trying to do? how are you trying to do it? how do you know it works? what do you need to change in order to improve?

– *Importance of QA for Leadership:*

- A means of getting HEI and departments to think critically about academic performance and improvement and development

- To get external views on the quality of programs

- To receive informed advice on how to improve: “Best Practice”

- To provide an independent catalyst for internal change and innovation

- To provide an external legitimisation /recognition

– *QA reflects the expectations of:*

- Graduates of secondary schools

- Students – consumers, partners in learning experience (current, alumni, future)

- Users of research and R&D

- External examiners

- Employers – labour mobility and competencies
- Government – safeguard consumer, value for money, relevance.

– *Quality Management Approach:*

The purpose for managing quality is to validate that the project deliverables are completed with an acceptable level of quality. Quality management assures the quality of the project deliverables and the quality of the processes used to manage and create the deliverables.

V. CASE STUDY

A. *The Experience of the SmartCity project [2]*

The project is in line with the principles of Bologna process which aims at creating a European Area for Higher Education through a common new degree system, a European dimension to quality assurance and the recognition of degrees and study periods abroad. Project wider objective is to create a new breed of multidisciplinary Information-Communication Technologies engineers in the Smart City(SC) technologies by harmonizing Kazakhstan (KZ), Mongolian (MN), Russian (RU) education with the EU one and provide double degree recognition through development and introduction the Double Degree Master Program in SC. Project specific objective is to develop the opportunity to study the Double Degree EU-KZ-MN-RU Master Program in SC both in Russian, Kazakhstan, Mongolian and EU universities. The quality assurance is based on national requirements of both partners, involved in the double degree programs. The individual agreements, about accepting of study programs results of other partner countries are developed,

B. *The Experience of the ELEMEND project [3]*

There are criteria/ guiding questions:

- Preparatory activities for creating new MSc program
- New MSc program created at the WBC HEIs
- Acceptance of the new program by the participating HEIs
- Update of BSc program
- New Laboratory for BSc and MSc Program
- Implementation of Program
- Accreditation of the new curricula in national level
- Increased collaboration among HEIs in Partner & EU countries: new teaching methodologies, including use of ICT / number of members of the network
- Creation and using of ELEMEND platform
- Establishment of cooperation with industry representatives
- Increase number of employed graduate students in smart grids / indicators are number of students enrolled and number of agreements with market stakeholders for enhancing employment opportunities.

-Dissemination activities

The project quality: -Feed-back from x students; -Feed-back from y teachers; Feed-back from representatives of the student's governance: -N feed-back reports and -K statistic forms. Student attraction events: "Open doors", excursion to the enterprise.

The numeric evaluation of the results:

-The number of teaching materials developed: lecture notes/synopses, descriptions/manuals of laboratory works, courses books, etc.

-The number and names of Standard master-level programs with ECTS system' application, accredited in the Ministry of Education.

-The number of education courses and study programs for master-level courses descriptions, as well as didactic materials uploaded to e-Library; Virtual laboratory for student training, the instruction for its on-line us.

The quality assurance is foreseen during the project, for example the Project Quality team are making internal evaluation monitoring visits, which clarifies QP will be used for the monitoring activities and periodic review of the project and its outputs. The report from internal quality monitoring visits is annex of Internal quality control report, which is done in according to the task Internal quality assurance activities.

The report is result of Quality monitoring Team member meeting with Partner university representatives on place:

The generally QP will be used for the monitoring activities and periodic review of the project and its outputs. It will ensure that:

1. Explicit intended learning outcomes are developed and published in the new syllabi;
2. industry (SME) representatives and students participate in syllabi design
3. the curriculum and program design and content, output of WP2, is reviewed and evaluated by involved parties and stakeholders; suggestions will be offered and follow-up procedures will be determined
4. specific needs of different modes of delivery (e.g. lecturing, lab work, e-learning) and target groups are taken into account
5. learning resources are available to the teachers and students
6. formal program approval procedures by the University authorities are initiated
7. monitoring of the progress and achievements of students is in place
8. finances and reports.

The Project Quality Monitoring and Control Team (PQMC), is specially established group of experts, in order to make internal evaluation processes of the project quality aspects. The experts, which are involved in this group are not

involved in any other activities of the project. The PQMC are responsible for preparing the guide for quality control and monitoring activities.

C. The Experience of the ESSENCE project [1]

The overall aim of the ESSENCE project is to modernize the master level curriculum in smart energy systems (SES) at Russian and Vietnamese universities in close cooperation with the industry and in accordance with the European Qualification Framework (EQF). Within the framework of the project, a core curriculum is developed to be embedded into existing master programs and implemented during the third year of the project life (academic year 2019/2020).

The core curriculum consists of 9 courses (syllabi and teaching materials) and an industrial practical training course with the average weight of each course being 3-6 ECTS credits and the total weight up to 45 ECTS credits.

The content of the practical course has been harmonized with the core curriculum and the expectations of the industry by incorporating appropriate learning outcomes and step-by-step navigation materials. To ensure the most efficient adaptation of graduates to the professional life as well as the involvement of the industry into the program implementation and to help designing an individualized industry involvement track, the Industry Involvement Guide has been developed as accompanying materials for the practical course.

The remaining credits of the modernized curriculum will be filled in with elective courses, pedagogic and research practical training and a master thesis, according to what is required by national educational standards in Russia and Vietnam or local standards of universities.

Integration of core curriculum is a very sensitive matter, which highly depends on the current situation and the resources of each partner university; thus, several options (however, the list is not exhaustive) are defined to form individual long-term implementation tracks:

- Adoption of the project results to modernize the existing curriculum, providing new courses, learning outcomes and teaching materials in Russian or Vietnamese;
- Adoption of the project results to modernize the existing curriculum, providing new courses, learning outcomes and teaching materials in Russian or Vietnamese and in English in an amount sufficient for implementing and facilitating international academic mobility (incl. summer schools) and staff mobility (invitation of visiting professors);
- Adoption of the project results to modernize the existing curriculum, providing new courses, learning outcomes and teaching materials in Russian or Vietnamese and in English in an amount sufficient for establishing double-degree program with Partners;
- Adoption of the project results to introduce a new curriculum in SES in Russian or Vietnamese, and/or English.

To improve skills in curriculum development, course content and teaching methodology in line with EQF, to support knowledge transfer and exchange of experience

among the experts, academic supervisors, course developers and future teachers, there have been conducted several trainings activities.

The modernization of the master program is carried out in the context of Bologna Process policies: it is the second cycle program (level 7 according to the EQF), ECTS compatible, the diploma supplement will be provided to program graduates, learning outcomes are defined, QA procedures are envisaged, advanced EU teaching and learning methodologies are applied. Compliance with the requirements of the Bologna process and other strategic issues of the project are addressed in the regular course of the project plan (see Fig.1).



Fig. 1. The main activities and QA of the ESSENCE project

The syllabus and teaching materials are developed in correspondence with the EQF, while taking into account pre-co- & post- requisites, intended learning outcomes. Special attention is paid to course harmonization and overlap elimination to ensure the integrity and accessibility of the project goals and tasks.

Industry-oriented and student-centered properties of the program and separate disciplines are thoroughly tracked through the project lifecycle by getting feedbacks from the main stakeholders (such as academia, industry, students and professional organizations).

As the international integration in education and technology is strongly happening, this is the positive moment for VN universities to give a try to fit well their course learning outcomes with the EQF, ECTS and the principles set by Bologna process, so that the equivalence and continuity between training programs in Vietnam and EU partners could be improved. Students are benefited with the mobility opportunity to pursue further education from one to the others.

Accordingly, when composing the course syllabi and teaching materials, developers are emphasizing the suitable outcomes, contents and related teaching methodologies.

To ensure high quality of the project implementation, its results and risks management, the multi-dimensional quality assurance has been realized within the ESSENCE project. The quality assurance methodology and measures, incl. quality control and monitoring strategy, QA internal and external processes, QA plan and criteria have been designed. As shown in Fig.1, the QA have been defined for each main stage of the project.

The quality team has been formed to monitor and evaluate the project implementation and the achieved results. The different tools have been used to evaluate the progress and results, e.g., surveys, feedback, self-evaluation, assessment visits, peer-review, etc.

CONCLUSIONS

The Quality activities should be the essential part of any higher education project. The Quality activities exist at the project activities level and project implementation level. At the project implementation level it is monitoring of the quality of the project generally from the outside – this type of activity is realized from inside, by the Quality monitoring teams, and from outside, by outside quality experts. At the level of project activities this is a day-to-day co-ordination of the entire project implemented steps, by estimation them by means of different criteria and indices. The Quality monitoring and assurance should accompany all steps of the project implementation. For each step own criteria and parameters to estimate should be created in accordance with the aims and objectives of the activity under consideration. Quality monitoring and control of new developed and modernised curricular in electrical engineering is vital to the sustainability and confidence for the prospective students. Quality control activities span the lifetime of the project as they include establishing the internal quality procedures, preparing

evaluation forms and guidelines, carrying out internal evaluations, reporting, engaging external evaluators for the engineering courses and programmes and paving the way to the accreditation. A form of a student organisation (Parliament, Self-Governance, etc.) is expected to complete this testing. The recommendation is to use the same questionnaire form developed before for students but to summarise the results in free form. In case of such organisation absence at the university this fact should be mentioned in the report.

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Diana Zalostiba, *Dr.sc.ing.* works as an Associated Professor and Leading Researcher at the Institute of Power Engineering of Riga Technical University. Diana has over ten years of research and teaching experience. She is author of more than 25 papers; also, she has many years of experience in project management and implementation, incl. leading of the ESSENCE.

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