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# ХИМИЯНЫ ОҚЫТУ ӘДІСТЕМЕСІ МЕТОДИКА ОБУЧЕНИЯ ХИМИИ METHODS OF TEACHING CHEMISTRY

DOI 10.31489/2019Ch4/110-115

UDC 378.147

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## **Engineering Educators Training in Kazakhstan: Situation and Prospects**

The article is a brief overview for the current state of engineering education in Kazakhstan and considers the prospects for its further development and implementation, which is due to the need for industrial and innovative development of our state. Kazakhstan, being an industrially developing country, needs qualified engineering personnel, therefore the training of such specialists at a sufficiently high level is a definite problem. It is noted that for its solution it is necessary to modernize existing study programs, train and retrain teaching staff, widely introduce modern educational approaches and technologies. The article discusses various forms of retraining of teachers of engineering disciplines, for example, advanced training courses for university faculty on the basis of additional education departments. Their topics, duration and forms of conducting are very diverse. Nevertheless, existing problems hinder the development of engineering education in our country; for their successful solution, representatives of the Chemistry and Physics & Technics Departments participate in the international project «EngineeriNg educaTors pEdagogical tRaining» (ENTER). This project implements goals aimed at creating an enabling environment in the educational space based on international cooperation between representatives of universities and the organization of Portugal, Estonia, Slovakia, Russia and Kazakhstan. So, it is planned to elaborate three educational programs (i-PETs) for engineering educators with a variable set of modules based on modern technologies (e-learning) and an individual approach. The implementation of the «ENTER» project is a real prospect of improving the status of engineering education and raising the level of engineering educators' training in our country.

*Keywords:* engineering education, engineering educator, study program, advanced training courses.

### *Introduction*

The economy of Kazakhstan is the largest economy in Central Asia. The country has significant reserves of oil, coal, as well as minerals and metals. The country's industrial sector is based on the extraction and processing of natural resources, as well as on a relatively large machine-constructing sector, specializing in construction equipment, agricultural equipment and some military products. The extractive industries have been and remain the engines of the economy of Kazakhstan and the growth of the country. The training of engineering personnel for the needs of the industrial sector is one of the key factors of state competitiveness and the basis for its technological and economic independence. This causes a social order for the engineering personnel training by the system of higher professional education of the country. The main industrial region of the republic is the Karaganda region which has the largest resources of raw materials of different origins for metallurgy and the construction industry. This defines the foundation for the development of such industries as ferrous and nonferrous metallurgy, coal mining, energy, petrochemical and chemical industry, the food industry, the construction industry. There is sufficient potential in the region for the development of enterprises of machine-constructing and metal-processing branches of industry [1].

The industrial orientation of the region determines the demand for specialists of various manufactories, engineering and teaching personnel. The needs of the region for engineering personnel are consistent with national priorities for the modernization of education.

However despite the significant scale of measures taken in Kazakhstan in recent years to support innovation there are still key problems related to the quality of training engineering professionals, the introduction of advanced technologies and best practices. Domestic universities are still divorced from the real needs of the regions; this is reflected in the discrepancy between the level of graduates and the demand in the local labour market and in distance from the business sector.

These problems lead to the necessity for modernization of existing educational programs at various levels based on a detailed analysis of the needs of the regions, the requirements for key competencies of University graduates defined by employers as well as an assessment of the expectations of Bachelor and Master students and graduates, their career prospects. It is necessary to identify and strengthen relevant and promising areas of training, modernize teaching methods and actively develop distance and online education systems, introduce modern information and communication technologies, improve the electronic infrastructure of universities, elaborate new interactive teaching & learning materials, improve forms, teaching methods and assess trainees' learning outcomes, skills and competencies, create conditions for the development of competence and the skills for faculties involved in the organization and implementation of research projects and programs (engineering and technical personnel, administrative — technical support and support service, etc.), advanced training of teachers.

So the aim of this paper is an analysis of current situation for engineering teachers training and making more precise the prospects for its improvement.

### *Results and Discussion*

The education system in the Republic of Kazakhstan on the basis of the principle of educational training programs continuity includes the following education levels: preschool education and training; primary education; main secondary education; secondary education (general secondary education, technical and professional education); postsecondary education; the higher education; postgraduate education.

Programmes for training of engineering teachers in the Karaganda region include training and professional development of teachers of technical higher educational institutions (HEIs) and technical specialties and also teachers of the multidisciplinary higher education institutions teaching engineering disciplines both on the basis of branches of Institute of professional development of the RK, and at departments of additional education of higher education institutions.

The most common form of the engineering and pedagogical personnel training organization is training at specialized departments in technical, state and pedagogical universities. At the same time, various forms of integration of education, science and production are used: intra-university, when faculties and university research institutes are combined, and external, consisting in creating cooperation with academic institutions and industrial enterprises. The task of engineering and pedagogical education is to provide specialists who are able to organize and carry out fundamental, technological and specialized professional training in the main sectors of the country economy.

The principle of university study programs construction is based on a combination of training based on the fundamental knowledge gained at the university, with practical industrial experience. Educational programs have a modular structure, are based on competence-based, student-centered, subject-activity approaches; are implemented on the basis of a credit system of education, which allows students choosing individual educational tracks. The educational disciplines of related content aggregated for providing meaningful unity are considered as a module. Each module forms specific competencies. The results of training in educational programs are based on the recommendations of potential employers. As applied to engineering education the training programs should be 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 he/she provides training, to know the peculiarities of industrial branch technology and a separate specialty in it, to have practical professional skills as he/she prepares to conduct both theoretical and practical training. Thus, the system of engineering and pedagogical education should integrate the pedagogical and professional components.

Now the engineering and pedagogical component is available in some Bachelor and Master programs, in particular in the Master degree program of the Academician Ye.A. Buketov Karaganda State University (KSU) 6M072100 — Chemical Engineering of Organic Compounds. Master students study disciplines «Pedagogics of the Higher School», «Psychology of Management», «Concept of Engineering Education for Chemical Technology», pedagogical internship that allows them to realize pedagogical, research and innovative activity in the field of the higher and professional education.

For the training of engineering educators in the universities of Kazakhstan traditional organizational forms of training are implemented. At the same time, peculiar meaning is given to lectures to which the most qualified and experienced teachers are involved (as a rule, professors and associate professors). The lecture lays the foundation of scientific knowledge, seminars allow trainees to expand and detail this knowledge, to develop and consolidate the skills of professional activity. Practical exercises are significant ones in developing students' skills in applying their knowledge to solve practical problems together with a teacher. The experiment plays a large role in the training of engineers who must have research skills from the first steps of their professional activities. In laboratory work the integration of theoretical and methodological knowledge with practical skills of students in a varying degree of proximity to the real professional activity is carrying out. A special attention is paid to trainees' joint group work. The maximum degree of approximation to the future professional activities is achieved during the internship at specific workplaces. Students' self-study under teacher's guidance and students' self-study itself play an important role in training modern specialists.

Karaganda State University developed the practice of opening branches of departments on the basis of partner organizations acting by external experts of educational programs and by potential employers as well. As a rule practical classes are held in the branches of the departments, professional internships are organized, approbation of final qualifying works is conducted. Experienced specialists of enterprises are involved in conducting classes and leading practices. In addition, practitioners are also involved in the final certification of students. The university has a program of attracting foreign specialists to deliver lectures, organize advanced training courses, and provide consulting assistance. Practitioners are involved in the implementation of the educational process. Students have the right to use virtual mobility windows, recruit credits from Kazakhstan or foreign partner universities in the framework of academic mobility, and use various forms of formal education in shaping the educational route. In this case all the results of such training are recognized at the university in accordance with accepted procedures.

The university creates conditions for professional growth as teachers working at KSU, and other educational institutions, including universities, colleges of Kazakhstan. The University has the department of Additional Education, which develops and implements programs for 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), academic load, forms of conducting (contact classes, a combination of online and offline forms, trainings and master-classes, internships in the manufacturing process, courses on open education platforms, online courses). The programs of advanced training courses for scientific and pedagogical staff of universities rely on modern achievements in fundamental and psychological and pedagogical sciences, world and national experience, new educational concepts, systems, technologies, methods and teaching aids, focused on acquaintance and introduction of innovative approaches in training with emphasis to improve the content of the educational program, the formation of a high level of research, the implementation of training using distance learning technologies, development of e-learning materials (multimedia technology, SMART learning technology, case study technology), the use of video materials in the educational process. For example, the result of advanced course «Distance courses «Developing e-learning aids» is learning to clearly formulate the SMART goal of lectures and 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 a one-time training or several cycles distributed over time — composite modules, allowing ensuring variability with advanced training.

For young teachers the University organizes the «School of lecturing skills» (free of charge), various forms of mentoring by more experienced teachers, and arranges courses for foreign lecturers and practitioners. In addition, university teachers have the opportunity to undergo advanced training courses 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 programs for teachers of pedagogical specialties of universities in Kazakhstan). University teachers regularly take part

in seminars on the base of Republican organizations; participate in conferences, educational and scientific events of different levels, in scientific and professional internships, etc.

Despite the measures taken for implementation of engineering educators training in Kazakhstan there are some lacks and contradictions between new and old educational media. For overcoming that the representatives of some Kazakhstani universities and organizations succeed in realization of the international project «EngineeriNg educaTors pEdagogical tRaining» (ENTER) which was launched in November, 2018. It is realized in the framework of Erasmus+ Programme; the project reference is 598506-EPP-1-2018-1-PT-EPPKA2-CBHE-JP. The consortium includes Universities and organizations from Europe, Russia and Kazakhstan. Instituto Politécnico do Porto (Portugal), Tallinn University of Technology (Estonia), and Dubnický Technologický Institut v Dubnicki nad Vahom (Slovakia) are European partners. Partners implementing the designed project programmes are Agency of Educational Strategies and Initiatives Bologna Club, Russian Association for Engineering Education, Don State Technical University, Tambov State Technical University, Tomsk National Research Polytechnic University, Vyatka State University, and Kazan National Research Technological University from Russia, Academician Ye.A. Buketov Karaganda State University, Al-Farabi Kazakh National University, and Kazakhstan Association of Engineering Education from our country.

The purpose of ENTER project is elaborating a novel multicultural and international approach for formal post-graduate professional and pedagogical education for engineering teachers. As it is focused on low cost and convenience of programmes the e-learning technologies are in the base of them. Whenever feasible, programmes should be designed with the objective of being internationally recognized and accredited. ENTER wants to go further than existing offers, offering the possibility of customization and adaptation to educators and HEIs' needs (e.g. national or regional context) and cover multiple areas of engineering [2].

One of the main objectives of the consortium is to work out multi-level modular system for pedagogical training of engineering educators based on international network cooperation. So the ENTER project participants propose a hierarchy of three well-structured educational programmes for engineering educators, so called iPET programmes which will be designed in the context of the European Qualifications Framework for Lifelong Learning. These educational programs will have various content and duration. They are:

- iPET-1 Short-focused (2 ECTS) — «Qualification Development» Certificate;
- iPET-2 Professional Retraining (e.g. 8 ECTS) — «Higher Education Teacher» Diploma;
- iPET-3 International recognized (e.g. 20 ECTS) — a full programme leading to international accreditation as «Engineering Educator».

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

Before starting elaboration of iPET programmes much preparatory work should be done. As project programmes are competence-based some questionnaires were developed aimed to analyze the situation about engineering education in Kazakhstan, to find out concrete expectations of the target audience, i.e. engineers, engineering educators, representatives of stakeholders, etc. much attention will be paid to establishing key competences for engineering educators.

Modern educational programs should include new disciplines reflecting innovative production technologies and giving qualifications that are in demand in the labour market. Educational programs should become practice-oriented. In order to train personnel for the innovation economy, entrepreneurial education will be implemented in the content of educational programs, which means the inclusion of disciplines (modules) that form entrepreneurial knowledge and skills. The authorized body in the field of education is introducing a system of rating educational programs of universities based on a survey of employers on an annual basis and other data. The main indicators will be employment, graduates' salary and characteristics of educational programs used by universities.

As modern forecasts show engineering and natural science specialties related to industrial production take the leading position in Kazakhstan, which should provide the regions with professional engineers, technical specialists and middle and top managers competent in various fields of interdisciplinary knowledge, engineering marketing and management. At the same time, high-quality training should be promoted: modernization of existing educational programs at various levels based on a detailed analysis of regional needs, employers' requirements for graduates' key competencies of from universities by, as well as an assessment of the expectations of applicants, students and graduates of the prospects for their professional activities and career expectations. In accordance with the economic and social transformations taking place in the country,

it is necessary to identify obsolete academic disciplines that lose their relevance, at the same time strengthening the relevant and promising directions, changing the focus and emphasis of educational programs, incorporating practical skills training and getting practical qualifications, entrepreneurial competencies. At the same time, it is necessary to modernize teaching methods and actively develop distance and online education systems, introduce modern information and communication technologies, improve the electronic infrastructure of universities, develop new interactive learning materials that will enhance learning motivation, enhance cognitive activity of students, develop abilities to self-study, develop creativity and thinking outside the box, reveal personality-individual capabilities of each student and determine the conditions for their manifestation and development, develop universal skills.

In the case that the university's curricula do not match current realities, it will not be possible to provide the Kazakhstan's labour market with highly qualified specialists in demand, ensure the competitiveness of educational programs and their recognition by potential consumers, prepare specialists for working in the «digital age», «digital communication», «digital decision making methods». Traditional educational programs and forms of advanced training will not be able to provide contextual learning, within which approaches to the use of professional context in the educational process, the transition from learning tasks to quasi-professional and further to professional tasks should be used. In Academician Y.A. Buketov KSU to solve this problem, the methods of forming educational trajectories are used with the inclusion of elements of professional activity on the basis of branches of departments in the educational process, as part of applied research programs, professional internships and practices, assessment of professional competencies of graduates by representatives of the professional community. The University maintains close contact with employers, analyses feedback on the work of graduates, attracts employers to accredit educational programs, the National Chamber of Entrepreneurs of Kazakhstan «Atameken» participates in competitions to assess the quality of educational programs, creates a register of educational programs based on monitoring the needs of the region in specialists, annually adjustment of learning outcomes based on recommendations of representatives of the relevant professional sphere. The content of educational programs includes elements of formal education with the recognition of their results.

### Conclusions

So the modern situation with engineering education in our country was presented based on the analysis of existing study programmes; problems were identified; solutions for them were suggested; one of them is realization of international project «EngineeriNg educaTors pEdagogical tRaining» via elaborating three modular programmes of various academic load and duration. These programmes will be based on modern educational approaches and technologies.

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## Қазақстандағы білім беру инженерлерін дайындау: жағдайы және болашағы

Мақалада Қазақстандағы инженерлік білім берудің қазіргі жай-күйіне қысқаша шолу жасалады және мемлекетіміздің индустриалды-инновациялық даму қажеттілігіне байланысты оны одан әрі дамыту мен енгізу перспективалары қарастырылған. Қазақстан өнеркәсіптік дамып келе жатқан ел бола отырып, білікті инженерлік кадрларға мұқтаж, сондықтан мұндай мамандарды жоғары деңгейде даярлау белгілі бір мәселе болып табылады. Оны шешу үшін қазіргі білім беру бағдарламаларын жаңғырту, педагогикалық кадрларды оқыту және қайта оқыту, заманауи білім беру тәсілдері мен технологияларын кеңінен енгізу қажет. Мақалада инженерлік пәндер оқытушыларын қайта дайындаудың әртүрлі түрлері қарастырылған, мысалы, қосымша білім беру факультеттерінің базасында университеттердің профессорлық-оқытушылар құрамы үшін біліктілікті арттыру курстары.

Олардың тақырыбы, ұзақтығы және өткізу түрлері әртүрлі. Осыған қарамастан, қазіргі мәселелер біздің елімізде инженерлік білімнің дамуын тежейді; оларды табысты шешу үшін химия және физика-техникалық факультетінің қызметкерлері «Инженерлік іс оқытушыларын педагогикалық дайындау»/«EngineeriNg educaTors pEdagogical tRaining»(ENTER) халықаралық жобасына қатысады. Бұл жобада жоғары оқу орындары өкілдерінің халықаралық ынтымақтастығы негізінде білім беру кеңістігінде қолайлы орта құруға және Португалия, Эстония, Словакия, Ресей және Қазақстан ұйымдасуына бағытталған мақсаттарды жүзеге асырады. Сонымен, инженерлік мамандықтардың оқытушылары үшін оқытудың заманауи технологиялары (e-learning) және жеке тәсіл негізінде модульдердің ауыспалы жинағы бар үш білім беру бағдарламасын (i-PET) әзірлеу жоспарлануда. «ENTER» жобасын жүзеге асыру инженерлік білім беру жағдайын жақсартудың және біздің елімізде инженер-педагогтардың дайындық деңгейін арттырудың нақты болашағы болып табылады.

*Кілт сөздер:* инженерлік білім, инженер-оқытушы, білім беру бағдарламасы, біліктілікті арттыру курстары.

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## Подготовка инженеров-педагогов в Казахстане: состояние и перспективы

Статья представляет собой краткий обзор современного состояния инженерного образования в Казахстане и рассматривает перспективы его дальнейшего развития и внедрения, что обусловлено необходимостью индустриально-инновационного развития нашего государства. Казахстан, будучи промышленно развивающейся страной, нуждается в квалифицированных инженерных кадрах, поэтому подготовка таких специалистов на достаточно высоком уровне является определенной проблемой. Отмечено, что для ее решения необходимо модернизировать существующие образовательные программы, обучить и переобучить педагогические кадры, широко внедрять современные образовательные подходы и технологии. В статье рассмотрены различные формы переподготовки преподавателей инженерных дисциплин, например, курсы повышения квалификации для профессорско-преподавательского состава университетов на базе факультетов дополнительного образования. Их тематика, продолжительность и формы проведения весьма разнообразны. Тем не менее, существующие проблемы сдерживают развитие инженерного образования в нашей стране; для их успешного решения сотрудники химического и физико-технического факультетов участвуют в международном проекте «EngineeriNg educaTors pEdagogical tRaining» (ENTER) /«Педагогическая подготовка преподавателей инженерного дела»/. В данном проекте реализуются цели, направленные на создание благоприятной среды в образовательном пространстве, на базе международного сотрудничества представителей вузов и организаций Португалии, Эстонии, Словакии, России и Казахстана. Так, планируется разработка трех образовательных программ (i-PET) для преподавателей инженерных специальностей с переменным набором модулей на основе современных технологий обучения (e-learning) и индивидуального подхода. Осуществление проекта «ENTER» является реальной перспективой улучшения состояния инженерного образования и повышения уровня подготовки инженеров-педагогов в нашей стране.

*Ключевые слова:* инженерное образование, инженер-педагог, образовательная программа, курсы повышения квалификации.

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