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Engineering Educators Pedagogical Training (ENTER)

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Engineering Educators' Pedagogical Training in Europe, Russia and Kazakhstan: background, best practices, challenges and opportunities

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ABSTRACT.

The present e-book considers political, economic, social and other prerequisites for the present state of engineering pedagogy. It gives analysis of the state of art of engineering pedagogy in three European countries - Portugal, Slovakia, Estonia and in two Partner countries - Kazakhstan and Russia. The analysis is based on the results of the survey held among ENTER consortium universities (ENTER Case Analysis Survey). The e-book defines stakeholders of the engineering educators' pedagogical training, provides typology and overview of engineering pedagogy best practices applied in consortium universities representing the leading universities of Portugal, Slovakia, Estonia, Kazakhstan & Russia. The e-book also analyzes the expected learning outcomes of the engineering educators' pedagogical training, and considers diverse learning tools, methods, environments and learning assessment technologies currently applied. Also in this e-book the prospects and opportunities of the Multi-Level Modular Curricula "Innovative Pedagogy for Engineering HEIs' Teachers" (iPET) are analyzed in the context of innovating the engineering pedagogical training.

INTRODUCTION.

The Erasmus+ project "Engineering educators pedagogical training" (ENTER) focuses on creating a novel multicultural and international approach for formal post-graduate professional pedagogical education of engineering educators and will result in development of multi-level modular system of engineering educators' pedagogical training based on international network cooperation (iPET programme).

Prior to developing the iPET programme it is necessary to carry out in depth research into the state of art of engineering pedagogy in consortium countries and in the target universities in particular in order to better understand requirements for iPET programme development. For this purpose the Case Analysis Survey has been held among the ENTER consortium universities as follows:

European Union:

- Instituto Politecnico do Porto, Porto, Portugal (IPP);
- DTI University, Dubnica nad Vahom, Slovakia (DTI);
- Tallinn University of Technology, Tallinn, Estonia (TalTech);

Kazakhstan:

- Al-Farabi Kazakh National University, Almaty (KazNU);
- Academician E. A. Buketov Karaganda State University, Karaganda (KSU);

Russia:

- National Research Tomsk Polytechnic University, Tomsk (TPU);
- Kazan National Research Technological University, Kazan (KNRTU);
- Tambov State Technical University, Tambov (TSTU);
- Don State Technical University, Rostov-on-Don (DSTU);
- Vyatka State University, Vyatka (VyatSU).

The present e-book is based on the results of the ENTER Case Analysis Survey and aims at:

- understanding the attributes, properties and requirements of the modern engineering pedagogy as well as factors and regulatory basis underlying it and steering its development;
- analyzing the state of art of engineering pedagogy in three European countries - Portugal, Slovakia, Estonia and in two Partner countries – Kazakhstan and Russia, i.e. pinpointing the best practices of engineering educators' pedagogical training implemented in the leading universities represented in the ENTER consortium;
- defining the role of iPET programme in the context of innovating the engineering pedagogical training in Europe, Kazakhstan and Russia.

1. BACKGRAOUND OF THE PRESENT STATE OF ENGINEERING PEDAGOGY: POLITICAL, ECONOMIC, SOCIAL AND OTHER PREREQUISITES.

The strength and economic power of society primarily depends on the level of its scientific and technological development. The modern 4th industrial revolution is essentially a technological one and has crucial impact on engineering profession. The amount of new knowledge is growing exponentially, the time for the transformation of knowledge into innovations is reduced. Production is robotized, individualized, decentralized and transferred to final consumers. In the context of globalization, network technologies are developing, a network society is being formed. A person learns to measure and model the real world, physical, biological, social and business processes occurring in it. There is a formation of a digital economy. It is characterized by the convergence of physical and biological technologies with digital technologies, as well as technical, economic and social cultures. The boundaries between them are blurred, due to their interpenetration synergy effects are achieved.

Revolutionary development of technologies in a priority order dictates the need to update higher engineering education**.** High-quality engineering education is the most important attribute and the main criterion of the technological development of society. New realities of social life in the digital economy conditions set new tasks for the higher education system in preparing modern engineers. For successful work in the conditions of changes, uncertainty, complexity and ambiguity (VUCA - Volatility, Uncertainty, Complexity, Ambiguity), a modern engineer needs fundamental knowledge; interdisciplinary, critical and systemic thinking; imagination and creative initiative; ability to solve unstructured problems; communication and collaboration skills, professional mobility and the ability to quickly adapt to new conditions.

For the teacher of engineering disciplines these new realities also require development of modern competences and skills, such as: adaptive abilities, abilities for critical analysis and creative thinking, ethical competence, cross-cultural communication skills, psychological sustainability under the stress factors of modern environment, marketing and management skills (including e-formats), social networking, ICT literacy, fund raising and financial accounting, linguistics, ability to writing world class reports, articles, teaching materials and guides. Professional and pedagogical activity of a teacher is a system in which information from different science fields is actively used. A teacher's activity is characterized by sufficiently high dynamics. Especially in recent years, it has undergone significant changes associated with the reforms ongoing in the field of education. Creating an educational

environment for the training of teachers of engineering disciplines is associated with the development of new breakthrough directions in engineering and technology and not least with the development of new teaching and learning technologies, e.g.: TRIZ-methodology, mind-mapping, brainstorming, case study, business games, blended-learning (integrated off-line and on-line facility using advanced networking system) and different sorts of trainings.

European Union. In the European Union the improvement of the engineering education and teaching is supported by many international, national and local initiatives, strategies and organizations. Among most acknowledged ones are CDIO Initiative (1), European network for Accreditation of Engineering Education (ENAEE) (2), International Society for Engineering Pedagogy (IGIP) (3).

The CDIO™ INITIATIVE is an innovative educational framework for producing the next generation of engineers. The framework provides students with an education stressing engineering fundamentals set in the context of Conceiving — Designing — Implementing — Operating (CDIO) real-world systems and products. Throughout the world, CDIO Initiative collaborators have adopted CDIO as the framework of their curricular planning and outcome-based assessment.

The European network for Accreditation of Engineering Education (ENAEE) – is a framework and accreditation system that provides a set of standards that identifies high-quality engineering degree programmes in Europe and abroad. The EUR-ACE label is a certificate awarded by an authorised agency to a Higher Education Institution in respect of each engineering degree programme which it has accredited. To ensure that engineering education programmes produce graduates who can demonstrate satisfactory achievement of specific competencies for safe and ethical performance of their work, the programmes are subject to accreditation by their professional body or another accreditation agency which carries out programme-based accreditation.

The International Society for Engineering Pedagogy (IGIP) is providing a link between engineering and pedagogy on a scientific level. IGIP aims at improving teaching methods in technical subjects; developing practice-oriented curricula that correspond to the needs of students and employers; encouraging the use of media in technical teaching; integrating languages and the humanities in engineering education; fostering management training for engineers; promoting environmental awareness; supporting the development of engineering education in developing countries.

In **Portugal** the National Agency for Assessment and Accreditation of Higher Education (A3ES) (4) focuses on fulfillment of quality assurance mechanisms but pedagogical educators' training is not involved yet. "Ordem dos Engenheiros", representative of the ENAEE in Portugal, defines quality requirements for pedagogical approaches. Among Higher Education Institutions of Portugal, Instituto Politecnico do Porto (IPP) is the one which has formally adopted the CDIO Initiative for engineering SPs. CDIO states that learning/practice of personal, interpersonal and professional skills, and product, process and system building skills should not be considered an addition to an already full curriculum, but an integral part of it. To reach the intended learning outcomes in disciplinary knowledge and skills, the curriculum and learning experiences must make dual use of available time.

In **Slovakia** the Programme Declaration of the Government of the Slovak Republic 2016-2020 (5) and Act no. 131/2002 Coll. on Higher Education (6) support higher education (HE) in general and engineering education as its integral part. HE must be at the core of

Slovakia's research potential, be driving force behind the development of Slovakia's society and regions, strengthen development of knowledge society, be linked to the needs of society.

In **Estonia** economic goals are laid down in the competitiveness strategy "Estonia 2020" (7, 8); education system principles are laid in the Republic of Estonia Education Act (9) and lower level acts regulating activity of universities, R&D, Higher Vocational institutions, private schools etc. Moreover continuing education is regulated by the Adult Education Act (10). The Estonian Lifelong Learning Strategy 2020 (11) specifies most important objectives in continuous education. In order to develop and value technology and engineering education Research and Technology Pact (12) has been launched in Estonia.

Kazakhstan and Russia. The Bologna process and the European Higher Education Area (EHEA) encouraged necessary reforms to improve engineering education in **Kazakhstan (KZ) and Russia (RU)**. Attractiveness of engineering education for young people in these countries has increased but there are still many common challenges for Kazakhstan and Russia. According to ICEF [13] the drop-out rate among students of engineering majors in KZ and RU is high (20-30 % in average), employment rates for bachelor graduates declines because industry enterprises are not keen to employ engineers with 4 years of training, teaching staff is becoming older (average age – 50 – 55 years) and universities fail to create an effective system to retrain young MS and PhD graduates in engineering disciplines to perform teaching and research.

Most of the above mentioned challenges are linked to the deterioration of teacher training system in universities of Kazakhstan and Russia and irrelevance of teaching methods used for engineering disciplines teaching. The answer to this problem is two-fold – modernization of pedagogic training of MS and PhD students and development of sustainable system of lifelong education for university teachers of engineering disciplines.

According to the ENTER Case Analysis Survey data the following common aspects influencing the state of engineering educators' pedagogical training in **Kazakhstan and Russia** may be highlighted:

- low scientific and methodological level of educational process at some universities;
- globalization of knowledge based on the Internet. Formation of a global market of educational services;
- development of e-learning tools for distance learning and mixed technologies;
- narrow specialization of engineering universities' graduates;
- growth of the high technology component of production processes, robotization and digitalization of processes and equipment;
- non-formal education recognition , that complements formal institutional education;
- sectoral orientation of the universities related to sectoral structure of the productive sector of the industrial society.

The need to improve pedagogical training of engineering educators in order to prepare highly qualified engineering personnel is consistent with national priorities of the modernization of education both in Kazakhstan and Russia and can be traced in the following regulatory documents of these countries.

Kazakhstan. The "State Program of Education Development of the Republic of Kazakhstan for 2011–2020" (14) aims to increase the competitiveness of education, develop human capital by ensuring the availability of quality education for sustainable economic growth. One of the key indicators is:

• an increase in the share of highly qualified teachers with the highest and first categories of the total number of teachers by 2015 - 49%, by 2020 - 54%.

In “Kazakhstan-2050 Strategy” (15) one of the priorities is:

• knowledge and professional skills - the key benchmarks of the modern system of education, training and retraining of personnel.

The goal of the State Program of Industrial and Innovation Development of the Republic of Kazakhstan (16) is:

• to encourage diversification and increase the competitiveness of the manufacturing industry.

Russia. The key points outlined in the regulatory documents of the Russian Federation, such as “Executive Order on the 2017-2030 Strategy for the Development of an Information Society in the Russian Federation" (17) and the priority project “Modern Digital Educational Environment in the Russian Federation 2016-2021” (under the auspices of the Russian ‘Education Development’ programme for 2013–2020) (18, 19) are as follows:

• the access to global market for extracurricular and advanced educational services;

• the emergence of open educational resources for personal and professional development;

• the transfer from short-term local MOOCs to providing full length educational programs for Bachelors, Masters and even PhDs in a form of MOOCs;

• the formation of a global university of professional and personal development paths.

2. WHAT WE HAVE: ENGINEERING EDUCATORS’ PEDAGOGICAL TRAINING OVERVIEW. STAKEHOLDERS AND BEST PARCTICES.

2.1 STAKEHOLDERS.

In ENTER Case Analysis Survey the project partners have identified the following stakeholders interested in enhancement of quality of engineering pedagogical training:

• The State, Governmental educational agencies - mega customers of educational services. Interested in formation and renewing of human capital for ensuring long-term progressive development of production industry.

• Industrial sector - university graduates’ employers. Interested in improving the professional level of employees thus supporting pedagogical upskilling of engineering educators, promoting work-based learning, providing sponsorship, patronage, internships, mentoring and work placements to HEI and its engineering graduates.

• Higher education institutions - technical and/or engineering universities. Interested to ensure provision of high level engineering education which strongly depends on pedagogical competence of teachers of engineering disciplines.

• Educators themselves - teachers of general and specific engineering disciplines stratified by teaching experience, industrial (practical) experience, age, etc.). Interested to upgrade pedagogical competencies to meet the latest achievement in the subject and to be able to implement new teaching technologies.

• Students majoring in engineering. Interested in teachers’ upskilling to ensure receiving of up-to-date education which offers all available teaching technologies and educational paths.

• Engineering graduates, Master and PhD students. Interested to undertake career of a teacher at higher or vocational education institutions and looking at improving their employability.

• University administration – units responsible for monitoring and upgrading pedagogical skills of teaching staff. Interested to diversify and improve engineering teachers' advanced training in order to raise competitiveness of university teaching staff.

• Vocational post-secondary education institutions – colleges teaching technology specialties. Interested to employ teachers of engineering disciplines who have passed special pedagogical training as well as delegate trainees.

• Engineering education research institutions. Interested to keep the on-going research in order to be able to offer innovative training to engineering educators.

• Public organizations - Association for Engineering education of Russia, International Society for Engineering Pedagogy (IGIP), etc. Interested in enhancement of engineering education for wider audience.

2.2 SPECIFICATION OF THE ENGINEERING EDUCATORS' PEDAGOGICAL TRAINING.

The overview of existing types of engineering pedagogical training of ENTER consortium universities from Portugal, Slovakia, Estonia, Kazakhstan and Russia is aimed at summarising and mainstreaming the best practices, setting the trends for further development of engineering pedagogy. The classification and representation of the types of engineering pedagogical training identified during the ENTER Case Analysis Survey is given respectively at Figure 1 and 2 below:

TYPES OF ENGINEERING PEDAGOGICAL TRAINING IN ENTER CONSORTIUM HEIs

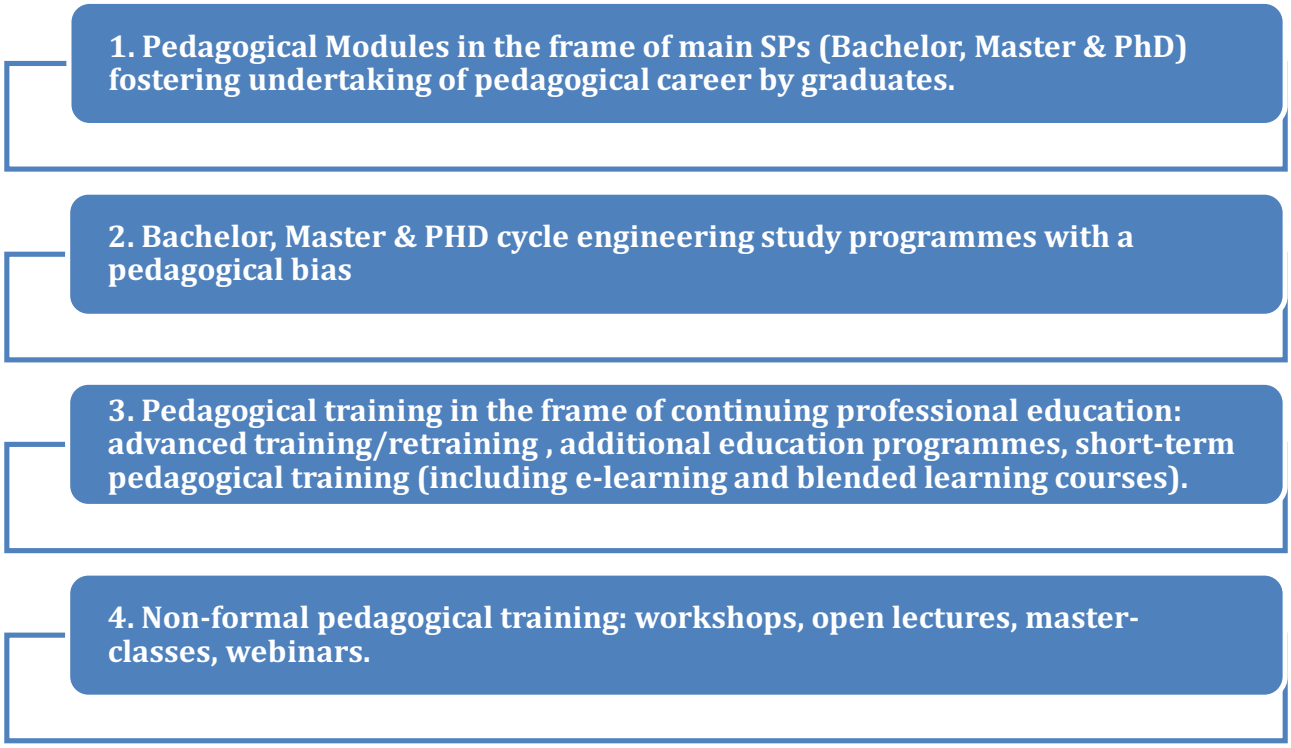

Figure 1.

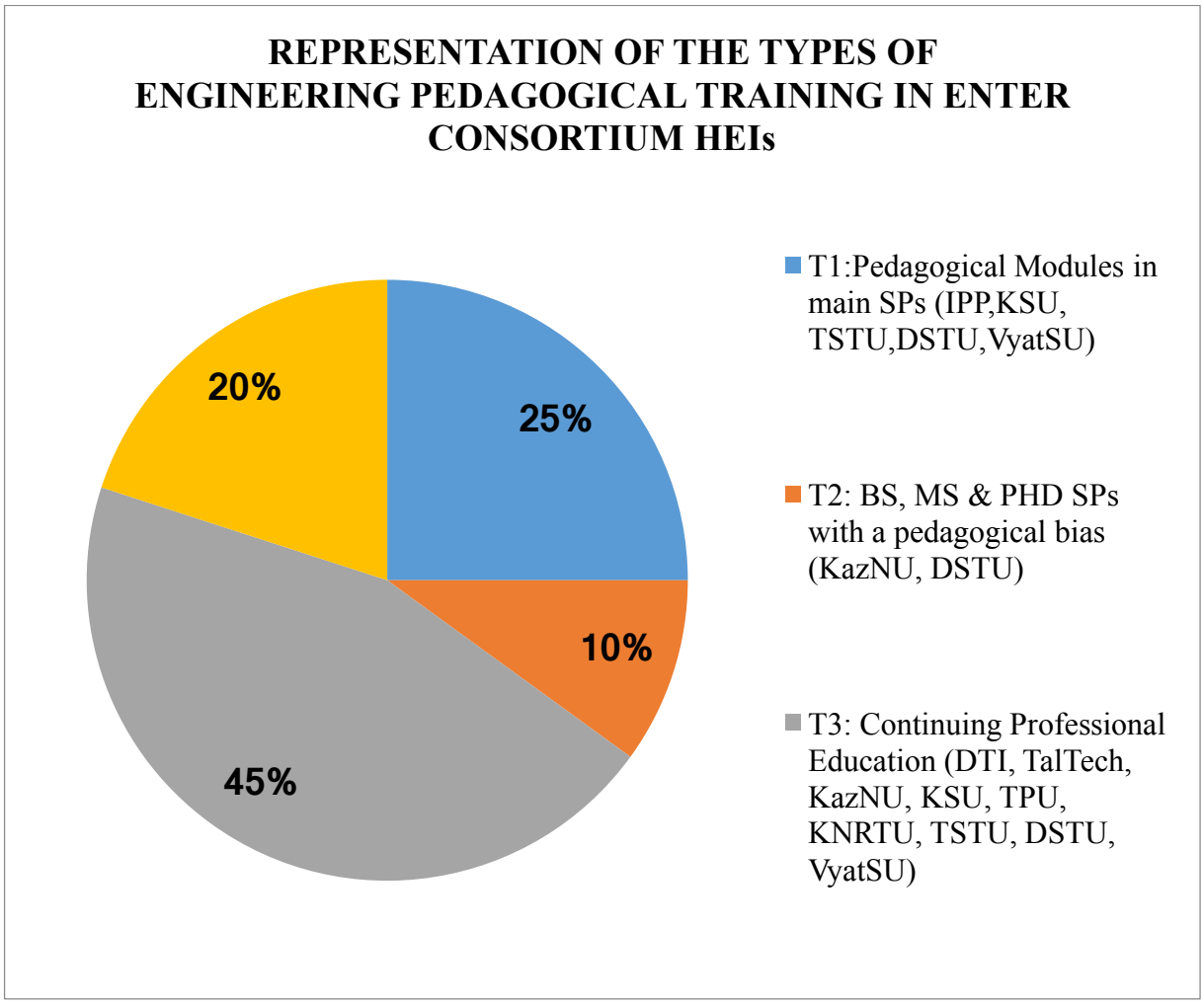

Figure 2.

2.2.1 ENGINEERING EDUCATORS' PEDAGOGICAL TRAINING IN EUROPE.

As noted by Katarina As˘kerc, from Center for Mobility and European Educational and Training Programmes (CMEPIUS) of the Republic of Slovenia and Sebastian Koc˘ar from the Faculty of Social Sciences, University of Ljubljana & Social Science Data Archives in their article (20), university teachers perform two basic activities, i.e. research and teaching. Although both activities play a central role in higher education (HE), in most European countries teachers are not required to obtain a certificate of teaching competencies. However, the quality of university teaching has come under focus in recent years, and the need to improve teaching skills and pedagogical thinking is now acknowledged to be essential (21) (Postareff, Lindblom-Yla¨nne and Nevgi 2007, 29). The importance of the pedagogical component in the professional development of university teaching staff is highlighted by different authors (22 - 30) (von Humboldt 1970, Fielden 1998, Cross 2001, Lueddeke 2003, D'Andrea and Gosling 2005, Marentic˘Poz˘arnik and S˘teh 2006, Grac¸a 2008, Rosado Pinto 2008, Marentic˘ Poz˘arnik 2009 etc.). Some of them refer to the modern phenomenon of mass higher education and, as a consequence, to the need for (additional) systematic pedagogical training of university teachers (Lueddeke 2003, Rosado Pinto 2008, Marentic˘ Poz˘arnik 2009). In Cross' (2001) opinion, the university favours the production of knowledge at the

expense of teaching which inevitably negatively affects progress and development in teaching. The absence of the pedagogical development of university teachers often results in maintenance of the old methods of teaching, which often focus on the teacher instead of the needs of students and on the subject matter instead of the transformation of knowledge (31) (Pleschova´ et al. 2012). As a result of the increased focus on quality and responsibility in HE, the larger and more diverse population of students, international competition and 'doing more with less', the 'professionalisation' of teaching practice in HE is becoming more important. The EU high-level group on the modernisation of HE recommends, among other things, mandatory certified training for professors and other teaching staff (32) (European Commission 2013).

Among European universities of ENTER consortium the following types of engineering pedagogy may be outlined.

Instituto Politecnico do Porto. In IPP engineering educators' training is not much organized and is done mostly in terms of attending the regular BSC/MSC in engineering or other science subjects *(type of training 1 according to Fig.1)*. New candidate educators have to contact senior teachers and understand how to go from theory to engineering education *(type of training 4 according to Fig.1)*. IPP has adopted the CDIO Initiative as the best framework for managing staff, but only few programmes have adopted it in a consistent way. Although, none of them has relevant work in standard 9 - Enhancement of Faculty Competence. As an example of deeper application of CDIO practices in IPP, the Software Engineering learning process of the Informatics Engineering 1st cycle is presented at Figure 3. Courses outlined in red are courses of the learning process, while the three courses filled in red are the core ones.

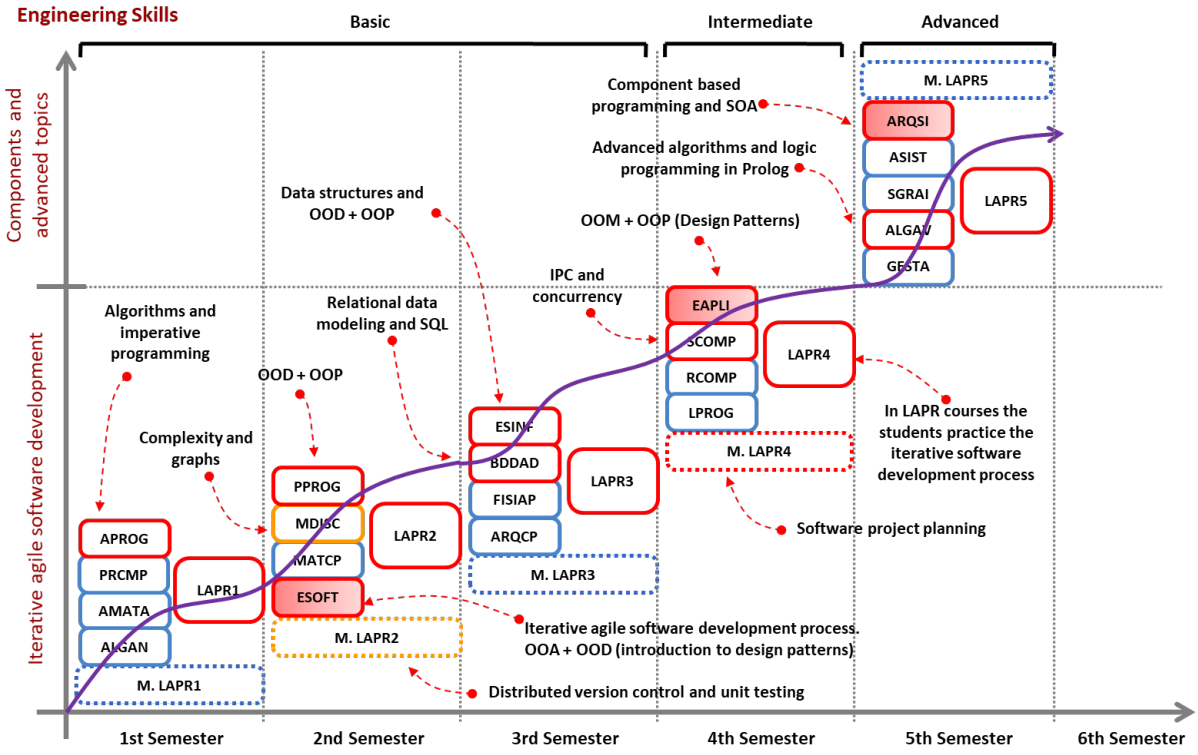

Figure 3

DTI University. DTI teachers can take Complementary Pedagogical Studies (*type of training 3 according to Fig.1).* By completing these studies graduates in non-teacher training study programs acquire pedagogical competence to teach specialised technical subjects, the content of which is linked to the subject of their studies. These complementary Pedagogical Studies are compiled according to the rules of IGIP. Participants and graduates from the course gain knowledge and experience from the following disciplines e.g.: Engineering Pedagogy, Selected Chapters from Psychology, Engineering-Pedagogical Practice, Communication and Discourse Training, Technology of Education, Didactics of Laboratory Exercises, Biological Foundations of Development, Selected Chapters from Sociology, Comprehensive Text Development, University Management, Rhetoric and Communication Training.

Tallinn University of Technology. In TalTech engineering educators were prepared according to the Master's degree programme during 2006-2012 (*type of training 2 according to Fig.1).* But since 2012 engineering educators training is coordinated by Estonian Centre of Engineering Pedagogy at TalTech. Training is organized in the form of Continuing professional development (CPD) programme (25 ECTS credits/approx. 90 academic hours) according to the IGIP requirements to curriculum design and TalTech Flexible Model of Teacher Education principles. Individual studies throughout 3 semesters *(type of training 3 according to Fig.1).*

2.2.2 ENGINEERING EDUCATORS' PEDAGOGICAL TRAINING IN KAZAKHSTAN.

In the Republic of Kazakhstan the engineering pedagogical personnel training was transformed into vocational pedagogical education in 2001, instead of qualification "engineer-teacher" graduates started to be awarded the qualification "teacher of vocational training". In 2013, the professional standard of technical and vocational education in the specialty "Vocational training (by industry)" was adopted. In the system of higher education the training of vocational teachers is carried out at all levels of higher and postgraduate education. Such Bachelor, Master and PhD programs are oriented towards the training of engineering educators who are capable of educational activities both in vocational educational institutions and in manufacturing. At the same time, the objectives and content of the training are determined by the profile of the industrial potential of the relevant region. In addition, an engineering educator must be an expert in the sector of the national economy for which the training is provided, know the specifics of the technology of the industry and a separate specialty in it, have practical professional skills and be prepared to conduct both theoretical and practical training. Thus, the system of engineering and pedagogical education integrates the pedagogical and pro-professional components.

Nowadays the education system of Kazakhstan is under the transformation and the training system is created in the way that can provide a person with not only knowledge, but also the ability to use this knowledge and continuously learn, that is, to realize the transition "from education for life" to "Lifelong education". To meet this requirement, models of the system of continuing professional education for engineering and pedagogical personnel are being developed on the basis of the competence-based approach, involving representatives from employers and other social partners in order to provide HEIs and vocational schools

with competent specialists who are able to train human resources in accordance with the needs of the labor market and the requirements of the intensifying industrial-innovative development of the country. Staff development and retraining is carried out at Kazakhstan universities with the aim of deepening previously acquired or acquiring new professional knowledge and skills in connection with the requirements of scientific and technological progress, economic development, structural changes in production and the social sphere, as well as meeting the individual needs of citizens in improving their professional training.

Among Kazakhstan universities of ENTER consortium the following types of engineering pedagogy may be outlined.

Al-Farabi Kazakh National University. KazNU currently trains engineering students in the following areas**:** Bachelor and Master of Pedagogical Sciences by the specialties: Technical Physics, Thermal Power Engineering, Electric Power Engineering, Standardization and Certification, Material Science and Technology of New Materials Radio Engineering, Electronics and Telecommunications, "Physics, Nanotechnology, Chemical technology" *(type of training 2 according to Fig.1).*

Continuing professional education of the university teachers is provided by the Institute of Development of Qualification and Additional Education *(type of training 3 according to Fig. 1).* Its tasks are as follows: organizational, informational, scientific and methodological support of the process of formation of educational and professional competence of trainees; conducting advanced training and professional retraining of teachers and specialists; consulting, research, design and expert activities; development of the system of additional education.

In 2008 Kazakhstan National Monitoring Committee IGIP (KNMK) was established at Al-Farabi Kazakh National University. The main task of KNMK IGIP is to participate in the formation of national policies in the field of engineering pedagogical education of teachers of technical colleges and harmonizing practical work in this area with the international requirements. The KNMK IGIP Centre for Engineering Pedagogy provides:

• effective development of pedagogical knowledge and pedagogical skill of engineering institutions' faculty staff;

• preservation of the best features and traditions of national schools of professional development of teachers of higher education;

• compliance of the content of preparation and requirements for teachers of engineering institutions of Kazakhstan to the conventional criteria and norms of the world community.

Academician E. A. Buketov Karaganda State University. In KSU the pedagogical component is available in several Bachelor's and Master's degree programmes of engineering field. Thanks to this the graduates are entitled to carry out pedagogical, science & research and innovative activity in the field of the higher and vocational education. They study disciplines enabling them to undertake pedagogical career: "Pedagogics of the higher school", "Psychology of management", "History and philosophy of science", "The concept of engineering education for chemical technology", "Pedagogical practice" *(type of training 1 according to Fig. 1).*

In the frame of continuing professional education *(type of training 3 according to Fig. 1)* Faculty of Additional Education of KSU develops and implements programs in the management of education and modern learning technologies, including professional engineering education. Teachers of educational institutions regularly (at least once every five

years) undergo advanced training at courses of various lengths (from 4 days to 3 months). The advanced training courses for scientific and pedagogical staff of universities rely on modern achievements in fundamental psychological and pedagogical sciences, world and national experience, new educational concepts, systems, technologies, methods and teaching aids. The courses focused on acquaintance and introduction of innovative approaches in training with emphasis on improving the content of the study programmes, fostering high level research activities, implementation of distance learning technologies, development of e-learning materials (multimedia materials, SMART learning materials, case study materials). For example, the learning outcome of the advanced course "Distance courses "Developing e-learning aids" is to clearly formulate the SMART goal of lectures and to be able to elaborate practical exercises, building a "chain" of logical interrelated actions, as a result of which the student reaches the final goal. The process of advanced training is carried out in the form of an one-time training or several cycles of trainings distributed over time. It consists of composite modules, ensuring variability within advanced training.

For teachers who have little teaching experience, the university organizes the "School of lecturing skills" free of charge, various forms of mentoring by more experienced teachers and courses for foreign lecturers and practitioners. In addition, university teachers have the opportunity to undergo advanced training courses *(type of training 3 according to Fig. 1)* on the basis of both Kazakhstan and foreign universities organized by JSC "National center for professional development "Orleu" (for example, under the program "Modern Pedagogical Technologies", advanced training programmess for Kazakhstan university teachers of pedagogical specialties).

In the frame of non-formal education *(type of training 4 according to Fig. 1)* university teachers regularly take part in seminars held at the base of republican organizations, in sessions of different international forums (for example, VII Eurasian Forum of Higher Education Leaders "Modernization of Higher Education in the Era of Breakthrough Technologies" (2018)), in conferences, educational and scientific events of different levels, in scientific and professional internships.

2.2.3 ENGINEERING EDUCATORS' PEDAGOGICAL TRAINING IN RUSSIA.

As has been already said the quality of training of engineers is a priority of the Russian state policy in the field of higher technical education and one of the decisive factors for the successful development of innovative industry and the economy of the country as a whole. Along with a high level of teachers' subject-branch competence, it is assumed that teachers of engineering disciplines are ready to perform educative, pedagogical (upbringing) and methodological functions. Changing the paradigm of the vocational higher education in the course of transition of Russian education to European quality standards requires from teachers serious designing and methodological skills. This includes a new format of goal-setting: planning students' competencies per subject, revision of subjects' content, selection of efficient teaching technologies and quality control tools. These tasks are difficult to solve for many university professors, especially technical ones. One of the reasons is the lack of didactic training of teachers at technical universities.

Moreover the entry of the Russian Federation into the international educational area requires the regulatory recognition of a number of international agreements and protocols, which change the structure and content of engineering education in the country significantly.

This in its turn requires appropriate retraining and advanced training of teaching staff at engineering universities. In this regard, the system of advanced training for engineering educators is being designed in Russia to meet the arising needs of the university administration and the teachers themselves, it should be changed towards the educator's professional development and planned for several years ahead. And the university administration should create conditions for the realization of flexible trajectory of the educator's personal development in the mode of self-organization and network interaction. In this context, there is the need for creating mass open online courses (MOOC) with international participation. The funds invested by universities, regional, federal and international organizations to create systems of professional development of Engineering educators should be assessed as investments in the country's human capital.

Among Russian universities of ENTER consortium the following types of engineering pedagogy may be outlined.

***National Research Tomsk Polytechnic University*.** The basis for the Engineering educators training in TPU is the additional educational program "Problem-based and project-oriented learning at university" (2 ECTS credits/72 teaching hours) in the system of advanced training for teachers and researchers *(type of training 3 according to Fig.1).* It draws upon competence-based approach as applied to teaching of natural sciences, engineering and technology disciplines (STEM – Science, Technology, Engineering, Mathematics) and the pedagogical theory of contextual learning. The theory of contextual learning is largely "consonant" with the CDIO approach, which determines the life cycle of the development and application of technical facilities, processes and systems as the context of basic engineering education (33) (Standard 1 CDIO – The Context). The structure and content of the modules of this basic program are formed by tailoring of soft skills of teachers, common to the development and implementation of educational programs and engineering disciplines in various areas and fields of study.

In the process of program implementation, a combination of on-campus and online technologies is used, open informational and educational resources are involved, best practices in implementing of dual and project-oriented education in the global experience of training of future engineers at universities is used. The program is taught by certified IGIP members. The main topics of the programme are:

- Fundamentals of the theory of problem-based and project-oriented learning.
- Best practices of problem-based and project-oriented training at foreign and domestic universities.
- CDIO Initiative. CDIO model as the context of engineering education.
- Normative and methodological documents, that regulate the organization of students' project work.
- Introduction to project management. Organizational structure of project management.
- Scheduling and organization of project monitoring system.
- Organization and evaluation of students' project activities.
- Network interaction of project participants. Means of communication.
- Optimization of research activities of project participants in the information and communication environment.
- Network Project Portfolio.
- Self-assessment, peer assessment and review of projects.

Kazan National Research Technological University. In KNRTU pedagogical training is carried out mostly through the wide range of continuing professional education courses, from short-term (2 ECTS credits/72 academic hours) to long-term (over 15 ECTS credits/540 academic hours) *(type of training 3 according to Fig. 1).*

1. Advanced Training programs (1-2 ECTS credits/16-72 academic hours), include profile modules of the disciplines, along with the psychological and pedagogical direction modules and the ones in information-communication technologies.

2. Professional Retraining (additional training) programs (7-14 ECTS credits/250-500 academic hours):

- "Engineering pedagogy" (7 ECTS credits/252 academic hours), accredited by the IGIP for obtaining the «European (International) Teacher of an Engineering University» certificate;
- "Higher School Pedagogy" (for post-graduate students, 8 ECTS credits /272 academic hours);
- "Higher School Teacher (in a specific direction)" (8 ECTS credits/278 academic hours) – consisting of the invariant part (psychological and pedagogical disciplines totaling to 5 ECTS credits/164 academic hours), and a variable part – in 5 directions (profiles) totaling to 3 ECTS credits/ 89 academic hours: Computer Technologies in Designing, Modeling, Design; Materials Science, System Analysis and Technologies for Processing of Materials, Precious Stones and Metals; Processes and Devices in Chemical and Petrochemical Industries; Metrology and Patenting; Law and Protection of Intellectual Property.

3. Professional Retraining (additional training) programs (over 14 ECTS credits/500 academic hours):

- "Higher School Pedagogy" (16 ECTS credits/557 academic hours) (for teaching staff). The program entitles teachers to conduct professional activities in a higher education institution.

Enhancement of teaching competence of KNRTU academic staff is also achieved through activities of the “Center for Training and Retraining of the Volga Region and the Urals Universities Teachers” *(type of training 3 & 4 according to Fig. 1).* The Center is cooperating with IGIP and has been co-organizer of the 42nd international IGIP Symposium on engineering education «Global challenges in engineering education», the fourth Symposium on engineering education in Russia. Since 2007 KNRTU has been a basic university for Federal Agency for education in university teaching staff professional development, about 850 teachers from more than 60 cities of the Russian Federation have been trained at the Centre. Since 2009 the Centre has become the representative of the authorized institution of the Federal Agency for education (Russian state pedagogical University after A. I. Herzen) in the Volga Federal region in the following areas of training:

- Psychological and pedagogical training of higher school teachers;
- Problems of pedagogical education;
- Modern educational technologies;

For 24 years the Center has given professional retraining and advanced training to about 6,000 teachers and staff from more than 30 universities and colleges of the Tatarstan region, including more than 950 teachers, 40 post-graduate students and about 150 KNRTU employees, including more than 75 chair heads and professors.

Annually KNRTU holds international scientific schools, network conferences and round tables on the issues of engineering pedagogy development *(type of training 4 according to Fig. 1.)*

Tambov State Technical University. The task of training teachers of engineering disciplines in TSTU is solved through different educational paths. These paths include pedagogical training in the frame of Master's & PhD's programmes, advanced training programs as well as networking in international projects.

In the frame of Master's programs the discipline "Optimization of scientific and pedagogical activity" is taught. The course covers such subjects as: regulatory support of vocational education in the Russian Federation, psychological and physiological bases of scientific and pedagogical activity, the influence of interpersonal relations on the effectiveness of scientific and pedagogical activity, guidelines for preparing for various types of training sessions, etc. *(type of training 1 according to Fig. 1).*

As part of the postgraduate programs, the discipline "Pedagogy and psychology of higher education" is taught. Subjects covered are: general principles of pedagogy and psychology of higher education, educational activity of a higher school teacher, didactics of higher education, etc. *(type of training 1 according to Fig. 1).*

The advanced training program "Engineering pedagogy" is implemented in TSTU covering an extensive list of subjects and based on the experience gained by TSTU thanks to participation in joint network projects with foreign partners (TEMPUS, ERASMUS+, etc.) *(type of training 3 according to Fig. 1.).*

Many teachers of TSTU, together with their European colleagues, have passed training in the advanced School of tutors and subsequently transferred their experience to other teachers. Those who achieved the best results received the prestigious title of the European teacher of engineering disciplines ING-PAED IGIP. *(type of training 4 according to Fig. 1.).*

In the frame of TEMPUS project, a specialized laboratory "Engineering Pedagogy" is set up in the university, equipped with specialized technical training aids and now offering pedagogical training courses. (type of training 4 according to Fig. 1.).

Don State Technical University. DSTU concentrates the full range of engineering specialties. It offers many opportunities for engineering teachers to enhance their pedagogical competence. First place Master's programmes with pedagogical bias are taught in DSTU - "Professional education (by industry). Innovative pedagogical technologies" (44.04.04). For example, a SP "Professional education in Informatics and Computer engineering. Innovative pedagogical technologies". Such programmes focus on preparing teachers for higher education institutions and vocational education institutions of post -secondary non-tertiary level *(type of training 2 according to Fig. 1.).*

Also the Module "Optimization of scientific and pedagogical activity" is implemented in some of the Master cycle curricula in DSTU. *(type of training 1 according to Fig. 1.).*

Department of Corporate Education and Advanced Training of DSTU offers many advanced training and professional retraining programmes (type of training 3 according to Fig. 1.) including the ones aiming at improving pedagogical skills and enabling teaching at HEIs: "Higher School Pedagogy" (8 ECTC credits/272 academic hours - for post-graduate students, 16 ECTS credits/557 academic hours - for teaching staff).

The structural unit of DSTU - Industrial Co-working Center Гараж - offers Continuing professional development (CPD) programmes preparing engineers for work with youth audience *(type of training 3 according to Fig. 1.).*

"School X" is a newly established unit of DSTU where new approaches and initiatives in educational, science-research and innovative activities will be worked out and probed. Development of innovative study programmes is among "School X" priorities. The SPs developed in the School X envisage learning innovative technologies in diverse fields including pedagogy *(type of training 3 according to Fig. 1.)*:

- three tracks of functional development: engineer-inventor, entrepreneur-manager, researcher;
- flexibility with built-in construction mechanism of individual learning paths;
- blended learning;
- project approach, practical component (close relationship with enterprises, the case model of learning);
- interdisciplinary approach;
- development of entrepreneurial thinking,
- motivation to launching and developing own projects;
- English language learning approach for engineers.

***Vyatka State University*.** In VyatSU potential teachers of engineering disciplines have the opportunity to gain professional and pedagogical qualification through studying Master's and PhD's programmes with integrated pedagogical Modules *(type of training 1 according to Fig. 1.)*.

The university regularly implements professional development programs (CPDs) for teachers *(type of training 3 according to Fig. 1.)*. The most popular programs are:

- "Design and implementation of the main educational programs in the TOP 50, taking into account Russian and international standards of training"
- "Training and socio-psychological support of students with disabilities"
- "Modern educational information and communication technologies in inclusive education"
- "Management of educational organization"
- "Innovative direction of educational-methodical and scientific activity of technological departments".

There is the Institute of continuing education at VyatSU which develops programmes of teachers' professional development as well as programmes of professional retraining including study programmes in the field of pedagogy and psychology *(type of training 3 according to Fig. 1.)*.

Some teachers of VyatSU have internships abroad and at the leading enterprises of the region and other cities of Russia *(type of training 4 according to Fig. 1.)*.

3. WHAT WE HAVE: LEARNING OUTCOMES OF ENGINEERING EDUCATORS' PEDAGOGICAL TRAINING.

As shown in the previous Chapter pedagogical training in EU, KZ and RU may be of different duration and content, may vary from short Modules to full Master and PhD programmes, from short-term additional education programmes to advanced training/retraining programmes (including e-courses), may cover non-formal pedagogical training workshops, open lectures, master-classes, webinars etc. Needless to say that the learning outcomes expected of engineering educators to obtain in each type of pedagogical training differ in scope and level. However based on the ENTER Case Analysis Survey it is

possible to draw out a set of core learning outcomes. From pedagogical perspective engineering educators should be able to:

- organize and perform learning and mentoring activity;
- analyse situations (conflicts) from pedagogical point of view and solve them;
- diagnose and forecast development of students' personality;
- determine goals and learning outcomes for the development of personal and interpersonal competencies of graduates, their skills of product, processes and systems creation;
- widespread and apply innovations into educational process;
- apply pedagogical creativity to maximize efficiency of learning the professional competences by students;
- create socio-cultural environment in educational institutions;
- outline educational and professional aims and objectives;
- forecast results of professional pedagogical activity;
- build up the content of study material;
- develop, analyse and adjust methodological documentation of a study programme in engineering discipline;
- use various forms and methods for intermediate and final assessment of learning outcomes achievement and confirmation of the planned competencies formation;
- organize students work in the context of educational and scientific projects and presentation of work results in various types and areas;
- organize students' work through communication and collaboration in local and open networks;
- create network project portfolios in the process of group remote communication, use available network tools to enrich content of a discipline and students' gadgets for organizing control and feedback.

HEI engineering educators should also possess knowledge and understanding of the following principles which they should consider and implement in their pedagogical activity:

- operational principles underlying the Higher Education Institution;
- quality assurance principles (both of National and International level);
- governance principles in a wide range of National settings;
- Higher Education study programme design principles;
- Qualifications Frameworks and credit systems principles (both on a National and International level);
- lifelong learning principles;
- research and university-enterprise cooperation principles.

In addition to the above, engineering educators should develop:

- information competences - information literacy, computer literacy;
- learning competences - motivating for education and self-learning, identifying student's preferred learning style, applying in-depth learning approach, applying meta-cognitive and meta-learning, advanced learning preparation, learning process and learning control);
- cognitive competences - problem solving, critical thinking, creative thinking;
- interpersonal (social) competences - to live and work effectively with other people, to learn and to work with others; to plan, organize, review and evaluate the team's activities and

take responsibility for team work; empathy; ability to resolve conflicts, respect, accept and tolerate the differences of other people; to behave responsibly and morally with other people, maintain harmonious relationships; emotional intelligence, etc.;

- communication competences - to express themselves orally and in writing, to read comprehensively, to listen carefully, to choose the optimal form and method of communication, to process written material in a comprehensible manner, to present information, to explain and illustrate in a clear and understandable way, to communicate through information and communication technologies;
- personal competence - self-awareness, self-control, motivation, commitment.

Besides engineering educators should be familiar of sections 2, 3 and 4 of the CDIO Syllabus which defines personal and interpersonal skills, and product, process, and system building skills of a CDIO programme (http://www.cdio.org/benefits-cdio/cdio-syllabus/cdio-syllabus-topical-form). Some CDIO standards also present learning process requirements related to these outcomes (from CDIO Syllabus - http://www.cdio.org/implementing-cdio/standards/12-cdio-standards):

- The Context of Engineering;
- Integrated Curriculum;
- Design-Implement Experiences;
- Engineering Workspaces;
- Integrated Learning Experiences;
- Active Learning;
- Learning Assessment;
- Program Evaluation

4. WHAT WE HAVE: LEARNING TOOLS, METHODS, ENVIRONMENTS AND LEARNING ASSESSMENT TECHNOLOGIES USED IN ENGINEERING EDUCATORS' PEDAGOGICAL TRAINING.

For engineering pedagogical training different contemporary learning tools may be used: interactive lectures with active breaks (with interaction, answering questions and discussions) seminars, exercises, active learning including problem-based and project-based learning, team-based learning, integrative learning, multidisciplinary learning etc.

Different contemporary environments are suitable for engineering pedagogical training may: e-learning, blended learning, virtual group work, remote and virtual labs, learning games, flipped and hybrid classroom, online conferences and workshops etc.

As a rule, the number of lectures is reduced to the minimum required for reviews and / or introduction parts of practical training. Practical classes are held in computer classrooms designed for work in small groups. In order to use audiovisual technologies in the educational process, a video hosting may be created on the university portal for posting video lectures and other video recordings created by educators both during and following the training. Opportunities of LMS Moodle platform or personal training environments of the university teaching staff may be used.

Among teaching approaches suitable for engineering pedagogical training ENTER partners have marked the following in the frame of Case Analysis Survey:

- Problem-oriented - aimed at the formation and development of problem thinking, mental activity and the ability to see and formulate problems, choose the means to solve them.

• Practice-oriented - aimed at the formation of a system of professional practical skills and abilities allowing to carry out professional activities with high quality.

• Student-oriented - ensuring that the learning process takes into account the various abilities of the trainees, creates the necessary conditions for the development of their individual abilities.

• Health-saving - allow to evenly distribute various types of tasks during the class, determine the time of submission of complex educational material, allocate time to conduct independent work

Traditional teaching methods have been also indicated by partners in ENTER Case Analysis Survey as currently applied for pedagogical training:

Explanatory illustrative method. Students receive knowledge at a lecture, from educational or methodical literature, through a screen aid in a "ready" form. Perceiving and comprehending the facts, assessments, conclusions, students remain within the framework of reproductive (reproducing) thinking. This method finds the widest application for the transfer of a large array of information.

Reproductive method. Includes the application of the study based on a sample or rule. The activities of the trainees are of an algorithmic nature, i.e., they are carried out according to the instructions, regulations, rules in similar situations that are similar to those shown in the sample.

Partial search *(or heuristic method)*. Consists in organizing an active search for solutions put forward in learning (or independently formulated) cognitive tasks, either under the guidance of a teacher, or on the basis of heuristic programs and instructions. The process of thinking acquires a productive character, but at the same time it is gradually directed and controlled by the teacher or the students themselves on the basis of work on programs (including computer programs) and teaching aids. Such a method, one of the varieties of which is heuristic conversation, is a proven way to activate thinking and arouse interest in knowledge at seminars and colloquiums.

Research method. After analyzing the material, setting problems and tasks, and brief oral or written briefing, the trainees independently study the literature, sources, conduct observations and measurements, and perform other search-related activities. Initiative, autonomy, creative search allow trainees to manifest themselves in research activities most fully. Methods of educational work directly develop into methods of scientific research.

Problem based learning. A method of active interaction of the subject with the problem-presented content of training, during which a trainee is attached to the objective contradictions of scientific knowledge and ways to solve them. The scheme of problem learning is presented as a sequence of procedures, including: the formulation of the educational problem, the creation of a problem situation for trainees; awareness, acceptance and resolution of the problem, in which they master the generalized methods of acquiring new knowledge; the use of these methods to solve specific systems of problems. The problem situation is a cognitive task, which is characterized by a contradiction between the existing knowledge, skills, relationships and requirements. When using this method a teacher, before presenting the material, poses a problem, formulates a cognitive task, and then, revealing a system of evidence, comparing points of view, different approaches, shows a way to solve the problem. Trainees become witnesses and accomplices of scientific research. Both in the past and in the present, such an approach is widely used.

The project method. A way to achieve the didactic goal through the detailed development of the problem (technology), which should be completed with a very real, tangible practical result, embodied in one way or another. It is a set of techniques, actions of trainees in their specific sequence to achieve the task - solving the problem, personally significant for trainees and embodied in the form of the final product. The main purpose of the project method is to provide trainees with the opportunity to independently acquire knowledge in the process of solving practical problems or problems that require the integration of knowledge from different subject areas. The teacher within the project is assigned the role of developer, coordinator, expert and consultant.

Active learning. Environment-based and activity-based pedagogical method in which educational environment is formed not only by physical spaces (buildings, auditoriums, training grounds, etc.) and subjects (stands, models, laboratory facilities and other teaching aids), but also by the conditions of pedagogical interaction and the nature of the subject-subject relations. Active learning features: "forced" activity, "forced" activation of thinking and activity of students; increasing the emotional involvement of trainees and the creative nature of the classes; direct interaction of trainees among themselves, as well as with the teacher; formation of collective efforts leading to intensification of the learning process. Different forms of active learning are implemented in ENTER consortium universities within the engineering educators' training programmes such as: creative tasks; small group work; study and consolidation of new material (interactive lecture, work with visual aids, video and audio materials, "studying as a teacher", "everyone teaches everyone"); testing; discussion of complex and controversial issues and problems; problem solving (decision tree, brainstorming); simulation exercises; round tables; internships; gaming forms (role-playing, business games, educational games (a blitz game, mini-games, individual gaming sessions on the PC), production games); research games.

The current full-time system of formal pedagogical training in KZ and RU must be supplemented with the elements of non-formal education. The thematic webinars (including webinars with invited foreign partners) and virtual workshops of innovative educators, should be streamed and shared via e-learning portals, promoted among engineering educators and made more and more popular and easy accessible.

For any type of engineering educators' pedagogical training the learning assessment methods should be mapped appropriately against the learning outcomes, so that they address disciplinary knowledge, as well as personal and interpersonal skills, and product, process, and system building skills. Thus assessment of gained learning outcomes (including assessment of personal and intrapersonal skills) can be made through:

- Portfolio assessment
- Group work presentations
- Mind map presentations
- Lab manual analysis
- Video-report presentations
- Group examination
- Design of a curriculum and syllabus
- Presentations
- Peer-assessment
- Self-assessment
- Poster

- Examination
- Essay
- Report
- Review

Entry, interim and final control may consist of tasks to prepare such materials as: guidelines for students with recommendations (e.g. on the use of presentation editors); file depository on services such as Box.net, DropBox, Google Disk; portfolio on a blog or virtual class platform; video presentations of educational material; formed topics, scenarios, assignments of students' roles within the project team; a system of assessing project participants' contributions; measurable objectives of engineering disciplines and required learning outcomes in the framework of the competence-based approach; problem-based home works; problem-based lectures-presentations' notes; schedule of control points, etc.

5. WHAT TO DO: CHALLENGES AND OPPORTUNITIES OF ENGINEERING EDUCATORS' PEDAGOGICAL TRAINING.

5.1 CHALLENGES.

The need to modernize professional pedagogical training system for engineering educators is acknowledged by universities but still faces resistance in implementing necessary changes. Among the **challenges** foreseen on the way of engineering pedagogy enhancement the following features have been named by ENTER consortium partners from Portugal, Slovakia, Estonia, Kazakhstan and Russia.

Firstly, poor **content-management** of engineering pedagogical training which happens due to:

- outdated content leading to the lack of educators' competences in project management, problem thinking, in soft and interdisciplinary skills;
- small share of interactive and research forms in the educational process;
- insufficient quality control of training;
- insufficient interdisciplinary training;

Secondly, insufficient **university-enterprise cooperation** which is the reason why engineering educators are often following "teaching what we can" principle instead of "teaching what is necessary for the labour market". They are unable to adjust teaching to the demands of the labour market and fail to update the practical content of engineering education due to the lack of first-hand practical experience. Week link between university and enterprise also leads to reduction of financing from the industrial partners and other stakeholders.

Thirdly, outdated and inappropriate **teaching-learning-assessment** methods and technologies used within engineering pedagogy, compared to innovative ones existing in other fields, e.g.:

- Lag between the level of educators' ICT competences and the level of ICT teaching technologies availability;
- Insufficient implementation of the evolving modern types of education (LMS Moodle, MOOCs, online universities, corporate universities, practice-oriented non-governmental institutions that focus on project-based learning)

Finally, poor **international cooperation** with regard to engineering educators' pedagogical training:

• Lack of opportunities for international cooperation and exchange of best practices due to low level of foreign languages of proficiency among engineering educators;

• Failure to update contents of engineering education according to the latest developments in the field due to educators' inability to find information on best practices from foreign sources.

5.2 OPPORTUNITIES.

Motivation behind ENTER project is the idea to strengthen engineering teachers preparation with innovative kind of engineering pedagogy - to upgrade traditional engineering pedagogy in order to meet modern society challenges mentioned above. The 21-st century engineering HEI teacher must be some kind of a coach with very strong psychological, sociological and methodological competences. Under modern realities an engineering educator needs novel skills such as: ethical and cross-cultural communication, psychological sustainability under the stress factors of modern environment; marketing and management skills, social networking, ICT literacy, financial literacy etc. It is very important how the teaching and learning process will be organized and what teaching methodology will be used.

In the context of innovating the engineering pedagogical training the ENTER project proposes the solution - to develop the multi-level modular system for pedagogical training of engineering educators (basic, fundamental and advanced iPET programmes) based on international network cooperation. The consortium will refer to IGIP General principles of development of engineering higher education and development of qualification requirements for teachers of higher technical schools and to CDIO Initiative and will develop 3-level innovative modular iPET programme consisting of:

• iPET-1 - short-focused programme (2 ECTS) awarding "Qualification Development" Certificate;

• iPET-2 - professional retraining programme (e8 ECTS) awarding Diploma "Higher Education Teacher";

• iPET-3 – full internationally recognized (20 ECTS) programme leading to international accreditation as "Engineering Educator".

Programmes will have modular structure, i.e. modules of iPET-1 will be included in iPET-2, and both included in iPET-3. This will provide a sustainable improvement path that educators can walk at their own pace. It will also be possible for the educators to combine modules from different ENTER network members.

These programmes will be available for experienced university teachers of engineering disciplines and for Master and PhD students majoring in engineering who intend to choose teacher career or gain teaching experience in order to improve employability or research skills. 3-level iPET programmes are Pathway Programs to train staff, students and other stakeholders and they will allow to reach a specific standard in implementing new teaching approaches in sciences or multidisciplinary fields.

iPET programmes address the challenges mentioned in the previous Chapter, thus the **opportunities** foreseen in iPET programmes and in the ENTER project on the whole in the context of enhancement of engineering pedagogy are as follows:

1. <u>Improvement of content-management thanks to:</u>

• modular structure;

- sustainable educators' path;
- innovative kind of Engineering Pedagogy;
- focus on Content (soft and interdisciplinary skills), Methodology, Pedagogical teaching and learning outcomes delivery.

2. Strengthening of University-Enterprise cooperation thanks to:

- orientation to socially significant and future-oriented curricula;
- emergence of teacher trainee-centered learning programs;
- implementation of teacher trainees' experimentation and realization of their ideas;
- encouraging interdisciplinary teams, including various fields engineering and business-specialties;
- mastering of innovations through inviting industry representatives in status of invited teachers or researchers

3. Modernising Teaching-Learning-Assessment thanks to:

- support of educators in studying and application of ICT technologies (LMS Moodle, MOOCs, and other);
- creation of specific learning environment enabling modern teaching methods introduction (computer classes, laboratories, video labs for creating video courses);

4. Fostering International Cooperation through:

- Networking ENTER Programme;
- International Networking Partnership;
- International Recognition and Accreditation;
- Multicultural and International Approach
- Continuous exchange of expertise in engineering pedagogy in order to get a broad understanding of modern international agenda (participation in multinational educational projects, international conferences, international societies and associations);

CONCLUSION.

Pedagogical education for engineering teachers is called upon to give a versatile pedagogical competence and initiate a process where the educators can develop into a self-directing professionals (34 - 35). Teachers of engineering majors often have broad and solid expertise in their subject field but lack pedagogical competencies relevant to the modern learning environment. HEI teachers and lecturers should have such pedagogical competencies which enable them to implement key educational approaches of the 21st century such as: Lifelong Learning, Information and Communications Technology literacy, e-learning etc.

With this respect it is obvious that innovative modular iPET system of pedagogical training based on international network cooperation offered within ENTER project will be of great benefit for working and potential engineering teachers. The acquired pedagogical competences can be directly applied to praxis.

The present e-book is designated to summarise the best practices of engineering educators' pedagogical training already applied in the ENTER consortium universities

because these practices serve as a foundation for the iPET programme. The data collected in the course of ENTER Case Analysis Survey has been systemised in order to draw out the political social and economic conditions gearing engineering pedagogy evolution, to describe its regulatory basis and institutions behind it, to define the stakeholders and differentiate the types of available engineering educators' pedagogical training, to crystallise the targeted learning outcomes, learning tools, methods and technologies and finally to show the strong points of iPET programme with regard to innovating the engineering pedagogical training.

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