







# Preparation of PhD Students for Engineering Disciplines' Teaching

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**Abstract.** The paper contains some findings of the study of the Russian universities' system of PhD students pedagogical training that have been carried on in the framework of the ERASMUS+ Capacity Building for Higher Education project EXTEND (# 586060-EPP-1-2017-1-RO-EPPKA2- CBHE-JP). The name of the project is "Excellence in Engineering Education through Teacher Training and New Pedagogic Approaches in Russia and Tajikistan", so it is devoted to the training of new personnel for the engineering universities. The strengths and weaknesses of the system of pedagogical training of young teachers are under discussion in this paper as well as few recommendations on how to enhance the Russian teacher's preparation.

**Keywords:** Erasmus+ · Education technology · Competence · Teachers training · Engineering education · PhD education

## 1 Introduction

The paper contains some findings of the study of the Russian universities' system of Ph.D. students training to be university teachers that have been carried on in the framework of the ERASMUS+ Capacity Building for Higher Education project EXTEND (# 586060-EPP-1-2017-1-RO-EPPKA2- CBHE-JP). The name of the project is "Excellence in Engineering Education through Teacher Training and New Pedagogic Approaches in Russia and Tajikistan", so it is devoted to the training of new personnel for the engineering universities. The strengths and weaknesses of the system of pedagogical training of young teachers are under discussion in this paper.

The authors describe the EXTEND project, a team of four Russian Universities, objectives of the analysis and its results.

The methodology part of the paper draws four following stages of the analysis: (1) Preparatory; (2) Data Collection; (3) Analysis; (4) Discussion and Exploitation. According to this schema, the content of the paper was constructed.

The main part of the paper presents the results of a study of 22 Ph.D. students' programs collected by Russian universities' team. The research questions are the following: (1) Do the Ph.D. programs in Russia include courses and internships on teaching and learning tools to prepare Ph.D. students to be a University teacher? If yes,

do these courses are sufficient and up-to-date? (2) What are the strengths and weaknesses of the system of pedagogical training of teachers of higher engineering education?

The Discussion part consists of three recommendations on how to enhance Russian teacher preparation.

## 2 Russian Higher Education System

Russian higher education system is based partly on the Bologna principles and includes the following levels of education [1]:

- bachelor's degree (4 years) – ISCED Level 6;
- master's degree (2 years) – ISCED Level 7;
- Ph.D. degree (3–4 years) – ISCED Level 9;
- specialist degree (5–6 years) – ISCED Level 8;
- clinical internship (2 years) – ISCED Level 9.

Along with the Bologna three cycle system, a part of traditional Russian system has been kept in the most important and intensive education fields, such as medicine [2] and several fields of engineering [3]. In these fields, the 5 or 6-year specialist degree programs are offered equally to ISCED Level 8.

In Russia the PhD degree programs were included in the system of higher education degrees in 2013 according to the Minister of Science and Higher Education Decree #1259 dated November 19, 2013 named as “About the statement of the Order of the organization and implementation of educational activity on educational programs of the higher education - programs of preparation of scientific and pedagogical shots in postgraduate study” [4] with modifications dated April 2016. Before that time (between 1925 and 2013) the Ph.D. programs were regarded as post-graduate education for specialists of the highest qualification and were completely research-based. The aim of students was to prepare and defend a thesis to obtain the so-called Candidate of Science degree, which is equal to a PhD degree according to the EU system. If the student failed to defend the thesis, he or she didn't get any document of education. In 2012 new Federal Law № 213-FS “On Education in Russian Federation” was issued and since 2013 postgraduate education were included in the system of higher education in the Russian Federation [5].

Regulation on postgraduate education is performed by the Higher Attestation Commission of the Russian Federation (VAK RF) [6]. All research fields are systemized into 26, specialties or mega-fields, which are further divided into smaller fields. The description of the research topics of each specialty is presented in a special document named “Specialty's Passport” issued by the Higher Attestation Commission of the Russian Federation (VAK RF). After the year 2013, the Ph.D. programs are the subjects to Federal Education Standards issued by the Ministry of Education and Science of the Russian Federation. They include requirements to contents, duration, learning outcomes and conditions of Ph.D. programs of a certain specialty. To be able to offer a PhD program, the university has to get a license and has to pass through state accreditation procedure every 5 years [7].

Graduates of a Master's or Specialist Degree can be enrolled in a Ph.D. program. The entry exams are the following: (1) foreign language, (2) philosophy and (3) major discipline. Every Ph.D. program includes regular classes according to the curriculum, teaching internship and research. The Ph.D. students select a research field and a subject of research for their dissertation. The full-time study lasts from 3 to 4 years, while part-time study lasts from 4 to 5 years. Upon graduation, a graduate is awarded a postgraduate certificate with the corresponding qualification "Research Fellow" or "Research-Teaching Fellow". Depending on the result of the dissertation's defense the Candidate of Sciences Degree (equal to the Ph.D. status) is awarded, which is the first Degree to confirm the status of a scientist. Next level can be achieved by the Researcher when the Candidates of Sciences proceed to their Doctoral Degree (the second Degree to confirm the status of scientist), which is awarded following successful completion of their doctoral dissertation. Some characteristics of the Ph.D. program are present in Table 1.

**Table 1.** Characteristics of the Russian PhD programs.

Program Characteristics	Ph.D. programs in the Russian Federation
Entry requirements	Master's or Specialist Degree
Duration of study	3–4 years (full-time), 4–5 years (part-time)
Academic qualification certificate	Postgraduate Degree certificate
Qualification (degree)	Researcher (qualification), research fellow (qualification), Candidate of Sciences (degree)
Type of study	Regular classes according to curriculum, teaching internship, research
Form of final state assessment	Three qualifying examinations for a candidate's Degree, state examination, dissertation defense
A further career in a scientific and professional field	Doctoral dissertation defense
Employment	Research, analytical and scientific work in accordance with the qualification

The Ph.D. graduates have the right to be employed as a university teacher. After that, each university teacher has to improve his or her skills every three years and participate in professional training programs with the duration of not less than 72 h (2 ECTS). It is an obligatory requirement to pass through the so-called teacher attestation procedure and prolong labor agreement.

### 3 Russian Universities Team

Four Russian universities' academic staff took part in this research materials' collection and they are listed below with a small description.

### **3.1 Bauman Moscow State Technical University (BMSTU)**

The BMSTU is one of the biggest and oldest universities in Russia with a total enrollment of over 28000 students. The university structure includes 8 Research and Education Units with 18 Faculties and branches in Kaluga, Mytischy and Dmitrov cities. Faculties and Research Institutes enable students, staff, and scientists to study and conduct research and offer courses covering all fields of Engineering Science including manufacturing engineering, computer science, control systems, robotics, medical engineering, power engineering, and industrial design. BMSTU pays particular attention to relationships with industrial enterprises and continuously searches for innovative, high-quality ways of preparing graduates for employment [8].

### **3.2 Moscow State University of Civil Engineering (MGSU)**

The MGSU is the leading University in Russia for the training of specialists for the construction industry and construction science. It plays a key role in the formation of high-quality human capital and the formation of the labor market in the field of construction in Russia and CIS countries. The MGSU, as well as the BMSTU, were among the first universities to receive the status of the National Research University of Russia in 2010. The main mission of the MGSU is to train high-quality civil engineers, urban planners, and architects. The MGSU has about 25 thousand students in 8 institutes. Training is conducted in 13 areas of bachelor's degree, 7 areas of master's degree, 2 areas of specialty; 18 programs for the training of highly qualified personnel (post-graduate) are implemented. More than 170 teachers are full professors (Doctors of Science degree) and more than 600 are the associate professors (Ph.D.), who work at 50 departments of the MGSU [9].

### **3.3 Nosov Magnitogorsk State Technical University (NMSTU)**

The NMSTU was established in 1934 as a general source of engineering staff for the Magnitogorsk Iron and Steel Factory, a major steel plant in the Russian's history. That is why some the most popular fields of study at the NMSTU include Metallurgy, Materials Science and Technology, Information Security and Automated Systems, Computer Engineering and Programming. A number of students are about 16 000. The NMSTU is engaged in international student exchange programs and has signed agreements with 75 universities from 60 countries. The NMSTU consists of 8 institutes and 2 faculties and encompasses a number of colleges and branches [10].

### **3.4 National Research Mordovia State University (MRSU)**

The MRSU was founded in 1931 and was awarded the status of National Research University in 2010. The MRSU incorporates 17 academic departments, 7 research institutes, and 2 affiliated campuses, fully-fledged research infrastructure, Distance Learning Centre. The student body counts almost 19000. University enrolls more than 1000 doctoral students and runs 11 dissertation councils. The teaching staff is almost 1400 people. The University offers over 200 academic programs in life sciences,

engineering, humanities, arts, and medicine. University awards Bachelor, Master, Doctoral and Post-Doc Degrees and equivalents. MRSU promotes ICT-based research and education. Quality Management System of MRSU is certified according to the requirements of ISO 9001. In 2012 the MRSU was awarded the Recognized Excellence Level by the National Quality Award for Higher Education.

The system of teachers' preparation in all four listed universities includes Ph.D. students training in pedagogy and teaching, as well as a set of teacher training courses, plans and other local documents relating to teacher training and re-training [11].

## 4 Methodology of Research

The objective of the analysis is defined as the identification of strengths and weaknesses of the system of pedagogical training of teachers of higher education based on analysis of the Ph.D. programs in Russian universities. The following tasks have to be solved to achieve the goal: selection and analysis of Ph.D. programs, identification of strengths and areas of improvement of the system of pedagogical training of teachers of higher education. The methodology of analysis consists of the following stages: 1. Preparatory stage; 2. Data Collection Stage; 3. Analysis Stage; 4. Discussion and Exploitation Stage.

### 4.1 Preparatory Stage

During the Preparatory stage, each University selected from 3 to 5 Ph.D. programs in the field of engineering to evaluate. Two types of programs have to be selected - the most popular programs and the programs in which the university has greater expertise.

According to the study's objectives the following parameters of each Ph.D. program have to be evaluated: number of students; annual enrollment; structure of the program; learning outcomes, connected to teaching activities; list and content of the courses and other activities, which are dedicated to prepare PhD student for teaching; teaching tools and approaches taught to students; assessment tools and practices; teaching internships; industry cooperation; ICT tools used in the program; international element in the program (mobility, conferences, languages, guest lectures).

### 4.2 Data Collection Stage

In total data, 21 Ph.D. Training programs were collected by universities teams with a total enrollment of 248 students. Unfortunately, the number of students per Ph.D. program varies significantly in Russian universities. The number of Ph.D. students depends usually more on a number of available state scholarships and much less on market needs and employers' demands. Table 2 includes the full list of the Ph.D. programs' names which have been analyzed in this research (Table 2).

**Table 2.** Titles of the PhD programs analysed in the paper.

No.	MGSU
1	Architecture
2	Equipment and building technologies
3	Mechanical engineering
4	Management in technical systems
BMSTU	
1	Computer science and engineering
2	Nuclear, thermal and renewable energy and related technologies
3	Mechanical Engineering
4	Aviation and rocket and space technology
5	Air navigation and operation of aviation and rocket and space vehicles
NMSTU	
1	Electric and Thermal Technics (Industrial Thermotechnics)
2	Geotechnology (underground, open and construction)
3	Technologies and machines of processing by pressure
4	Building structures, buildings, and structures
5	Electrical systems and complexes
MRSU	
1	Electrical and heat engineering (Lighting Engineering)
2	Electrical and heat engineering (Electrotechnical complexes and systems)
3	Electrical and heat engineering (Power plants and power systems)
4	Technology, mechanization and power equipment in agriculture, forestry (Technologies and means of technical agricultural services)
5	Engineering and construction technology (Building structures and buildings)
6	Engineering and construction technology (Building materials and products)
7	Engineering and construction technology (Heat Supply, ventilation, air conditioning, gas supply, and lighting)

Data collection has been performed by universities' EXTEND project teams as a desk and field study. The following documents have been used to collect data for this research: Federal State Education Standards on Ph.D. programs, basic professional educational programs (a set of documents describing the contents of each program, learning environment, teaching tools and learning outcome), curricula, course descriptions, internship descriptions, Ph.D. department and academic department reports, teacher interviews.

### 4.3 Analysis Stage

The analysis methods were comparison and content analysis. The comparison criterion are the following: number of students; structure of the program; learning outcomes, connected to teaching activities; list and contents of the courses and other activities, which are dedicated to prepare Ph.D. student for teaching; teaching tools and

approaches taught to students; assessment tools and practices; teaching internships; industry cooperation; ICT tools used in the program; international element in the program (mobility, conferences, languages, guest lectures).

The research questions to be answered in the study are the following.

1. Do the Ph.D. programs in University include courses and internships on teaching and learning tools to prepare Ph.D. students to be University teachers? If yes, do these courses are sufficient and up-to-date?
2. What are the strengths and weaknesses of the system of the Ph.D. students' pedagogical training?

The research aimed to investigate the crucial factors of university education quality – the quality of educational resources and quality of education technologies, as authors seek to investigate whether Ph.D. students receive substantial education in the implementation of teaching tools and approaches. Education technologies are the framework term which includes theoretical pedagogic approaches, teaching tools and information technologies facilitating teaching and learning [12].

#### **4.4 Discussion Stage**

The final Discussion stage supposes to produce the following results: strengths and areas of improvement of Ph.D. training programs according to criteria; suggestions of results implementation.

## **5 Results of the Study of Russian Practices in Ph.D. Programs with a Focus on Teaching Engineering Disciplines**

In Russia, every Ph.D. program is of 240 ECTS or 4 years duration.

The structure of the program includes the mandatory part (basic) and the variable part, which provides the opportunity to implement different directions within one area of training.

The Ph.D. program consists of the following blocks:

Block 1 “Disciplines (modules)” includes disciplines related to the basic part of the program (History and philosophy of science and Foreign languages) and disciplines related to the variable part. This block workload is 30 ECTS.

Block 2 “Internship” refers to the variable part of the program and includes internships to obtain professional skills and experience (including obligatory teaching internship).

Block 3 “Research” refers to the variable part of the program. Block 3 and Block 2 workload is 201 ECTS. Block 3 includes research activities and preparation of scientific qualification work (dissertation) for the degree of Candidate of Sciences.

Block 4 “State final attestation” refers to the basic part of the program (workload is 9 ECTS) and ends with the award of the qualification “Researcher. Teacher-

researcher”. It includes the preparation for the state exam and submission of a scientific report on the main results of the prepared scientific qualification work (dissertation).

The list of existing courses and internships in pedagogy which are included in Ph.D. programs of Russian universities are shown below (Table 3).

**Table 3.** Courses and internships on pedagogy included in Ph.D. programs.

Ph.D. Programs	Courses on Pedagogy	Teaching Internship
MGSU		
All Ph.D. programs in engineering	Pedagogy and methods of professional education (2 ECTS)	Pedagogical Practice (3 ECTS)
BMSTU		
All PhD programs in engineering	Fundamentals of pedagogy and psychology of higher education (6 ECTS)	Pedagogical Practice (18 ECTS)
NMSTU		
All PhD programs in engineering	Pedagogy and Psychology of HEI (3 ECTS)	Pedagogical Practice (9 ECTS)
MRSU		
All Ph.D. programs in engineering	IT in research and education (2ECTS), included (1 ECTS self-study) Pedagogy of higher education (2ECTS), included (1 ECTS self-study)	Pedagogical Practice (3 ECTS)

The readiness of the Ph.D. program graduates to teach, as well as his/her ability to develop scientific and methodological support of academic disciplines in the professional field, are formed by following activities: (1) study of the courses on pedagogy; (2) teaching internship; (3) preparing for the state exam.

According to the results of the State final examination, the graduates are awarded the qualification of “Researcher. Teacher-researcher”.

In Russian universities, each Ph.D. program has at least one general course on pedagogy with the value between 2 and 6 ECTS.

In NMSTU, in addition, the Ph.D. students must acquire a good level of foreign language proficiency to be able to deliver lectures for foreign students; acquire fundamentals of inclusive education to be able to deliver lectures for inclusive students.

In MRSU an additional course is included: “IT in research and education” (2 ECTS). The teaching internship is obligatory and its duration varies between 3 and 18 ECTS.

In BMSTU the maximum share of the curriculum dedicated to pedagogical training is 10%.

Also it can be considered that some other courses contribute to the development of related soft skills of the future university teacher, such as History and Foreign Language (all universities), Communicative and Stylistic features of the Academic Language and Writing (BMSTU), Professionally-Oriented Translation (NMSTU), although



the major part of the curriculum is dedicated to professional courses, courses on research methodology and research activities.

Analysis of Ph.D. programs shows that each Ph.D. program includes one general professional competence in teaching – “Readiness for teaching on the educational programs of higher education”. The Ph.D. programs in MGSU include in addition two general competencies which are connected to teaching: “Willingness to participate in the work of Russian and international research teams to solve scientific and educational problems” and “Ability to plan and solve problems of professional and personal development”. Ph.D. programs in MRSU include two additional professional competences concerning teaching – “Readiness for teaching in the specific field” and “Ability to develop scientific and methodological support of educational disciplines in the specific field. It means that teaching is regarded as a general professional skill for each Ph.D. graduate although in some universities the role of the teacher is considered as more important for Ph.D. graduate.

Content analysis of learning outcomes shows significant differences between universities in terms of what exactly should know, be able to do and which skills should Ph.D. graduate possess to be a university teacher. Although each university includes understanding and ability to implement teaching tools, technologies, and methods.

The contents of the pedagogical courses also show significant differences between universities. Analysis of the courses allows identifying three main parts: fundamentals and theories of pedagogy, psychology, methods, and tools. Table 4 presents three different examples of the courses on pedagogy. Two selected courses include three out of four main parts (modules), NMSTU course includes all four parts but the number of a topic is fewer.

Structures of two selected courses on pedagogy delivered to Ph.D. students at three Russian universities are shown at the following (Tables 4, 5 and 6).

**Table 4.** Structures of course on pedagogy delivered to Ph.D. students at the BMSTU.

Instruments of the course	Topics in the course on Pedagogy
Fundamentals and theories of pedagogy	Modern requirements to the European engineer according to the concept of sustainable development History of formation and development of technical education in Russia History of foreign engineering education Modern trends in the development of higher technical education in Russia and abroad Comparative analysis of foreign systems of higher education subject “Engineering pedagogy”, its place and role in the system of pedagogical science Social expectations concerning qualities of a graduate of higher technical school Professional requirements to the teacher of higher school Structure of activity of the teacher of the higher school Theoretical bases of a technique of teaching at the higher school

*(continued)*

**Table 4.** (continued)

Instruments of the course	Topics in the course on Pedagogy
Psychology	Psychology of higher education Components of professionalism and creative self-realization of the person Self-Improvement of the person as one of the bases of achievement of tops of creative potential Pedagogical experience as result and support of self-realization of the creative potential of the teacher Pedagogical skills – the highest level of professionalism of the teacher Preparation of classroom with the use of techniques of rhetoric and public speaking Dynamics of mental development (childhood, adolescence, and youth) Dynamics of mental development (adult psychology, old age) Role of the group in human behavior and activity (group structure, group processes) Role of the group in human behavior and activities
Methods and tools	Overview and experience of the use of modern educational technologies in higher education Modernization of traditional types of training Active educational technology Project-based learning E-learning New organizational and technological formats of educational activities Requirements for modern educational technologies Organization of forms and content of training at the University The modular system of training, design goals, and content of the curriculum Practical use of the properties of the material for the preparation of training sessions and presentations Methods of preparation and control measures Methods of evaluation of the teacher The professional culture of the engineer Culture of a high school teacher
Communication and classroom management	Role of the group in human behavior and activity (structure of psychological climate in the group) Conscious communication in conflict situations (conflicts in different spheres of human interaction)

**Table 5.** Structures of course on pedagogy delivered to Ph.D. students at the MRSU.

Instruments of the course	Topics in the course on Pedagogy
Fundamentals and theories of pedagogy	Higher educational institution as a pedagogical system Functioning and efficiency of pedagogical process in a higher educational institution The pedagogical activity of researchers and teachers, pedagogical laws of formation and development of the personality of the student Process of higher education and self-education Education and self-education of students Personality of the teacher
Psychology	No data
Methods and tools	Forms, methods and pedagogical technologies in a higher educational institution Pedagogical aspects of continuous independent work of students
Communication and classroom management	Pedagogical interaction between students and teachers

**Table 6.** Structures of course on pedagogy delivered to Ph.D. students at the NMSTU.

Instruments of the course	Topics in the course on Pedagogy
Fundamentals and theories of pedagogy	Fundamentality and humanization in higher education Integration processes in modern higher education Principles of training as the main reference point in teaching The essence, structure and driving forces of the learning process in higher education Forms of organization of the educational process at the University A systematic approach to the formation of the student's personality in pedagogy and psychology of higher education The personality of the student as a subject of education and psychological and pedagogical bases of its study The main problems and trends in the development of modern higher education
Psychology	Pedagogical skills of a high school teacher Psychological and pedagogical bases of formation of professional and pedagogical thinking of post-graduate students Pedagogical abilities of a higher school teacher Cognitive activity of University students, ways and means of its activation Psychological and pedagogical bases of formation of communicative competence of students in high school Typology of the University teacher's personality

*(continued)*

**Table 6.** (continued)

Instruments of the course	Topics in the course on Pedagogy
Methods and tools	Teaching methods in higher education The business game as a form of active learning in high school Technologies of developing education and their application in higher education System design on the example of the development of a specific educational technology Portfolio at the University, the technological map of its preparation The instructional strategy of the teacher of the high school Information technologies in University education Development of creative abilities of students Competence approach in higher education Research skills of students Development of critical thinking of students. Development of creative thinking of students
Communication and classroom management	Communicative characteristics of a higher school teacher Monitoring the quality of education Organization of the research team

Taking into account that courses are rather short, the contents are ample and cover the major topics to achieve the necessary competencies. The less attention in the courses is paid to the “Communication and classroom management”. Also, our analysis shows that training is oriented mostly on the theory where often Ph.D. students with engineering background try to study the fundamentals of pedagogy and pedagogical psychology in only 2 or 3 ECTS courses. The structure of the courses is not clear and rather unbalanced. It makes almost not possible to make exchange programs for Ph.D. students because it would be difficult to compare and recognize the period of study in partner universities.

The practical-oriented training in teaching students is received through internships, which aim at revealing the principles of the educational process at the University: the study and analysis of scientific and technical information, domestic and foreign experience in the area of study; the development of teaching materials, laboratory and practical training tasks and classes for bachelor and master students; classroom training, preparation for the implementation of the educational process in higher education institutions.

Besides the contents of the courses on pedagogy, students value the active teaching tools as well as ICT tools, the integration of international component and involvement into activities of industry partners. Unfortunately, universities provide only general information about these dimensions of the Ph.D. programs.

## 6 Conclusion and Recommendations

The research developed in the framework of the EXTEND project had the intention to present a comparative analysis of the practices in Ph.D. students teacher training with a focus on teaching engineering disciplines in Russian universities. Our data collection intended to cover information related to the content and courses' structure of the selected Ph.D. training programs.

The contextual background allowed us to identify the similarities of the Ph.D. education in Russian universities, the fact that the Ph.D. programs are aligned with the Bologna system and are regarded as higher education of 3rd Cycle.

Results of the study allow giving three recommendations.

### 6.1 Recommendation 1

Develop networking in the university's Ph.D. students' teacher training system to create joint flexible courses and programs.

The analysis revealed that each university has different approaches to Ph.D. students' teacher training focusing on the specific areas of study. Networking between partner and program universities involving other countries universities could help to joint efforts and achieve synergy effect in the development and delivery of fully-fledged training and re-training programs for teachers. The network would allow each university to excel in the selected area thus improving the quality of the whole program. Involvement of foreign partners could provide an international dimension to the program. According to types of inter-university partnerships [13] such networking could lead to emergence of multi-level educational complex of continuous training including development of academic exchange of students and teachers; carrying out joint individual PhD research projects; organization and implementation of joint conferences, seminars, symposia of PhD students; development and implementation of modern educational programs and their continuous improvement; expansion of the range of joint educational programs/"two diplomas" programs (joint or double degrees).

### 6.2 Recommendation 2

Develop university teacher model of competences with the descriptor of learning outcomes for the teacher of engineering disciplines.

The competencies on teaching used in Ph.D. programs are standard in Russian universities but at the same are very vague and general. It confuses all stakeholders about the real competences which the university teacher should possess. That is why there are significant differences between universities in the description of these competencies and learning outcomes achieved. On one hand, it allows to achieve diversity in teacher training approaches but on the other hand, it decreases the compatibility and portability of teaching competencies, decreases opportunities for Ph.D. student mobility and recognition of periods of study in other universities, confronts the rights of student for the quality education.

University teacher model of competences could be used also for design of teacher enhancement programs. It would help to increase the continuity of teacher training and improve career opportunities.

### 6.3 Recommendation 3

Introduce a modular approach to teacher training and re-training programs.

Each university offers several (some of them offer dozens of) Ph.D. programs where a set of competences could vary as well as the duration of the program/course. The modular approach could provide flexibility and scalability of the programs/courses, design tailor-made courses and create network joint programs with partners. Analysis of teaching competencies and real contents of the programs/courses allowed to identify basic modules to be developed: Project Based Learning (PBL), E-learning and ICT Tools [14, 15], Foreign Languages for Engineering + Academic Writing, Research-Based Learning (PhD Students) [16], Curriculum Design and Development, Assessment, Design thinking, Communication, Active Learning Strategies [17], etc.

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