New educational programmes as a factor in forming students' innovative competencies

Olga Semenyuk†, Sabina Kuc‡, Sara Sadykova†, Kaldybay Arynov†, Ella Beloussova†, Shakizada Niyazbekova* & Buldyryk Suleimenova**

L.N. Gumilyov Eurasian National University, Astana, Kazakhstan†
Cracow University of Technology, Kraków, Poland‡
S.U. Vitte Moscow University, Moscow, Russia*
S. Esenov Caspian State University of Engineering and Technology, Astana, Kazakhstan**

ABSTRACT: The main reason for creating new educational programmes is to produce highly qualified graduates from university-level institutions to meet demand in the workplace. These experimental programmes enable students to be trained in professional skills, while exposing them to the latest technologies, and the practice of that knowledge through universal standards and reality. The graduates also develop an outlook, which contributes to their gaining professional experience within design organisations and public institutions. In today's rapidly changing labour market, graduates must be provided with innovative knowledge that enables adaptation to new technologies. Labour market studies indicate a deficiency in highly qualified specialists in areas where interdisciplinary competencies and a broader range of knowledge is required. The fostering of competencies, such as creative thinking, an active stance in life and a creative and analytical approach are significant in enabling students to solve problems in the professional sphere. Educational programmes must adapt to the demand of the global market.

INTRODUCTION

The experimental educational programme, Energy-saving Design of Buildings and Structures was developed by teachers at the Architecture Department in *L.N. Gumilyov* Eurasian National University, Astana, Kazakhstan, with employers of the architectural design organisations of the city of Astana. Every employer wants universities to provide the best-trained personnel who are innovative in their approach to solving various problems in businesses, regions and on a national scale. It is necessary to train students properly - not only in theoretical knowledge, but also to turn them into specialists who can explore and identify new ideas and apply their knowledge in practice. The programme is relevant in the context of the transition of the Republic of Kazakhstan to an energy-efficient economy and contributes to the development of the design of energy-efficient buildings in the field of education and in the workplace [1].

IMPACT OF ARCHITECTURE ON THE ENVIRONMENT

The need to design energy-efficient buildings and structures is dictated by the ecological state of the environment in the Republic of Kazakhstan, which is the world's seventh-largest producer of carbon pollution. Modern life requires energy-saving technologies. Because of rapid scientific and technological progress, energy efficiency has become a major factor in solving problems of the architectural and construction sector, as well as those of nature and society.

Modern energy-efficient architecture was designed by means of a clear focus on a new approach to design, through alternative energy sources, as well as co-operation between sectors of the national economy. A modern architect not only designs buildings and structures, but also influences the environment, creating conditions for human life, the microclimate in the surrounding space and can help solve acute problems related to a lack of natural resources.

Around the world, buildings have high energy consumption, as well atmospheric greenhouse gas emission rates, significantly exceeding the total emissions from vehicles. There are significant opportunities to reduce energy consumption by buildings at lower costs and with a greater profit than in other sectors.

These reductions are fundamental to achieving the goal of the International Energy Agency (IEA), which is to reduce global carbon emissions by 77 percent from the predicted rate for 2050 and to achieve stabilised CO_2 level envisioned by the Intergovernmental Panel on Climate Change (IPCC) [2]. The IEA experts believe transition from the construction of ordinary buildings to the construction of energy-efficient residential and public buildings should be important in achieving these goals. Experts have stressed the significance of designing and building energy-efficient housing around the world.

RELEVANCE OF ENERGY-EFFICIENT BUILDING DESIGN

A study of modern sustainable architectural design practice has examples of an integrated approach to design: this is when the architect is the head of a group of specialists from various areas related to the energy efficiency of buildings and structures. This approach to design enables the creation of integrated solutions, including the most cost-effective ones. The process of integrated design requires the architect to have knowledge not only in his/her field, but also in other related areas, including civil engineering, physics and environmental sciences [3]. It is evident that effective mastering of a wider range of knowledge and skills by future specialists implies the need for a specialised approach to architectural education.

Energy-efficient architecture is rapidly developing and becoming an important factor in improving human life and the environment. The contemporary economy is based on the development of new technologies in design and construction, and the exploitation of potential natural energy sources. These make it possible to effectively apply advanced technologies in architecture and civil engineering. The potential impact on the economy and lifestyle underlines the significance of the development of energy-efficient architecture in modern Kazakhstan.

The state's energy saving policy prioritises transitioning to new technologies that improve the performance of heating and power supply to buildings and structures, conserving resources and creating an improved architectural environment. Regarding the advantages of energy-efficient design in architecture, the technologies and developments in Kazakhstan for such buildings and structures not only conserve energy, but also improve the quality of the environment (buildings and structures are the main source of carbon pollution in the urban environment) [4]. Though the environmental requirement to conserve energy resources is being addressed, the design of energy-efficient buildings requires a new approach to teaching architecture.

EXPERIMENTAL EDUCATIONAL PROGRAMME AND ENERGY-EFFICIENT ARCHITECTURAL DESIGN

Principal Aim of the New Curriculum

The main idea behind the experimental programme, Energy-saving Design of Buildings and Structures, is to produce highly qualified staff in the field of energy-efficient design of buildings and structures. The purpose of the experimental programme is to teach students professional skills in energy-efficient architecture, energy-saving technologies, and the application of knowledge reflecting universal laws and reality. This should shape the worldview of graduates on ecology and facilitate the acquisition of professional experience in design organisations. In a rapidly changing employment market, it is most important for graduates to be equipped with the latest knowledge of energy-efficient architecture and the application of new technologies in an environmentally friendly manner.

Energy-saving Design of Buildings and Structures Programme: the Main Advantages

A study of the labour market has shown a shortage of highly qualified specialists in the design of energy-efficient buildings and structures, especially in areas where interdisciplinary competencies are required. The transition to energy-efficient technologies in architecture requires a broad range of knowledge by the architect. Because of this, the programme was designed to meet the new challenges of the global market and the latest trends in the development of modern architecture and civil engineering.

A graduate, an architect, will possess skills in the field of architectural design and energy conservation. Knowledge of the nuances of designing energy-efficient buildings and structures, as well as of the use of alternative energy sources in buildings, enables the creation of an environmentally friendly environment for humans. Graduates will be able to work in architectural design firms and organisations involved in energy-efficient building design, as well as to perform management functions.

The programme is interdisciplinary and provides in-depth knowledge of energy-efficient architecture. Skills and competencies in the professional field of architectural design, combined with technical design skills, will help graduates in gaining an advantage in the employment market. Particular emphasis has been placed on enhancing knowledge of energy conservation in architecture; the energy-efficient remodelling of buildings; the formation of competencies, such as creative thinking; an active, creative, engineering-like approach to solving professional problems [5].

The Energy-saving Design of Buildings and Structures programme is compliant with normative legal acts and standards in higher education of the Republic of Kazakhstan, and is in line with international trends in science and education. The structure of the experimental programme features practice-oriented disciplines that can be taught by architecture practitioners and which also provide assistance to students in job placement.

The experimental educational programme was partially tested in the Department of Architecture at the Faculty of Architecture and Construction of *L.N. Gumilev* Eurasian National University. Since the 2013-2014 academic year, the Department of Architecture has been developing and implementing modules concerning the design of energy-efficient buildings and structures, as recommended by employers, in the framework of the existing educational programmes below:

- *Energy-efficient housing design.*
- *Energy-efficient public building design.*
- *Energy-efficient civilian building design.*
- *Alternative energy sources in architecture.*

Architectural design projects prepared by students are shown in Figure 1.

Figure 1: Architectural projects of students from *L.N. Gumilev* Eurasian National University.

Students are able to master the content of these modules and graduates are in demand in the employment market. Experts from employers and organisations focusing on energy-efficient architecture were involved in the development of the experimental educational programme and elective modules. These included representatives from Astana-based architectural firms: *Gulden AS* LLP, the *SANAR* design and manufacturing company, and *Saulet Studio* LLP, as well as specialists from the Saint-Gobain energy-efficient building materials production company. Saint-Gobain specialists repeatedly have provided support during lectures and seminars for students and teachers on energy-efficient architecture. Over the past three years, Saint-Gobain representatives have been actively conducting training seminars and organising various student competitions at state and international levels.

The *SANAR* (Head Architect S.S. Dzhambulatov) design and manufacturing company and the *Gulden AS* LLP (Head Architect B.Z. Bazyken) architectural firm have expressed a desire to co-operate during all stages of the implementation of the experimental educational programme and implement this experimental educational programme in co-operation with the Department. Practitioners from these manufacturing firms, with the departmental teachers, will teach the following modules within the framework of the experimental educational programme:

- *Energy-efficient building materials.*
- *Alternative energy sources in architecture.*
- *Passive house design.*
- *Methodology for designing energy-efficient buildings.*
- *Conceptual design of energy-efficient buildings and complexes.*
- *Energy-efficient architectural design XI, XII.*
- *Design as a business.*
- *Design work organisation.*
- *Scientific basis for the design of energy-efficient buildings.*
- *Pre-diploma design project.*

A student who has completed the experimental educational programme, Energy-saving Design of Buildings and Structures, should:

- be competitive in the employment market, in energy-efficient architecture, and demonstrate global thinking;
- be familiar with the modern achievements of science and advanced technologies in energy-efficient architecture; be creative and competent, i.e. possessing knowledge of modern technologies in energy-efficient architecture;
- possess both specialised and interdisciplinary knowledge, skills and abilities, competencies and familiarity with technologies in energy-efficient architecture;
- display interest, motivation and enthusiasm; be ready to learn and undergo self-improvement throughout life;
- be innovative and creative; have specialist knowledge in energy-efficient architecture and possess leadership qualities; be quick and flexible.

CO-OPERATION BETWEEN *L.N. GUMILEV* EURASIAN NATIONAL UNIVERSITY AND CRACOW UNIVERSITY OF TECHNOLOGY

Students of Cracow University of Technology, Kraków, Poland, and *L.N. Gumilev* Eurasian National University annually conduct joint practical training in architectural design, in addition to participating in creative workshops [6][7] and competitions [8]. Architectural design projects prepared by students are shown in Figure 2. They also share experience and knowledge in various areas of architecture, including in energy-efficient architectural design.

Each year, groups of second-, third- and fourth-year students of the architecture specialisation travel to Poland for one semester. Students of the Faculty of Architecture at Cracow University of Technology go to *L.N. Gumilev* Eurasian National University to participate in seminars and student workshops. The student exchange has been observed to yield positive results. Students acquire additional competencies, experience and knowledge; they improve their language and communication skills.

Figure 2: The architectural projects of students from *L.N. Gumilev* Eurasian National University. International student workshop students of the Architecture Department, Eurasian National University on the subject: *Projecting of energy efficient residential buildings Saint Gobein in city environment of Madrid*, November 2016 [7].

Undergraduates also engage in practical training at a foreign university and participate in joint international conferences. The teachers of the two universities jointly develop textbooks, scientific monographs and conference presentations [9-11]. Co-operation enriches the theoretical, practical and scientific body of work of teachers, students and undergraduates, particularly at an international level.

Universities are modernised and computerised. Gradebooks, e-passports for students, schedules, grading and assessment tasks for independent work and practical training have been converted into digital formats. Electronic textbooks are being created; the number of massive open on-line courses and the number of their consumers is growing.

The rapid modernisation and digitalisation in education contributes to the development of new methods of teaching and learning. Educational programmes will be aimed at training personnel with specialist industry skills, as well as skills enabling the formulation of creative and innovative solutions to complex problems, continuous self-improvement and the ability to work in a team.

Experienced foreign professors are involved in lecturing. One example is a Visiting Professor, Professor Sabina Kuc who gave a series of lectures and conducted seminars on the subject of the energy design of residential buildings in late 2016 [12]. Questions on developing new educational programmes in specialisations that are in high demand in the workplace are being actively considered. New modules are being introduced into existing educational programmes to provide graduates with sufficient competencies to be desirable employees in the employment market. Thus, co-operation creates a new educational environment in which to develop innovative professional personnel.

COMPUTERISATION OF THE EDUCATIONAL PROCESS

Education is a priority in the computerisation of modern society [13]. Computerisation intensifies intellectual activity through information technologies. These technologies enable:

- Rational organisation of learning by students.
- Construction of an open education system.
- Individualisation of the teaching process through digital tutorials.
- More effective teaching through multi-media.
- Increase of intensity of teaching at all levels.

Information and communication technologies promote student interest and stimulate learning. Information technology allows the creation of an interactive teaching environment with enhanced opportunities for both teacher and student. Unlike ordinary teaching, information technologies promote students' mental and creative abilities.

Students' abilities also improve in acquiring new knowledge and working with sources of information. The use of computer models contributes to an improved understanding of teaching material. Electronic textbooks with three-dimensional illustrations contribute to the development of spatial thinking. Electronic textbooks feature convenient keyword search systems and glossaries, as well as a convenient hyperlink-based navigation system.

Training presentations (slides) can include animations, audio and video fragments, and interactive elements. Virtual systems are convenient to use. Experiments can be conducted in a virtual laboratory through using such software. Information and communication technologies can be used to study new material and refresh material prior to assessment.

CONCLUSIONS

Higher education involves the development of skills and competencies. There is growing competition not only between educational institutions, but also between countries and educational systems. As new professions emerge, so do new directions in professional activity. This leads to the need to introduce new educational programmes.

The application of modern innovative technologies in universities, in both research and education, is necessary to improve the level of education of students and to improve the professional competence of teaching staff. The experimental educational programme, Energy-saving Design of Buildings and Structures, meets contemporary requirements, and is being successfully implemented with the support of architectural design organisations and the students themselves. Specialists who have completed this programme are in demand in the contemporary labour market, in architectural and construction firms, as well as organisations.

REFERENCES

1. Semenyuk, O., Relevance of the New Experimental Educational Programme Energy-saving Design of Buildings and Constructions for the Modern Sphere of Design Activity. The Collection of Materials of Methodical Decade Innovative Technologies and Methods of Training in the Context of New Rules of Law in the Sphere of the Higher and Postgraduate Education. Astana (2019).
2. Rakhimbekova, S., *Green Way: Expo-2017 and Green Economy.* Karaganda: Regrast LLP, 228 (2018).
3. Feist, W., Basic Provisions on Design of Passive Houses M. Publishing House of the Association of Construction Higher Education Institutions, 144 (2008).
4. Semenyuk, O., Beloussova, E., Nechay N., Listkov, V., Kurbatova, N., Niyazbekova, S. and Abdrashitova T., The influence of ecology and economic factors on eco-architecture and the design of energy-efficient buildings. *World Trans. on Engng. and Technol. Educ.*, 16, **2**, 186-192 (2018).
5. Olkhovaya, T., Competence-based Approach to Determination of Content of Higher Education. Materials of a Lecture on the Subject. Orenburg: Regional Public Institution Public Educational Institution (2010).
6. Sadykova, S, Semenyuk, O., Khvan, E. and Kuc, S., Development of students' creative skills through architectural workshops. *Global J. of Engng. Educ*,, 18, **3**, 223-231 (2016).
7. International student workshops - students of Katedra Architecture Eurasian National University on subject: *Проектирование мультикомфортного дома Saint Gobein. Восстановление городской среды г. Мадрид.* Tutors: Sabina Kuc and Sara Sadykova, with help of Olga Semeniuk, Nur-Sultan (Astana), November 2016, 18 November 2018, http://www.enu.kz/ru/info/novosti-enu/46630/?sphrase_id=1369988 (in Russian).
8. *Приглашение к участию в конкурсе Проектирование Мультикомфортного дома Saint-Gobain, Восстановление городской среды микрорайона в г. Мадрид, Международный двухэтапный открытый конкурс,* ISOVER students' contest 2016-2017 (Ru) Kz and Kg.pdf
9. Kuc, S., Sadykova, S. and Kuc, W., The Architecture of Astana as the Example of Contemporary City Creation. *Proc. 3rd Annual Inter. Conf. on Architecture and Civil Engng.*, 13-14 April 2015, Singapore. Global Science and Technology Forum, 2, 683-690 (2015).
10. Kuc, S., Projecting of Energy Efficient Residential Buildings - ISOVER 2017, ENU, Astana, Kazakhstan - the Educational Role of Student Workshops. Oral Presentation. 5th Mediterranean Seminar on Engineering and

Technology Education, Educating - Networking - Evolving, 11-15.09.2017, Piraeus University of Applied Sciences (PUAS), World Institute for Engineering and Technology Education (WIETE) Athens, Greece.
11. Kuc, S., Cracow University of Technology and Eurasian National University: a Bilateral Agreement On Technical and Architectural Education. Oral Presentation. 7th WIETE Annual Conference on Engineering and Technology Education and 4th Mediterranean Seminar on Engineering and Technology Education, Education for the Globar Community, 04-08.04.2016, Piraeus University of Applied Sciences (PUAS), World Institute for Engineering and Technology Education (WIETE) Athens, Greece.
12. *Цикл лекций и семинаров на тему: Энергоэффективное проектирование жилых зданий на кафедре «Архитектура» ЕНУ (Series of lectures on the subject: Projecting of energy efficient residential buildings on Katedra Architecture ENU)*, 18 November 2018, http://www.enu.kz/ru/info/novosti-enu/46630/?sphrase_id=1636263
13. State Program *Digital Kazakhstan* (2017), 17 June 2019, https://primeminister.kz/ru/page/view/gosudarstvennaya_programma_digital_kazahstan