

Harmonized Quality Assurance and Assessment Methodology for Engineering Education

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Abstract — *Communiqué of the Conference of European Ministers Responsible for Higher Education, Leuven and Louvain-la-Neuve contains proposition to continue cooperation in further developing the European dimension of quality assurance. European approaches/dimensions in quality assurance comprise a harmonized conformity assessment system developing in the European Economic Area through implementation of a New Approach and Global Approach. Higher education institutions, with their triple roles as providers of the highest levels of education, advanced research and path-breaking innovation, are at the heart of Europe's knowledge triangle. Implementation of cooperation/partnership arrangements should be encouraged to facilitate implementation of successful and significant value-adding solutions in applied research, practical education and innovation domains for increased effectiveness of Europe's economy. In higher education should be created environment, promoting and facilitating acquisition of creative and innovative skills, developing production and entrepreneurial capabilities, purposeful inclusion/practising of students and academic staff in production/economic activities, particularly in development of small/medium size enterprises and small-scale production establishments. Student's centred learning, balanced mobility will facilitate student's aspirations to acquire useful and necessary knowledge, skills and competence and contribute alignment with the fast changing and value-adding production/economy system. New 'learning outcomes approach' is promoting implementation of essential transition/changes in the higher education: from inputs – study duration, study content and qualifications regulation towards study results – recognition/certification of the set of knowledge, skills and competence at the end of corresponding study cycle. Learning outcomes – totality of knowledge, skills and competence which student has acquired within the study programme/cycle and what is certified in the qualification description issued upon completion of bachelor's, master's or doctoral studies. QFD self-assessment methodology is based on careful evaluation of professional knowledge, practical skills/abilities and competence level acquired during different study activities of the study programme/cycle. Knowledge/competence comprises aligned continuum of knowledge, skills and competence which is formed within the thematic parts or modules of the study programme. Study module/course/subject study outcomes can be used for definition of criteria for normative conformity assessment and self-assessment of the student's personal achievements. Scoring criteria are expressing expected results, how student will certify/demonstrate the completeness level of his/her acquired study outcomes after completion of the study module/course/subject. Ranking criteria are reflecting completeness of the acquired study outcomes, they can be evaluated using different scales. Teaching staff and personnel, researchers and professionals are the driving force of higher education/practical research institutions. Teaching staff, researchers are the main staff implementing the Bologna process at all levels of studies/research training levels/cycles and increase in Bologna process effectiveness can be achieved by elimination of unproductive support/administrative processes/structures. Quality management – assurance, improvement and excellence systems started to emerge in European higher education simultaneously with the beginning of Bologna process, and gradually were developing in both – the regulatory and the voluntary spheres, taking into account the differences in study goals, content and activities of academic and professional studies. European approaches/dimensions to higher education – development of new, value increasing professionalism, valuable/continuously developing qualifications, substantially enhancing intended smart, sustainable and inclusive growth in Europe.*

Index Terms — *Higher education, conformity assessment, learning outcomes, quality assurance.*

INTRODUCTION

Communiqué of the Conference of European Ministers Responsible for Higher Education, Leuven and Louvain-la-Neuve [1] contains proposition to the E4 group (ENQA-EUA-EURASHE-ESU) to continue cooperation in further developing the *European dimension of quality assurance* and in particular to ensure that the European Quality Assurance Register is

evaluated externally, taking into account the views of the stakeholders. European approaches/dimensions in *quality assurance* comprise a *harmonized conformity assessment* system developing in the European Economic Area through implementation of a New Approach [2] and Global Approach [3] which are accepted and implemented globally in accordance with the requirements of ISO 17000 standards series in regulated and voluntary spheres of professional area. In their entirety these approaches guarantee four ways of freedom – free movement of goods, services, financial resources and citizens, and in current turbulent time period [4] provides for the ‘fifth freedom’ in Europe as well – *the freedom of knowledge* [5].

EEA Single market – successful development of the knowledge economy is facilitated by mutually harmonized systems ▪ quality assurance ▪ conformity assessment ▪ market surveillance ▪ supervision on the mandatory use in regulated sphere and appropriate deploying in the voluntary sphere. In the ENQA document *Standards and Guidelines for quality assurance in EHEA* [6] the essential process ‘quality assurance’ in higher education is shrewdly substituted ([6, p.5]* the term ‘quality assurance’ in this report includes processes such as evaluation, accreditation and audit) by ‘quality assessment’ for formal external (top-down) evaluation transparency and comparability of qualifications with external reference points, only for interests of higher education administration/overregulation.

Qualifications framework for EHEA is developed exclusively for academic teaching in higher education. Other learning options cannot be used for obtaining formal higher education qualification levels. Since 2005 framework is adapted for all three cycles of studies.

European Qualifications Framework is established for promotion of lifelong learning and balanced mobility, carefully elaborated in higher education/lifelong learning policy – studies and programmes are grounded in learning outcomes, professional skills, competence according to qualifications descriptions [7].

QUALITY OF PROFESSIONAL STUDIES

Engineering entrepreneurial education/qualification in current fast changing working world can be characterized by:

- valuable and useful study programmes grounded on the workforce qualification ▪ learning outcomes ▪ workload/job description approach
- productive study activities, procedures and processes, change from traditional professor’s centred teaching approach to student’s centred learning style
- effective management of formal education and individual learning path, efficient leadership, application of steering and governance principles in studying, training, practicing and institutional government.

University-Business Forum 2009 [8]: Higher education institutions, with their triple roles as providers of the highest levels of education, advanced research and path-breaking innovation, are at the heart of Europe’s knowledge triangle. While fulfilling this significant role, implementation of cooperation/partnership arrangements should be encouraged in order to facilitate implementation of successful and significant value-adding solutions in applied research, practical education and innovation domains for increased effectiveness of Europe’s economy.

In higher education should be created environment, promoting and facilitating acquisition of creative and innovative skills, developing production and entrepreneurial capabilities, purposeful inclusion/practising of students and academic staff in production/economic activities, particularly in development of small/medium size enterprises and small-scale production establishments. Experienced professionals from production companies and entrepreneurs have to be invited in capacity of part-time teaching staff at universities, sharing of their best practices with students through different ways and activities - cooperation in practising, design, individual and group multi-branch project elaboration, joint problem solving in target/work groups, participation in conferences, etc. Recommended forms of cooperation could be also different other out-of study activities: taking part in youth consultancy groups, business incubators including ‘start-up’ and ‘spin-off’ initiatives, participation in different formations - professional societies, associations, foundations, etc.

Real autonomy should given to higher education institutions and they should accept full institutional accountability to society at large for study, research and innovation activity results; over-regulation and micro-management should be avoided. A new internal governance systems comprising professional management of human resources, investment and administrative procedures should be created. Excessive administration, fragmentation of higher education institutions into faculties, departments, laboratories and administrative units/departments should be avoided [9].

Effective management system of independent institutions will facilitate implementation intensions/efforts of personnel in areas of study, innovation and effective management. Reward/promotional measures enabling effective management and leadership capabilities and having a great development potential should be challenged, national higher education institutions’ leadership and modern management study centres should be created as well [10].

NEW STYLE – FROM TEACHING TO LEARNING

Student’s centred learning, balanced mobility (including virtual mobility) will facilitate student’s aspirations to acquire useful and necessary knowledge, skills and competence and contribute alignment with the fast changing and value-adding production/economy system.

Study programme improvement implies development of high quality, flexible, and more individually oriented learning path. Academic staff in close cooperation with professionals, students and producers/employees should further develop 'learning outcomes approach' and harmonized knowledge and skills transfer in fast developing thematic areas. Particular attention should be devoted to teaching quality enhancement and learning quality improvement of the study programmes at all levels.

In order to facilitate enactment of education based on studies the national governments have to ▪ create possibility to increase the number of students with individual learning paths ▪ develop 'new approach' to teaching/learning ▪ set up effective supporting measures, indications, explanations ▪ facilitate development of more realizable/suitable study programmes for students at all three study cycles.

Doctoral studies should be organized ▪ in full conformity with the European overarching qualifications framework ▪ on the basis of learning outcomes ▪ incorporating into the doctoral study programmes transdisciplinary, interdisciplinary themes ▪ developing knowledge at the most advanced frontier of a field of work or study, at the interface between fields and of transferable skills allowing to expand/increase possibility of alignment with the working world [11].

Reforms of the doctoral programmes should continue in accordance with the basic principles – *qualifications framework, learning/study outcomes and workload, overregulation of doctoral programmes must be avoided* [12,13].

NEW APPROACH – LEARNING OUTCOMES

The following transition/changes are implemented in the higher education:

- from inputs – study duration, study content and qualifications regulation,
- towards study results – recognition/certification of the set of knowledge, skills and competence at the end of corresponding study cycle [14].

Learning outcomes – totality of knowledge, skills and competence which student has acquired within the study programme/cycle and what is certified in the qualification description issued upon completion of bachelor's, master's or doctoral studies.

Learning outcomes are comprising the achievements/performance of the student, not what was conceived/intended by the professor and reflected in the descriptions of the study courses/modules/subjects. The study/learning/practising results are illustrating study ▪ modules ▪ courses ▪ subjects ▪ content ▪ methods and in their entirety are constituting layouts of the levels of the study cycles and qualification descriptions.

The learning outcomes approach is justified by ▪ more thoughtful recital of the qualifications framework/content ▪ deployment of student's understanding/awareness ▪ possibility to create options for individual education path ▪ enhancement of cognition about the expected needs for workforce ▪ establishment of education recognisability ▪ elimination of gaps between the higher and lifelong learning education, facilitation of their merger ▪ study programme transformation undertakings e.g.

European Qualifications Framework (EQF) is rooted in study results and more valuably describes the levels of qualification – knowledge, skills and competence levels and workload content, ensuring high personal level of employability/marketability and establishes effective educational options in studies, knowledge acquisition, skills advancement and research training.

Transition from traditional input/content regulation to achievement oriented/results approach in design, assessment, maintenance and description of qualification is complex, difficult, time-consuming and labour-intensive process [15].

EUROPEAN QUALIFICATIONS FRAMEWORK

EQF – *European Qualifications Framework for Lifelong Learning* is set up for promotion/facilitation of lifelong learning and includes all levels of professional education – from the basic until doctoral cycle of education; in successive eight-level formation it harmoniously comprises all types of formal, non-formal and informal education activities – studies/learning/practising and possibility of accumulation of different study activities for recognition of formal higher education levels. It represents a common, overarching qualifications reference framework harmonizing national qualifications frameworks, simply/explicitly understandable to students, educators, stakeholders and to society at large.

EHEA-QF – the *Framework of Qualifications for the European Higher Education Area* is designed for three cycles – bachelor's, master's and doctoral studies only, with a purpose to encourage students' mobility and to promote studies abroad and mutual recognition of study results in different national higher education systems.

NQF – *National Qualifications Framework* defines education/qualification characteristics: ▪ level ▪ knowledge ▪ skills ▪ competence ▪ job description/workload. Development of the NQF is a significant step towards implementation of *lifelong learning* which will contribute to transformation of study process and study programme assessment system. Implementation, improvement and self-certification of the NQF according to *EHEA framework* (EHEA-QF) and in its turn, alignment of the EHEA-QF with the terms of the *European Qualifications Framework for Lifelong Learning* (EQF) in accordance with the incentive of European Commission should be accomplished until the year 2012.

EQF FROM THE VIEWPOINT OF ENGINEERING EDUCATION

EQF harmoniously embraces all studying/learning/practising options for acquisition/development/ deployment of higher education:

<i>Qualification</i>	▪ level of education/professionalism, characterizes achievements, performance and acquisitions of a person in a certain field of professional activity/education
<i>Description of qualification</i>	▪ expresses degree at which the qualification is achieved and evaluated/compared to – considering acquired knowledge, developed skills and competence needed for work performance in economy, social and cultural environment
<i>Knowledge</i>	▪ theoretical applicable knowledge, understanding of principles, methods and their application in the field of professional activity/education
<i>Skills</i>	▪ proficiency in putting of knowledge into practice, embraces logical, intuitive and creative activities and their practical handling
<i>Competence</i>	▪ efficient realization of knowledge, skills and individual abilities in studies, work and professional development/growth
<i>Job title description, work load</i>	▪ allows to assess, compare usefulness of qualifications ▪ creates requirements for qualifications transfer ▪ provides opportunity for assessment of needed qualifications, their content and significance ▪ stimulates improvement of qualifications studies and quality.

EQF qualifications descriptors are arranged at eight successive levels according to the cycles of study results: ▪ knowledge (theoretical, applied) ▪ skills (intellectual, practical) ▪ competence (responsibility, independence) ▪ education/qualification cycles.

Within the *National qualifications system* the education/qualification/job title, workload descriptions should be harmonized with those at European level. It would be beneficial due to the following factors: ▪ possibility more carefully assess/compare value of qualifications ▪ conditions and terms for education/qualifications transfer, accumulation are developed ▪ provision of better options for entrepreneurs to assess type, content and significance of qualifications required in the working world/workforce markets ▪ enables educators to compare education/study programmes ▪ facilitates quality assurance in education/learning/practising [16].

LEARNING OUTCOMES – ACCUMULATION, ASSESSMENT

Learning outcomes are achieved by rational integration of ▪ studies under supervision of academic staff ▪ learning in libraries/networks ▪ discussions with other students ▪ practising in production/research establishments ▪ group work at classes/training centres ▪ participation in conferences/qualification courses ▪ study exchange/mobility results, as well as, by use of ▪ Internet databases ▪ e- mails ▪ www-pages ▪ distance learning tools ▪ CD/data storage devices ▪ printouts ▪ audio/video bridges ▪ cyber-studies/e-learning options.

Study outcomes are justifying the volume of credit points acquired by the student. Assessment of the study content, planning and activity conformity to certain level should be carried out according to self-assessment methodology, but self-assessment of study outcomes' conformity to certain qualifications level can be carried out according to *Quality Function Deployment (QFD)* methodology.

QFD self-assessment methodology is based on careful evaluation of professional knowledge, practical skills/abilities and competence level acquired during different study activities of the study programme/cycle. At the final stage of QFD self-assessment process recommendations for improvement of study/learning/practising processes are worked out. Knowledge/competence comprises aligned continuum of knowledge, skills and competence which is formed within the thematic parts or modules of the study programme.

ASSESSMENT – SCORING, RANKING

Good/best practice implementation according to 'New approach/style' denotes ▪ study programme development/improvement ▪ improvement/innovation of study activities ▪ actions/behaviour of the students/teaching staff ▪ management of study support processes. Participation in efficient/excellent research projects should be encouraged as well.

Improved study outcomes are aligning ▪ truly achievable knowledge/understanding ▪ efficient skills/abilities ▪ wisdom/intellectual abilities in certain profile, in inter/transdisciplinary knowledge/skills areas ▪ education/decision making independence.

Study module/course/subject study outcomes can be used for ▪ definition of criteria for normative conformity assessment ▪ self-assessment of the student's personal achievements.

Scoring criteria are expressing expected results, how student will certify/demonstrate the *completeness level* of his/her acquired study outcomes after completion of the study module/course/subject.

Ranking criteria are reflecting *completeness* of the acquired study outcomes, they can be evaluated using different scales (10-point scale, pass/fail, etc.).

Common/applicable (transversal, transferable, generic) knowledge/competences are successive integral parts of the continuing bachelor's, master's and doctoral qualifications cycles.

The main goal of doctoral studies – the knowledge/competences acquired in doctoral/researcher study cycle will facilitate personal workability/employability and adequate career path and growth in higher education/research and production/economy sectors.

EDUCATORS – PROFESSORS, RESEARCHERS, PROFESSIONALS

Teaching staff and personnel, researchers and professionals are the driving force of higher education/practical research institutions [17]. Teaching staff, researchers are the main staff implementing the Bologna process at all levels of studies/research training levels/cycles – increase in Bologna process effectiveness can be achieved by elimination of unproductive support/administrative processes/structures.

Administrative implementation of the Bologna process puts undesirable impact on the productivity/wholesomeness of the main work execution and career growth of the teaching staff/researchers.

Urgent administrative directions, useless requests on the number and type of publications/patents, preparation of programme accreditation/reaccreditation documentation, hastily/unprofessional study reforms should be replaced by a totality of support activities offered to the teaching staff/researchers in implementing Bologna reforms, particularly in relation to administrative work at institutional, administrative and governance levels [18].

'*New approach/style*' could be implemented in universities by undertaking radical changes in strategic and executive management, fostering creation of excellence and true leadership strategies. We should derogate from the great number of structured administrative/governance units in faculties, departments, administrative structures/services.

Autonomous institutional management system will promote joint intentions/efforts towards realization of effective education, research, innovation and management system.

QUALITY SYSTEM – EFFECTIVE, SAFE AND SUSTAINABLE

Quality management – assurance, improvement and excellence systems started to emerge in European higher education simultaneously with the beginning of Bologna process, and gradually were developing in both – the regulatory and the voluntary spheres, taking into account the differences in study goals, content and activities of academic and professional studies.

In the *regulatory sphere* of higher education – fields such as medical, maritime, construction, pharmacology, food, etc., conformity assessment of the study programmes or modules should be designed:

- quality assurance system based on the standard ISO 9001 requirements
- conformity assessment based on internal (first person's) audit statement and external (third person's) audit report according to requirements of ISO 19011, as well as, issuance of the self-assessment, peer assessment reports.

In the *voluntary sphere* of professional activity the higher education institutions can choose either to develop

- quality improvement system ISO 9004, IWA-2 (guidelines on application of ISO 9001 to higher education institutions) which envisages preparation of conformity certification documents: internal conformity self-assessment report and external peer assessment report in accordance with the requirements of standard ISO 17040 or they can go for the option to create
- quality excellence system (according to quality award model); this option envisages preparation of excellence confirmation document (quality award application) and conformity is accessed by the recognition of excellence by the professional institution.

European approaches/dimensions to higher education – development of new, value increasing professionalism, valuable/continuously developing qualifications, substantially enhancing intended smart, sustainable and inclusive growth in Europe [19].

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