

## ABSTRACT

**of Kymbatsha M. Mukhamediyeva's thesis research "The Methodology of design and Robotics technologies educational implementations in the higher education establishment" submitted in candidacy for a Doctor of Philosophy (PhD) degree in 6D011100 – "Informatics"**

**Research relevance.** Digital transformation formation is the key goal at the high strategical level. Digital transformation in the higher education is a part of the process of changings affecting the society in general. The fourth industrial revolution has been started already in the world, and world-wide digitalization in economics leads to the necessity to use the elements of this revolution like automatization, robotization, robotics and mechatronics, artificial intellectual, technology of 3D object modelling, and the exchange of "great data".

That's why the issue of advanced digital technologies, appropriate for implementation in teaching students can be solved in account for the elements of the fourth revolution. Being very important to carry out the industrial revolution and contemporary development in economy, the Robotics field demands the training specialists, including Robotic teachers. The problem of world-wide training teachers to conduct essential and additional lessons on Robotics and Mechatronics in schools, high schools and universities is vital. The educational system feels the need in teachers who are familiar to the appropriate teaching methods at the high level (T.O. Balykbaev, E.Y. Bidaibekov).

The development of high technological sectors in the industry of Kazakhstan has affected the strategy of education development which directs the system of school education to the integration of knowledge and increase of the role of STEM-education. STEM-education suggests a complete planned education including Natural Sciences studying together with Engineering, Technology and Mathematics and with the use of cross-subjection and applied approach. Within the frame of such education Robotics has become widespread; it means that Robotics can be used in the studying subjects in primary Training (A. Strawhacker, G. Keren, A. Ben-David, and M. Fridin); primary Schools (T.Zh. Baidildinov, M. U. Bers and M. Portsmouth, F.B.V. Benitti); at University as a part of special professional training (E.Y. Bidaibekov, B.G. Bostanov, Zh.K.Nurbekova, M. Serik, A.Zh. Asainova, G. Tewolde, J. Kwon, E.A. Krasnobaev, and others); to increase students' motivation (Zh.K. Nurbekova, A.Zh. Asainova, K. Zawieska, R. Wyffels, R. Pérula-Martínez, M. Petre, L. Alfieri and others); as a unique means to improve cross-subjection knowledge (D. Alimisis, J. Carne, A.M. Vollstedt and others).

Robotics implementation in the system of school education has determined the necessity of qualitative teachers' training who can be able to teach Educational Robotics. Nowadays pedagogical universities train would-be teachers of Informatics and Robotics.

The conditions for students' training to their would-be activity in the sphere of educational Robotics have been studied by many researchers. The beginning of development of Robotics teaching was made by the group of scientists (in charge of D. Alimisis) as a project for improving teachers' qualification in the field of educational Robotics and its Methodology – TERECOP (D. Alimisis A. Pina, J. Arlegui, E. Menegatti, M. Moro). The research considers active methods for Robotics training, active methods, didactic means, based on the constructivism. Despite some imperfections, some research showing experience in Robotics training look like empirical material, solving tasks on making and improving pedagogical impact of a teacher on a student in the frame of Robotics training were incompletely described because it doesn't cover technology in making teaching process on Robotics. In many cases teachers have difficulty in using methods and teaching forms based on constructivism, the project-making method is used partly, teaching material is given in ready-made form or in a step-by-step instructions. The above mentioned deficiencies can be deleted using the so-called Educational technology which is a constituent (processing) part of methodological (didactic) system. Thus, for instance, if the methodological system is designed to solve the tasks like: 1) what teach, 2) why teach, 3) how to teach, then the educational technology will answer the third question with the addition: 4) how to teach effectively? So, the methodological education system is the base to choose methods, means and teaching forms in the particular terms for teaching Robotics.

Methodologists of teaching theory as B.T. Lihachev, V.A. Slastenin, and P.I. Pidkasisty and others proved in their research that one of the guaranteed means for improvement of educational process effectiveness is the use of educational technology.

As we know Educational technology (technology in the sphere of education) is a set of scientifically and practically reasonable methods and tools for achievement the desired result in any educational field. N. Simsek and R. Luppisini determine the educational technologies as a field which conducts the link with project-making, development, use, management and assessment in process and resources for teaching.

The project-making problems in the system of teacher's work in the base of educational technology were studied in the works by Yu.K. Babansky, V.P. Bepalko, I.M. Cheredova and others. According to this research educational technology looks like a system of complicated elements, and in order to achieve the result in the educational process, it is necessary to formulate the sequence of algorithmic steps in the arrangement of educational process.

Educational technology structure in the frame of methodological teaching system is determined with many factors depending on the educational purpose, and the structure includes:

- competent-aimed stage: the analysis of the initial level of students' competencies is carried out, together with it a set of competencies is selected. These competencies will be formed in the process of studying the discipline and the learning objectives are determined;

– content stage: the content of education is selected taking into account standard curricula, standard curricula for vocational training, students' capabilities, modern trends in the development of science and technology, as well as its layout in the curriculum in accordance with the logic of learning material;

– methodological stage: developing methodological support in accordance with the goals, content of the educational material performs the selection of teaching aids or their creation with instrumental and didactic tools and forms the content of each thematic block in the system;

– assessment and diagnostic stage: developing a diagnostic system and control and measuring materials for each thematic block, assesses the achievement of goals.

Our analysis of the state of teaching robotics in the country and in the world shows that when creating a methodology for teaching robotics, the authors cannot do without using educational technology, but educational robotics was not fully used in their research as an object of pedagogical design.

Therefore, it is clear that in order to cover the technology for developing educational material on robotics in the complete volume, it is necessary to use educational technology as an object of pedagogical project-making for guaranteed achievement of the learning outcomes in Robotics, which our study is devoted to.

Educational technology project-making in Robotics requires a strict logical sequence including expert knowledge and solutions in the field of Robotics, which can be implemented with the help of digital technologies.

The problem of digital transformation in education is studied by some researchers as E.Y. Bidaibekov, V.V. Grinshkun, A.E. Sagimbaeva, Zh.K. Nurbekova, B.D. Sydyhova, B.G. Bostanov, D.B. Abykenova, I.T. Calgozha and others. Their research points out that digital transformation is the key task for universities in the highest strategic level. Digitalization is integrated into the general universities development as the solution of existing problems on the fundamental level. Also digitalization creates new opportunities and spheres of activities in order to increase universities profiles, making them visible at the international level, widening and strengthening their role in the society.

The use of digital technology for pedagogical project-making has been considered in several works. A group of scientists led by Doctor of Pedagogical Sciences D.Sh. Sailor has developed a program to design a computer science lesson system for school education. Also, scientists led by Professor J.K. Nurbekova have developed software which lets to design the content of training courses: using graph theory, the content is structured and its information model is built. The study covered only the area of structuring the content of training, but, nevertheless, it reflects the necessity for the use of digital technologies in the construction of the educational process.

The development of software for the educational technologies project-making in Robotics requires structuring the content of teaching educational robotics as applied to a pedagogical university, taking into account the interdisciplinary content, systematization and formalization of a methodological training system for Robotics.

Thus, our approach to the design of educational technology in Robotics allows us to ensure the organization of educational activities in Robotics using the project method, which is the target result of cross-subject data and research.

Conducted research analysis allows to reveal **contradictions** *between* the requirements for the content of educational robotics corresponding to the professional competence of future specialists in robotics and the insufficient development of existing content that meets the requirements of STEM education, *between* the necessity of increase of an educational process effectiveness with the use of pedagogic project-making and the lack of practice in project-making of educational technologies on Robotics; *between* the necessity of using digital technologies in the process of pedagogical project-making and the lack of tooling computer means for development of educational technologies on Robotics.

The solution of these contradictions allow us to formulate **the problem for the research**, i.e. search and found out the theoretical and practical bases for project-making and implementation of educational technologies on Robotics at Pedagogical University on the basis of Methodology of pedagogical project-making.

Theoretical and practical meaning of the problem and its incomplete development are bases for selection of the topic for the research “**The Methodology of design and implementations of educational technologies on Robotics in the higher education establishment**”.

**The research target:** development of methodology for teaching Educational Robotics based on the use of Educational technology.

**The objective of the research:** the process of teaching Robotics at Pedagogical University.

**The research subject: theoretic and practical bases for** design and implementation of educational technologies on Robotics on the base of Methodology of pedagogical design using digital technologies.

**The research hypothesis:** if a project-making process of educational technologies on Robotics is built in accordance with the functional model in the specially-made digital eco-environment with the use of computer program for project-making educational technologies, digital educational resources, electronic diagnostic materials and the system of Robotics and technical educational tasks, then the project-making and implementation of educational technologies on Robotics at pedagogical University will be effective.

Naturally, the design of educational technology in Robotics based on the above structure is impossible without determining the content of educational Robotics.

According to the objective, the subject and hypothesis of the research, the **following tasks** have been formulated and solved:

- based on the analysis of scientific and methodological sources to study the Methodology of pedagogical project-making, and to describe the structure of educational technology;

- to determine the specific features in the content of teaching Robotics at Pedagogical Universities;

- to develop a functional model for project-making educational technologies on Robotics based on the Methodology of pedagogical project-making with the usage of digital technologies;

- to develop the computer program for project-making of educational technologies, digital educational resources, electronic diagnostic materials, and the system of Robotics and technical educational tasks in the structure of digital eco-environment;

- to test the functional model of project-making of educational technologies in digital eco-environment while teaching Robotics taking into consideration qualitative and nquantitative criteria.

**Research methods:** analysis of sources, educational programs, teaching aids on Robotics, Pedagogy and Psychology; study and analysis of sources connected to theoretical issues on teaching Informatics including Robotics; study and summarizing experiences of Universities in the IT-field and teaching Robotics; study theoretical bases of Robotics and project-making of educational process; study existing methodics for teaching Robotics; technologies for project-making of educational process, system analysis and functional modelling, monitoring, surveying, testing, expert assessment, and analysis of student's results; analysis of the pedagogical experiment and its results.

**The Research Methodological background** is the concept of a technological approach to education, Methodology of pedagogical project-making, pedagogical and psychological principles for the increase of effectiveness in the educational process while using information technologies and aspects of digitalization in education.

**The Research Theoretical background** is taken from the Pedagogy theory in project-making of pedagogical systems comprised by V. Guzeev, V. Yudin, the educational technology as the didactic system (Yu. Babansky, B. Bloom, G. Selevko, V. Zagvyazinsky), theory of educational Robotics by D. Alimiss; theory of constructivism in teaching Robotics by S. Paipert, and bases for mathematical working of information.

**The research scientific novelty:**

- we have determined the content of educational Robotics teaching at pedagogical University;

- we have developed a functional model of educational technologies project-making in Robotics on the base of Methodology of pedagogical project-making with the usage of digital technologies;

- we have made the tooling means: the computer program for project-making of educational technologies, digital educational resources on Robotics, electronic diagnostic materials, and the system of robotics and technical educational tasks in the structure of digital eco-environment and implementation of educational technologies on Robotics at pedagogical University.

**Theoretical significance of the research** is in the definition of the stages in project-making of educational technology on Robotics in accordance with the specific features of a teaching subject, and the subject matter and structure of digital

eco-environment for project-making and teaching Robotics with the usage of educational technologies.

**The practical significance** of the research results is generalization of Methodological system for teaching Robotics. A special computer program, digital educational resources on Robotics with the animated content and AR, electronic diagnostic materials, and system of Robotic and technical studying tasks have been created.

**The considerations submitted for the defence:**

- the content of teaching of educational Robotics at pedagogical University;
- a functional model of project-making the educational technologies on Robotics with the usage of digital technologies;
- the structure of digital eco-environment in order to make a project and implement educational technologies on Robotics at University. The structure includes a computer program for project-making educational technologies, digital educational resources on Robotics, electronic diagnostic materials and the system of Robotic-and-technical studying tasks.

**Testing the research results and publications**

The main issues and research results were reported and discussed at international scientific-practical conferences: «QED'16: Technology Advanced Quality Learning for All» (Bulgaria, 2016), «Intellectual informational and communicative technologies as means for fullfilment of the third industrial revolution in the frames of strategy “Kazakhstan 2050”» (Astana, 2016, 2017, 2018), «Actual problems of natural sciences knowledge and education» (Pavlodar, 2017), «Modernization of educational environment at higher pedagogical schools» (Pavlodar, 2017) and at the scientific-methodological seminar and the meetings at Informatics department of L. N. Gumilyev Eurasian National University.

The introduction of the thesis results has been confirmed by two certificates of copyright intellectual property, the acts on the introduction of elective courses and digital educational resources on Robotics in the educational process of undergraduate and graduate programs of Pavlodar State Pedagogical University, the acts of the introduction of a continuing education course on Robotics at Pavlodar State Pedagogical University, and Pavlodar Innovative Eurasian University

**Research results publications.** Research results have been published in 16 works, i.e. 2 – in the journals indexed in Scopus, 4 – in the journals recommended by the Committee for Control of Education and Science of the Republic of Kazakhstan, 1 – in the scientific journal in Kazakhstan, 6 – in the international scientific-practical conference proceedings (1 – in the foreign conference, 5 – in the conferences in Kazakhstan), 1 – a teaching aid (ISSN 978-601-7839-90-1, Pavlodar, 2017); 2 – intellectual property certificates (№825 from 06.12.2018, №958 from 13.12.2018, Kazakhstan).

**Thesis structure:** the thesis consists of introduction, two chapters, conclusion, bibliography, and supplements.