

# CENTRAL ASIAN JOURNAL OF THEORETICAL AND APPLIED SCIENCES

Volume: 02 Issue: 02 | February 2021

ISSN: 2660-5317

## Formation of engineering competence of technical university students

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*Received 22nd December 2020, Accepted 12th January 2021, Online 21th February 2021*

**Abstract-** This article aims to consider the view of foreign authors on the problem of the formation of engineering competence. Study the practice of establishing the engineering competence of students of higher educational institutions for subsequent introduction into the education system of the Republic of Uzbekistan.

**Key word:** competence, knowledge, ability, skill, competence, knowledge, ability, readiness, engineering education

### Introduction

The engineering, science, technology and mathematics are the most important sectors which need to be considered for maintenance of the status of the economy based on knowledge.

The engineering program of the 20th century isn't sufficient for the solution of engineering problems of the 21st century any more. Certain engineering competences, such as design and analytical thinking, became necessary even for those who study and work in not engineering disciplines. Graduates of engineering specialties not only are demanded for technical and scientific career, but also began to play an important role in such areas as business, finance, management, policy, social sciences, etc. It is claimed that definition engineering has to be expanded to correspond to the arising trends and roles of modern and future engineering.

Researches in the field of engineering education, whether it be the higher education or education at schools, are important for development of the modern training program, ensuring competent teaching engineering education and training and also for the solution of problems which graduates in a professional situation in a workplace face [1]. The growing complexity and interdisciplinarity of an engineering profession demands equipment of graduates of engineering specialties a set of non-technical skills, such as communication, decision-making, management, leadership, emotional intelligence, cultural awareness and social ethics. The attention to researches in the field of engineering

education promptly grows in many countries of the world, such as the USA, Malaysia, India, Mexico, Europe, Taiwan, etc. [2].

Researches in the field of the engineering education (EE) are a new cross-disciplinary area of researches. In particular, research methods in the field of pedagogics, psychology and social sciences are important for informatization of researches in engineering education [2]. Other areas which as it was established, influence IO: sociology, ethnic and gender researches, international relations, etc. [3]. Experts in the field of engineering, natural science and mathematical education put in the forefront a variety of reasons to focus on engineering education, such as globalization and transcontinental business, big problems in steady design, decrease in interest in engineering among school students, maintenance of innovative potential and the international competence in the world market, etc. All these and other reasons demand radical changes in the training program and in a technique of teaching and training of engineers [4].

The centers and divisions of university or engineering colleges for engineering education, pedagogical support, outreach activity, researches and curriculum development are quite widespread in the USA from 1990th. Outside the USA the centers, divisions and research groups which are engaged in engineering education are scattered worldwide, however their frequency is much less, than in the USA; it is expected that this number quickly will grow in the next several years. Examples of such centers are: Engineering center of excellence in the field of teaching and training at the University of Loughborough, Great Britain, research group on engineering education at the Linchyopinga University, Sweden and Department of engineering training in the University of Melbourne, Australia. These departments were aimed at movement of the status in engineering education from the isolated research efforts to the active academic communities intended for scientific research.

Realization of various forms of engineering education at the K-12 level (School to the USA, K – kindergarten, 12 classes) was carried out generally to the USA and traced prior to the beginning of the 1990th. By estimates, more than six million pupils of K-12 in the USA passed formal engineering education in schools, and tens of thousands of teachers of K-12 completed the relevant advanced training courses. Engineering activity was used as one of the most effective remedies for demonstration of applicability taught mathematicians, physics and chemistry in education of school students. There are more and more certificates that inclusion of engineering education in school education has positive impact on stimulation of interest and improvement of studying objects of natural sciences and mathematics. Besides, as engineering applications are very notable and strongly depend on science and mathematics, such approach usually attracts school students to future career in the subject STEM [5]. Engineering could improve achievement of results of training in natural science and mathematical objects in the training program of K-12 [6]. Irrespective of whether pupils will choose technical or non-technical training or career after school, use of engineering education in formation of K-12 is way of development of necessary skills for career of the 21st century, such as solution of problems, creativity, leadership, team work, the organization skills of management, etc. [6].

The countries of Europe, the USA, Russia began to treat more seriously diversification of the economic resources, paying special attention to rationalization of technologies, innovations and the economy based on knowledge. Engineering and technological shots play a key role in this process of

diversification. For example, the bigger number of graduates of technical specialties and, therefore, increase in amount of works, since school will be required. In terms of quality the considerable proportional transition to functions of innovations, design, stability, research and development and commercialization will be required. Therefore, the competences demanded from graduates of technical specialties have to will to change significantly.

Some time ago large training centers of engineering education led to new, based on results, to approach to creation of programs in engineering sciences [7]. These results are based on a set of the qualities of the graduate received by him for satisfaction of estimated requirements of the industry in the future. Nevertheless graduates of engineering specialties can not have the competences necessary for modern practice even if results of the program were developed taking into account the stated requirements of the industry. There is a perceived gap between knowledge of the graduate and competences necessary in practice for satisfactory work in the industry. The analysis of an empirical research leads to multiscale system model of engineering competence where installations and a self-assessment are at the metalevel, and they help to organize and kontekstualizirovat a concrete set of competences of the person of a specific working situation [8].

The competence is more than possession of knowledge or psychomotor skills necessary for performance of a specific objective. The engineering competence means that the engineer who is carrying out any production consistently integrates knowledge, skills and personal qualities into daily practice to conform to the established standards of performance [9].

The education based on competences is focused on knowledge, professional skills and behavior necessary for new graduates.

Bases of competence of engineering education are closely connected with innovative training to reduce passive dependence on teachers and to stimulate team work of students and a critical self-assessment.

The competence is most often used for the description of skills, understanding and professional values of the person ready to begin independent engineering activity in industry

The engineering competence combines attributes of the corresponding auxiliary knowledge and professional installations and also reliable work under natural conditions without assistance.

Earlier engineering education was structured so that pupils substantially studied what the curriculum of higher education institution chose for training. The purpose was in training the engineer with the ordered packages of knowledge after the end of training. This traditional approach was generally disciplined [10]. Now the tendency to the training based on competences which provides the sequence of a certain educational experience for students that upon termination of training and practice they could be considered the qualified young specialists is more often observed. Acceptance of the training based on competences demands reevaluation and revision of old training programs, but between traditional and based on competences by education there is certain common language.

The emphasis is placed on assessment of performance and demonstration of skills or competences, but not just written confirmation of knowledge. Assessment based on results is comprehensive and covers broad results, but not several narrow fields of knowledge in the established education [11].

The difference between the disciplinary education and education based on competences has to be considered during the planning and curriculum development which are intended for ensuring practical requirements of the future. However these two approaches aren't mutually exclusive, and between them there is a certain common ground.

To become the professional – means to pass through the predictable sequence of qualitatively various models of skills, knowledge and values. The competence includes development of behavior models which are open for wider protocols of assessment, than traditionally used in formal training. The problem of the education based on competences is in integrating the purposes with statements for competences for key tasks.

The competence is reached not at once, and reached step by step as it is described in S. Male's work et al. [12].

More often in engineering education the main objective of training is in that the pupil gradually became independent, and independent training was replaced by teaching [12]. Some educational tasks can help pupils to master quicker the intellectual processes necessary for training [13]. The successful strategy of training can include practice of the concrete skills corresponding to a task (cognitive aspect). Students, perhaps, should give accurate instructions how to get and control the skills (metacognitive aspect) acquired by them and also to explain why and as the skills acquired by them work (the informed training) [13].

Teaching at the universities is generally concentrated on development of skills and knowledge at students. This emphasis on field of knowledge and skills doesn't consider competence of change of the personality, motives and a self-assessment [14]. The competence is conceptualized as an iceberg where the skill and field of knowledge forms the top seen over a waterline, traits of character, the self-assessment and motives form the basis of human competence. More specifically, it means that these lines of the human person were defined as much more reliable predictors of long-term labor productivity, L. Spencer notes in the work [15].

The student upon termination of education receives a portfolio or the magazine of the completed stages answering to certain criteria, the letters or forms confirming the abilities of the student in various disciplines signed by heads of departments, videotapes about his / her work during practice and also research works or papers. This system of assessment is created in four stages( figure 1).

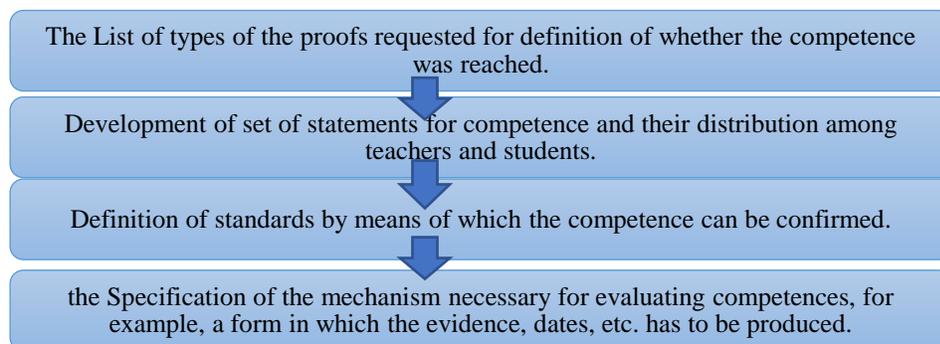


Figure 1 System of assessment

In practice the gap in competence arises generally from two main reasons. First, a question that in principle is possible in education. And secondly, some aspects concern deeper personal lines of the graduate and motives, his ethical and social understanding, it is obvious that it can't be learned at the level of the actual knowledge, D. Radcliff notes [16].

The engineering as a profession becomes more and more various with a wide range of career opportunities. Thus, a task of teachers to prepare the students for this variety of requirements of competence. It leads to the conflict of the general education against preparation for specific working objectives.

Gain scores of students can be as forming to stimulate further progress by means of feedback of results, and summarizing when results are final for the subsequent education. Such estimates were effective in the educational programs based on competences for engineers for improvement of knowledge, the professional relation and skills of work. Laboratory and practical educational tasks easily give in to the continuous forming assessment. Right after a lesson each pupil has to write down the educational experience and independently estimate the level of knowledge, professional behavior and skills of work. Though, by experience of authors, some students are inclined to overestimate the abilities, more realistic prospect develops with increase in a maturity.

Acquisition of competence in general as complex system [14] are the accidental competences and abilities important for work in the professional industry which aren't connected with target training. Engineering students gain these competences through difficult interaction of the traditional forms of education and other elements surrounding formal educational process. The external circle contains various clusters of elements which make a complex system of education and by that promote formation of competences of students.

For students it is difficult to define difference between science and technology today. Increase in awareness on the fundamental principles which are the cornerstone of an engineering profession has to possess a high priority.

There are strong reasons to convince the governments to make engineering the main subject in the training program of school students. From the beginning of training at 12-year age, with continuous strengthening of mastering of this program before entering a university.

With introduction of bases of engineering competence in the school program there will be an opportunity to use and develop a number of creative educational and teaching resources which recover many objects through engineering discipline. Research objectives are generalization of best practices of early involvement of school students in research activity, development of the new theoretical representations conceptualizing early scientific cognitive activity of pupils researchers. As a result of long-term studying practice according to the Step to the Future program two types of motivation of early research activity of school students – social and formal educational are revealed. The Epistemodidaktichesky analysis of experimental data shows a key role of social motivation and a supporting role of formal and educational motivation. New theoretical concepts are developed: research behavior of scientific type, epistemic (research cognitive) imprinting, socialization of research type. The relation to the truth in educational work with school students researchers is analyzed; micropedagogical roles of the research supervisor are defined. The conclusion is drawn that scientific and informative self-

realization of the person is governed not by the formal system of the relations of teaching and training, and the human factor playing a key social role.

Thus, development of "engineering competence of pupils of educational institutions (school)" is a formation and awakening of interest, knowledge of itself, own keenness, sharp mind, a different view and thinking, formation, I repeat in the simplest and initial condition of the most demanded competences of the 21st century – creativity, critical thinking, communication, work with information, cooperation by means of design events.

### Conclusions

There are many problems which demand special methodology and methods of a research. In this regard it is useful to use and integrate experience of other countries and also to be guided by their national peculiarities of an education system.



Figure 2 The formation of learning

All this will help to build, modify and add correctly competences, to define structure and structure of professional competence of future experts and to estimate whether correctly they are created as the structure of the required competences in the market can change if we consider conditionality of competence requirements of labor market.

For creation at future students of interest in engineering specialty it is necessary to enter acquaintance of school students to engineering specialty at schools, to tell about communication of technical science (mathematicians, physics, IT), to create "windows of opportunities" for talented school students and creation of the training program for school students.

Certainly, it is possible to apply the experience of foreign authors investigated by us on formation of engineering competence of pupils of the higher and secondary education in an education system of the Russian Federation both on regional, and on federal levels.

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