

ENGINEERING EDUCATION – NEW APPROACH AND NEW STYLE

**Guna Civcisa, Jolanta Janauska, Iveta Mezinska, Janis Mazais, Janis Mikelsons,
Janis Rudnevs, Narimants Salenieks**

Institute for Quality Engineering, Riga Technical University

guna.civcisa@rtu.lv, jolanta.janauska@rtu.lv, iveta.mezinska@rtu.lv, janis.mazais@rtu.lv,
janis.mikelsons@rtu.lv, janis.rudnevs@rtu.lv, narimants.salenieks@rtu.lv

Abstract. Initial intentions of the European higher education change were caused by expectations of globalization and technology challenges, however global financial and economic crisis stimulates European higher education to facilitate sustainable economical recovery/development and development of innovative – flexible, dynamic national education systems, based on integration of studying/learning/practising and research. Environment of higher education in Latvia should promote and facilitate creative and innovative skills, entrepreneurial and entrepreneurship development, involvement of students and professors in production/industry practising, especially in micro-, craft and artisan, small and medium sized enterprises. Involvement of industries' professionals and entrepreneurs in education, assessment and improvement processes shall be stimulated. Research, practising, design and innovation, “start-up” and “spin-off” initiatives, cooperation of business incubators and professional societies and associations should be launched as well.

Keywords: entrepreneurship, higher education, innovation, learning outcomes, qualification description.

Introduction

Significant contributions in European higher education and dedication of efforts for improvement of inhabitants' talents and capabilities, research and innovation in order to establish the Europe of Knowledge shall be done by the year 2020 [1].

Higher education, research, entrepreneurship cooperation and partnership improvement intentions are centred towards universities – the heart of Europe's knowledge triangle for harmonized improvement of essential, value added, useful education, advanced research and path-breaking innovation [2].

Higher education environment shall promote and facilitate creation of innovation abilities, entrepreneurial skills and useful research competence. For after-crisis recovery in the European national higher education systems should be developed facilitation/promotion, further development of workforce qualification, continuous/effective improvement of a value-adding knowledge, skills and competence [3, 4].

Higher education at all levels has to be grounded in useful/efficient research and innovation, thus promoting creativity and innovation in society. Intensions of the higher education programmes which are based on promotion of creativity and innovation, facilitate growth of persons with research competences and are highly valuable. In doctoral programmes high quality disciplinary research work shall be carried out. Those increasingly are to be supplemented with inter-disciplinary and intersectorial, trans-disciplinary doctoral study programmes. Regulations of governmental and administrative institutions on doctoral programmes and qualifications shall be prevented [5, 6].

New approach – Vision Statement

New approach to higher education – new skills for new jobs is confirming the EU needs for highly qualified graduates with entrepreneurial skills, because competitiveness of economies increasingly depends on the availability of a qualified workforce with entrepreneurial skills [7-10].

Harmonization of qualifications, obtained in higher education institutions and necessary for entrepreneurship, shall be promoted, substantial and detailed changes of the study programmes and study process shall be implemented:

- transversal/transferable knowledge and skills shall be developed, including deep understanding of developed market and technologies; “T-shaped” programmes shall be elaborated, which should be profoundly grounded in sector/field study topics and related to other study subjects;
- examination/evaluation methods, exhaustively valuating studying/learning/practising results and qualification shall be elaborated;

- diversified programme topics and studying/learning/practising opportunities shall be provided;
- trans/interdisciplinarity shall be included/incorporated in higher education and research content.

Higher education quality characteristics – valuable, appropriate study/learning/practising programmes, productive learning process, actions, activities and supporting processes; effective management system – governance, management, leadership.

New Strategy

Higher education strategy – entity of objectives/intentions of society needs/necessities satisfaction:

- readiness of the students/graduates for active life in democratic society;
- target oriented studies for successful career and personal growth;
- important, broad and deep knowledge base, useful/appropriate body of skills/competence;
- research and innovation ability.

Higher education reform – higher education programmes and higher education institutions' improvement for implementation of the “new approach”:

- transition from teaching to learning;
- study programmes, actions and processes grounded on learning outcomes;
- lifelong learning development and expansion, providing sustainable learning opportunities, time and cost effective, close to place of work and residence.

Lifelong learning includes obtainable classification:

- excellent knowledge, valuable skills and useful competence;
- professional qualification, which is necessary for further professional activities/workload and ensures person's ability to take a challenge of changing a labour market.

Lifelong learning – studies, training and practising (including voluntary work) promotes effective qualification obtained by following a flexible learning path, including part time studies and work based routes. Lifelong learning policy includes learning outcomes – knowledge, skills and competence evaluation principles/procedures/activities, gained in formal, non-formal and informal education processes. Learning path – academic, professional studies; teaching studies – professors' lectures, students' examinations, ranging and classification (professor-centred learning); lifelong learning – studies, learning and practicing for obtaining intended qualification (student-centred learning).

New Qualifications

Qualifications Framework for the European Higher Education Area (EHEA-QF) is developed within the Bologna process, adopted in May, 2005 in Bergen.

The European Council (EC-Council of Europe) and the European Commission (EC-European Commission) took care of European Qualifications Framework for Lifelong Learning (EQF-LLL) development, which started in 2004. After the EC launched Europe-wide consultation process – EQF was published in 2005 and adopted by the European Parliament and Council in April, 2008.

EHEA-QF and EQF-LLL are overarching qualifications frameworks; national qualifications frameworks are referenced in both documents.

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

EHEA Framework facilitates mobility, promotes study opportunities, results and mutual recognition in different national higher education systems. In EHEA S&G document (Standards and Guidelines for Quality Assurance in the European Higher Education Area) essential process “quality assurance” is shrewdly substituted by “assessment”, carried out by governing institutions. National assessment agencies and EQA Register are acting only for interests in higher education system.

EQF-LLL is established for promotion of lifelong learning and balanced mobility (including virtual mobility), it includes all professional education levels – primary and higher education, eight cycles, following consecutively each other. EQF embraces formal, non-formal, in-formal ways of education/learning/practising; EQF is not developed for one, isolated learning way.

EQF is based on New Approach, carefully elaborated in higher education/ lifelong learning policy – studies/programmes are grounded in learning outcomes, professional skills/competence according to qualifications descriptions. EQF qualifications certificates/conformity attestations are issued by authorized professional institutions, covering all eight EQF qualification levels.

Qualifications – level of professionalism and education, to be confirmed by competent authority, evaluating the person's performance in particular professional area. Qualifications descriptors establish a level, to which qualification – knowledge, skills and competence, appropriate for needs of labour market - is measured/compared.

Qualifications descriptions

In EQF successfully and systematically the qualifications descriptions components are explained – knowledge, skills, competence, learning outcomes, workload; in EHEA framework the term “competences” is uncertain and vague.

The importance of qualifications frameworks shared approach and activities for reducing differences should be noted, which promotes generic national qualifications frameworks elaboration according to EHEA and EQF frameworks.

EQF Qualification descriptions are arranged at eight consecutive levels according to the importance level of the learning outcomes – knowledge, skills and competence.

Knowledge – theoretical, applied proficiency, acquired comprehension, principles and methods in study, professional area.

Skills – application of knowledge, which includes logical, intuitive and creative processes and practical use.

Competence – knowledge, skills and application of personal ability in studies, work and professional growth.

Transparency of qualifications

- to allow individually assess/compare valuability of qualifications;
- to establish prerequisites and obstacles for qualification transfer and; accumulation in lifelong learning there is a possibility to build up, obtain and diversify qualifications, necessary for different labour markets;
- to increase entrepreneurs possibilities to assess qualifications profiles, contents, importance;
- to allow compare education/teaching programmes' profiles and contents, which is important for actual quality assurance in education/ learning.

EQF embraces general and vocational education, professional education and training, higher professional education. Descriptors of qualifications for engineering/entrepreneurial education and Total Quality Management, and related job titles are shown in the table.

Table

EQF. Qualifications descriptors & Job titles for Quality Professionals

EES – Engineering Entrepreneurial education / qualification	TQM – Total Quality Management education / qualification	B2B – industry (production, logistics) B2C – entrepreneurship (small, micro, craft) Com – common titles (entrepreneurial/education/research)
EQF 5 EES. Extended theoretical, specialized technical knowledge, deployed skills for implementation of suitable solutions and actions in the area of professional activity, abilities of professional management, supervision, improvement and assessment of results of the processes and activities.	EQF 5 TQM. Basic knowledge in quality, productivity and reliability assurance and assessment. Applied skills in process measurement/gauge accuracy maintenance. Ability to apply in practice conformity assessment and professional activity improvement procedures.	B2B: quality inspector, resource inspector, production inspector, health/safety inspector B2C: foreman, manager, supervisor, craftsman Com: educator, instructor, trainer, coach
EQF 6 EES. Expanded knowledge in the area of professional activity, evaluative comprehension of the subject matter, increased level of proficiency and innovative skills in addressing complex problems, initiative in new projects planning, developing solutions, assessments and decision making, group work and cooperation abilities.	EQF 6 TQM. Extended knowledge in product, process quality assurance, assessment and monitoring. Increased proficiency in engineering and technology improvement and innovation. Broadly developed abilities to incorporate in development of complex projects and to undertake responsibilities of a team leader.	B2B: quality technician, quality analyst, calibration technician, measurement technician/manager B2C: designer, manufacturer, entrepreneur, craftsman Com: assistant, lecturer, instructor, inspector, assessor, auditor
EQF 7 EES. Comprehensive, profoundly developing professional knowledge, creativity and innovation skills, comprehension of inter(trans)disciplinary relationships and interconnections, appropriate skills of addressing the professional challenges in research / innovation and integration in particular fields, leadership and group work management abilities to lead development of projects.	EQF 7 TQM. Deep, profound knowledge in product / process design, operations and organizational management. Comprehensive competences to apply the developed applicable innovative skills for increased effectiveness and productivity, improved reliability and sustainability of products / processes.	B2B: quality engineer, measurement engineer, design engineer, production engineer/manager B2C: quality engineer/manager, product/process engineer/manager, safety/sustainability engineer/manager Com: assist./assoc. professor/researcher, educator, consultant, adviser, assessor/evaluator, auditor, lead auditor
EQF 8 EES. Outstanding developing knowledge in specific professional area, large-scale knowledge in comprehensive professional and inter(trans)disciplinary thematic.	EQF 8 TQM. Excellent knowledge at the most advanced frontier of the professional field of study and at the interface between fields – inter(trans)disciplinarity.	B2B: reliability/safety engineer/manager B2C: project consultant, assessor/evaluator, adviser
The most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems and find solutions in research and/or innovation and to extend and redefine existing knowledge or professional practices. Distinguished leadership, integrated professional and innovative competences, constancy of purpose and challenge of an educator, enthusiasm and continual implementation of new, value-adding conceptions and more productive actions in significant areas of professional activity / studies and research.		Com: professor, researcher, lead researcher, lead assessor, senior adviser
EQF: 5 – short cycle/level, 6 – Bachelor cycle/level, 7 – Master cycle/level, 8 – Doctoral cycle/level qualifications: learning outcomes/workload		

New Style – Mission Statement

The global financial and economical crisis stimulates European higher education institutions to participate in facilitation of sustainable economical recovery/development, innovative – flexible, dynamic national education systems development, based on integration of studying/learning/practising and research [11].

The *New Style* in education – *from teaching to learning* in higher education improvement justification, determines mature *transition* from *professor-centred learning* to *student-centred learning*. Student-centred learning and balanced mobility will promote students' efforts for obtaining the necessary knowledge.

For implementation of student-centred learning the *governments are required*:

- to provide opportunity for increasing a number of *individual learners*;
- to promote development of “new approach” in teaching/learning;
- to elaborate effective *support* mechanisms, references, explanations;
- to facilitate creation of programmes, which are more realizable/appropriate *for students in all three study cycles*.

Curriculum reform is improvement process, which embraces high quality, flexible and individually directed education path development. Professors in close cooperation with professionals, students and entrepreneurs shall develop learning outcomes and balanced exchange of international experiences in fast developing areas. Especial attention shall be paid to enhancement of the teaching quality and learning opportunities improvement at all levels of the study programmes.

Learning outcomes

New Approach message ... *knowledge, skills, competence, which student could obtain in study/qualification cycle* – study programme, which in total is attainable by studying separate thematic modules, courses.

Learning outcomes mostly are related to *achievements of student*, in lesser extent to *professor's intentions*, described in modules/course description. *Learning outcomes* are written in narrow or wide conception – *knowledge, understanding, skills, competences, attitude*, attainable in successful engagement in set of higher education experiences.

Studying/learning/practising results embrace and exemplify individual:

- particular methodological approach;
- curriculum;
- modules;
- units/courses;
- qualifications;

and study cycles levels /qualifications descriptors expression and description according to Bologna qualifications frameworks.

In European countries national education/learning/training system objectives and qualification descriptions are based on *learning outcomes*. Important transition takes place *from input* – duration, location, pedagogical content and qualification approach *to output* – knowledge, skills, competence, obtained in a particular learning cycle.

Transition *from teaching* (“old approach”) *to learning* (“new approach”) goes on. Justification for transition to learning outcomes includes:

- qualifications framework/ content clear/detailed layout;
- student's understanding/awareness;
- created possibilities for individual learning;
- focus on identification of labour market needs;
- promotion of education recognition;
- eliminating differences in higher and vocational education, facilitating their merge;
- curriculum reform
- etc.

Conclusions

1. Bologna reform results in better qualifications, grounded in learning outcomes, but not in establishments of new educational structures. For execution of the bottom-up reforms fundamental changes at institutional level are needed. It will allow to incorporate institutions/professors efforts to qualifications creation and maintaining motivation, promotion, facilitation.
2. Transition from traditional input/content to output/outcomes approach in qualification conceivment, validation, monitoring, expression is a hard, complicated and slow process.
3. Lifelong learning embraces obtainable qualification - knowledge, skills, competence and workload, that are needed for further professional activities and ensuring the person's ability to take a challenge of the changing labour market.
4. Lifelong learning - studies, training and practising (including voluntary work) promotes obtaining effective qualification in flexible learning path, including part time studies and work-based routes.
5. Lifelong learning policy includes learning outcomes – knowledge, skills and competence levels, their evaluation principles/procedures/processes, which are acquired in formal, non-formal and in-formal learning processes.
6. Curriculum reform is improvement process, embracing high quality, flexible and more individually directed education path. Professors in close collaboration with professionals, students, government and entrepreneurs shall further develop learning outcomes approach and balanced international exchange in fast developing thematic areas. Especial attention shall be devoted to the teaching quality and learning possibilities improvement in study programmes at all levels.

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