The Use of Mobile Internet Devices in Teaching Bachelors of Electromechanics Modeling of Technical Objects

Yevhenii O. Modlo[a], Ruslan P. Shaida[b] and Oleksandr V. Lytovchenko[c]
State University of Economics and Technology, 5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine

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Abstract: The article is devoted to the problem of using development and implementation of methodic of using mobile Internet devices in learning bachelors of electromechanics in modeling of technical objects. Based on the analysis of scientific literature, the content of the bachelor of electromechanics competency in modeling of technical objects, the criteria for its formation and the model of using mobile Internet devices in learning bachelors of electromechanics in modeling of technical objects are theoretically substantiated and developed. The methodic of using mobile Internet devices in learning bachelors of electromechanics in modeling of technical objects was developed and experimentally tested; the concept of a mobile Internet device is clarified; the system of mobile ICT for learning bachelors of electromechanics has been improved; the methodic of learning bachelors of electromechanics to computer modeling was further developed.

1 INTRODUCTION

The Law of Ukraine "About the National Informatization Program" (Verkhovna Rada of Ukraine, 2022) defines the creation of an education system focused on the use of the latest ICT in the formation of a comprehensively developed personality as the main direction of the use of information and communication technologies (ICT), which provides the opportunity for each person to independently acquire knowledge, skills and abilities during education and professional training.

The goal of the Strategy for the development of higher education in Ukraine for 2022-2032 is to update the content, forms, methods and means of education through the wide introduction of modern ICT and electronic content into the educational process (Cabinet of Ministers of Ukraine, 2022). The absolute priority of education development is the introduction of modern ICTs, which ensure the improvement of the educational process, accessibility and effectiveness of education, and the preparation of the younger generation for life in the information society. Among the key directions of the state education policy defined by the strategy, two directions are interrelated. This is the informatization of education and the creation of a modern material and technical base of the education system, which require updating the outdated fleet of computer equipment, due to an increase in the share of mobile Internet devices (MID), which are the leading modern means of ICT education (Chieng, 2007).

One of the components of the professional training system of a modern engineer is computer modeling of technical objects and processes, which are widely used in all types of engineering activities. Modeling plays a special role in the training of specialists in the field of knowledge 14 "Electrical engineering", providing from 60% in the cycle of mathematical, natural and scientific training to 72% in the cycle of professional and practical training of electrical engineering and electromechanics bachelors. This is connected to the fact that, on the one hand, computer modeling of electromechanical objects and the processes flow in electromechanical systems is one of the types of professional activity of an electromechanical engineer, and on the other hand, to the fact that mathematical modeling is the basis of fundamental (physical and mathematical) training of an elec-

[a] https://orcid.org/0000-0003-2037-1557
[b] https://orcid.org/0000-0002-7942-9592
[c] https://orcid.org/0000-0002-2142-2697

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tromechanical engineer. Therefore, the ability of electromechanics bachelor to apply the modeling methods, theoretical and experimental research using ICT is the basis of the general professional competences of electromechanics bachelors in modeling technical objects.

Despite the fact that ICT tools are actively used by electromechanical engineers, the method of their use in the process of teaching professionally oriented disciplines for electromechanics bachelors has been considered in few studios of Ukrainian researches (Sobko, 2002; Kobysya, 2012). The analysis of theory and practice of the researched problem revealed a contradiction between:

- the high level of mobility of an electromechanical engineer in the professional activity process and ensuring its ICT support with the help of mobile devices, on the one hand, and the lack of focus on their use in the process of training bachelors of electromechanics at the HEI – on the other hand;
- the need to develop integral competence in electromechanics bachelors in solving specialized problems and solving practical problems characterized by the complexity and uncertainty of the conditions – modeling of technical objects, and the insufficient level of development of its components;
- the significant influence of mobile Internet devices on all components of the process of teaching bachelors of electromechanics modeling of technical objects and the lack of scientifically based methods of their use.

2 METHOD

The relevance of the investigated problem, its insufficient development in pedagogical theory and practice, as well as the need to resolve isolated contradictions led to the choice of the research object – the process of teaching bachelors of electromechanics modeling of technical objects – and the research subject: the method of using mobile Internet devices in the process of teaching bachelors of electromechanics modeling of technical objects.

The *purpose* of the study is to theoretically justify, develop and experimentally verify the methodology of using mobile Internet devices in teaching bachelors of electromechanics modeling of technical objects.

The *hypothesis* of the study is the assumption that the methodically justified use of mobile Internet devices in the training of bachelors of electromechanics in the modeling of technical objects will contribute to increasing the level of formation of their competence in the modeling of technical objects.

In accordance with the purpose and hypothesis, the following main *tasks* of the research are defined:

1. To analyze the sources of the problems of teaching bachelors of electromechanics modeling of technical objects and the use of mobile Internet devices in education.
2. To theoretically substantiate the content, structure, criteria and levels of formation of the competence of the bachelor of electromechanics in the modeling of technical objects.
3. To develop a model of the process of using mobile Internet devices in teaching bachelors of electromechanics modeling of technical objects.
4. To develop a method of using mobile Internet devices in training of bachelors in electromechanics modeling of technical objects
5. Experimentally verify the effectiveness of the developed methodology in the process of forming the competence of bachelors of electromechanics in modeling technical objects.

The following *research methods* were used to solve the tasks:

- *theoretical* – analysis, generalization, systematization of the legal framework, educational standards, Internet resources, modern mobile ICT learning tools to determine the theoretical basis of the research, substantiation of the model and methods of using mobile Internet devices in education bachelors of electromechanics modeling of technical objects;
- *empirical* – purposeful pedagogical observations, conversations with teachers and students, questionnaires, analysis of teachers' work experience, expert evaluation to determine the structure and content of the competence of a bachelor of electromechanics in modeling technical objects, selection of mobile Internet devices for training bachelors of electromechanics in modeling technical objects entities; ascertaining and formative stages of the pedagogical experiment – for the purpose of approbation of the proposed methodology and experimental implementation of the main provisions of the study into the practice of higher education institutions;
- *statistical* – for quantitative and qualitative analysis of learning results according to the developed methodology.

The theoretical and methodological foundations of the research are philosophical propositions about

the unity of theory and practice, interdependence and interrelationship of objective and subjective factors of personality formation; conceptual ideas of the philosophy of education (Andrushchenko, 2020; Savchenko and Kurylo, 2018; Kremen and Ilyin, 2020); theoretical foundations of the organization of the educational process in institutions of higher education (Atanov and Dudyanova, 2003; Yildirim et al., 2019), in particular technical higher education institutions (Luzik et al., 2019); theoretical foundations of modeling of training and education systems (Bykov, 2010; Dokuchaieva, 2022); scientific provisions of the competence approach in education (Spirin, 2010; Ovcharuk and Ivaniuk, 2021; Volkova et al., 2021), in particular, the formation of competence in modeling (Teplytskyi, 2000; Teplytskyi et al., 2019); theoretical and methodological principles of professional training of specialists in electromechanics (Roney, 1966a,b; Sobko, 2002; Wang et al., 2009; Kobysya, 2012; Dixit, 2012); scientific provisions of the theory and methods of using ICT in education (Bykov, 2010; Robert et al., 2016; Leshchuk et al., 2022; Nychkalo et al., 2021; Semerikov et al., 2021; Volkova et al., 2021; Zhaldak et al., 2021; Kukharenko et al., 2022; Spirin et al., 2022); theory and practice of implementing innovative technologies in institutions of higher education (Bespalko, 2018; Savchenko and Kurylo, 2018; Symonenko et al., 2020; Drushlyak et al., 2021; Volkova, 2022), in particular the use of mobile ICT in education (Slovak, 2013; Tkachuk, 2013; Echkalo, 2014; Kyslova and Slovak, 2015; Kazhan et al., 2020; Stepanyuk et al., 2020; Amelina et al., 2022; Tkachuk et al., 2022).

3 THEORETICAL PRINCIPLES OF THE USE OF MOBILE INTERNET DEVICES IN TEACHING BACHELORS OF ELECTROMECHANICS MODELING OF TECHNICAL OBJECTS

Analysis of the theory and practice of professional training of bachelors of electromechanics in Ukraine and abroad (Roney, 1966a,b; Hanson, 1994; Motorina, 2002; Vishniakova, 2004; Vaughan et al., 2008; Wang et al., 2009; Kobysya, 2012) made it possible to determine that one of the leading trends in its modernization is the synergistic integration of various branches of engineering (mechanical, electrical, electronic engineering and automation) for the purpose of designing, manufacturing, operation and maintenance of electromechanical equipment (Dixit, 2012). This approach, called mechatronics, involves the meaningful integration of various disciplines of professional and practical training of electromechanics bachelors based on the concept of modeling and the complex use of various forms of organization and training methods based on the concept of mobility.

It is shown that with such an approach, mobile Internet devices – multimedia mobile devices that provide wireless access to information and communication Internet services for collection, systematization, storage, processing, transmission, presentation – become the leading means of forming the competence of a bachelor of electromechanics in the modeling of technical objects all kinds of messages and data (Chieng, 2007; Modlo et al., 2018). The possibilities of using mobile Internet devices in education in order to ensure equal access to education (Molina and Chirino, 2010), personalization of education (Kinshuk et al., 2010), instant feedback and assessment of learning results (Bas and Slovak, 2014), organization of mobile learning (Traxler, 2021) are characterized, effective use of study time (Idrus, 2015), formation of mobile learning communities (Kukharenko, 2013), support of situational learning (Restivo et al., 2014), development of continuous “seamless” learning (Fernando et al., 2013), provision of communication connection between formal and informal education (Baloch et al., 2012), minimization of the consequences of the destruction of the educational process in areas of military conflicts or natural disasters (Dahya, 2016), assistance in education for persons with special educational needs, improvement of the quality of communication and management of an educational institution, maximization of cost effectiveness.

The generalization of the theoretical provisions gave grounds to define the competence of a bachelor of electromechanics in the modeling of technical objects as a personal and professional education, which includes a system of knowledge, abilities, skills, activity experience in the modeling of mechatronic systems and a positive value attitude towards it, and is manifested in the readiness and ability to apply modeling methods and software and hardware tools for process analysis, system synthesis, assessment of their reliability and efficiency for solving practical problems in professional activity, and distinguishing its components: cognitive, praxeological, axiological and information-communicative (communicability, ability to adapt and integrate). The structure of competence is reflected in the corresponding system of competences (figure 1).

The content of each competency is specified in competency matrices, which contains assessment criteria for 4 components (cognitive, praxeological, axiological, information-communicative) at 4 levels (levels of formation, low, medium and high). The use of the defined assessment criteria made it possible to determine the integral level of formation of the competence of the bachelor of electromechanics in the modeling of technical objects. Taking into account that the highest level of systematicity in the process of its formation is achieved during preparation for state certification (exam, passing of the qualification work), it is appropriate to take into account its detection by students during state certification when assessing the level of formation.

4 METHODICAL PRINCIPLES OF USING MOBILE INTERNET DEVICES IN THE EDUCATION OF BACHELORS OF ELECTROMECHANICS OF MODELING TECHNICAL OBJECTS

The model of the process of using mobile Internet devices in teaching bachelors of electromechanics modeling of technical objects (figure 2) contains: socially and technologically significant factors that determine the expediency and necessity of developing a methodology for using mobile Internet devices in teaching bachelors of electromechanics modeling technical objects; methodological approaches (competent, systemic, interdisciplinary, model and activity) use of mobile ICT and learning tools; a target block that specifies the goal – formation of the competence of a bachelor of electromechanics in the modeling of technical objects; content-technological block, which reflects the connection between the content of education and the formation of individual components of the competence of a bachelor of electromechanics in the modeling of technical objects and the technology of using mobile Internet devices in the education of bachelors of electromechanics in the modeling of technical objects (a system of forms of organization of the educational process with using mobile Internet devices, methods of their use and mobile ICT tools); a diagnostic result block containing evaluation criteria, indicators, levels of formation and tools for diagnosing the competence of a bachelor of electromechanics in the modeling of technical objects. The implementation of the process of using mobile Internet devices in the training of bachelors of electromechanics in modeling technical objects is an appropriate method of use, the components of which are partial methods of using mobile Internet devices in the formation of general scientific, general professional and specialized professional components of the competence of a bachelor of electromechanics in modeling technical object.

It was determined that the leading ones for the formation of general scientific competences are: in applied mathematics, the content of the academic disciplines “Higher mathematics” and “Computer technology and programming”; in ICT – “Computer technology and programming” and “Engineering and computer graphics”; in fundamental sciences – “Higher mathematics”, “Theoretical mechanics” and “Electric machines” (Modlo et al., 2019a,b). It was determined that in the process of forming the general scientific component of the competence of a bachelor of electromechanics in the modeling of technical objects, it is advisable to use: for visualization of the structure of objects and the results of modeling – mobile means of augmented reality (SIKE Software); at all stages of modeling – mobile computer mathematical systems with object and symbolic input type (Scilab on cloud, MATLAB Mobile, Octave, SMath Studio, SageCell); cloud-based spreadsheet processors as modeling tools (Google Sheets, Microsoft Excel) and text editors for software description of models (Google Documents, Microsoft Word); mobile automated design systems for creating and viewing physical properties of models of technical objects (Electrical, Autodesk Inventor, AutoCAD – DWG Viewer & Editor, A360 – View CAD files, Fusion 360); mobile communication tools for organizing joint modeling activities (Modlo and Semerikov, 2014; Syrovatskyi et al., 2018; Kiv et al., 2019; Shepiliev et al., 2020).

It has been established that the content of the educational disciplines “Computing technology and programming”, “Theory of automatic control” and “Modeling of electromechanical systems” are the leading ones for the formation of general professional competences: from solving professional problems by means of ICT; in electric machines – “Electric machines” (Modlo et al., 2020). It is substantiated that for competence in the application of various methods of presentation of models and competence in critical thinking, it is not possible to single out the leading educational disciplines – the formation of these components of the competence of a bachelor of electromechanics in the modeling of technical objects takes place throughout the professional training of a bachelor of electromechanics. It was determined that in the process of forming the general professional compo-

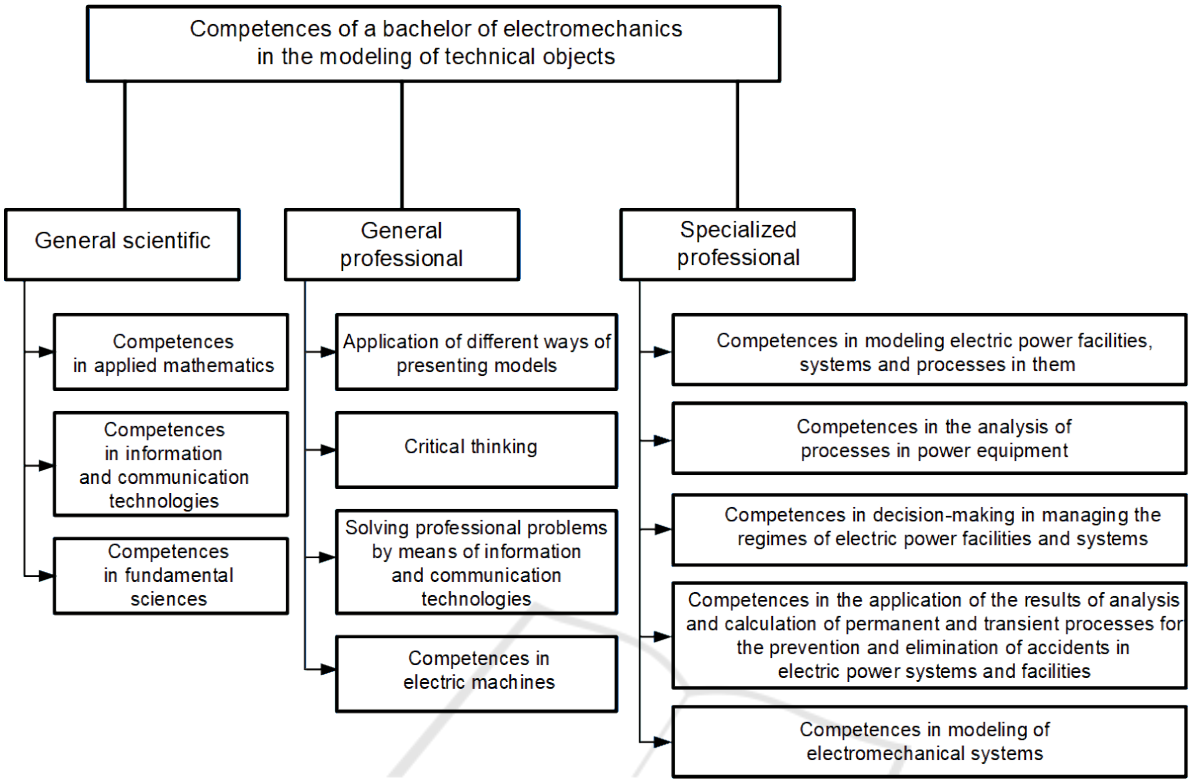

Figure 1: The system of competences of a bachelor of electromechanics in the modeling of technical objects.

nent of the competence of a bachelor of electromechanics in the modeling of technical objects, it is advisable to use: cloud-oriented spreadsheet processors, such as Google Sheets as modeling tools, including neural networks (Modlo, 2013); visual modeling systems, such as Xcos and Simulink, for structural modeling of technical objects (Modlo and Semerikov, 2018); mobile computing mathematical systems, such as SageCell, Scilab and MATLAB Online, used for all stages of modeling; mobile communication tools for organizing joint modeling activities. It was determined that the content of the educational discipline "Modeling of electromechanical systems" is leading to the formation of specialized professional competencies: in the modeling of electric power objects, systems and processes in them, and in the modeling of electromechanical systems; from the analysis of processes in power equipment – "Theoretical foundations of electrical engineering"; in making decisions on the management of modes of electric power facilities and systems and in the application of the results of analysis and calculation of permanent and transient processes for the prevention and elimination of accidents in power systems and facilities – "Automatic control theory" and "Electric drive theory". The expediency of using specialized systems for calculating electric circuits (ZRLC(Circuit solver)) in the process of formation of the specialized professional component of the competence of the bachelor of electromechanics in the modeling of technical objects is substantiated. visual modeling systems for simulation modeling of technical objects (Xcos); means of simulation of dispatch control and data collection for simulation modeling of processes in electric power systems (Simple-Scada); mobile computer mathematical systems (Scilab); mobile communication tools for organizing joint modeling activities. Leading forms of organizing the educational process using mobile Internet devices: demonstrations for the formation of new concepts and methods of action using mobile augmented reality devices; laboratory work, during which all classes of mobile ICT tools are comprehensively used; lectures: informative (when presenting new material), lecture-seminars (provided the problem-based method is used), demonstration lectures (for the comprehensive formation of modeling skills) and consultation lectures (for the preparation and support of a research project); a business game using SCADA systems to develop operator skills means of simulation modeling; work in pairs and small groups; project form of education; consultations (face-to-face and remote).

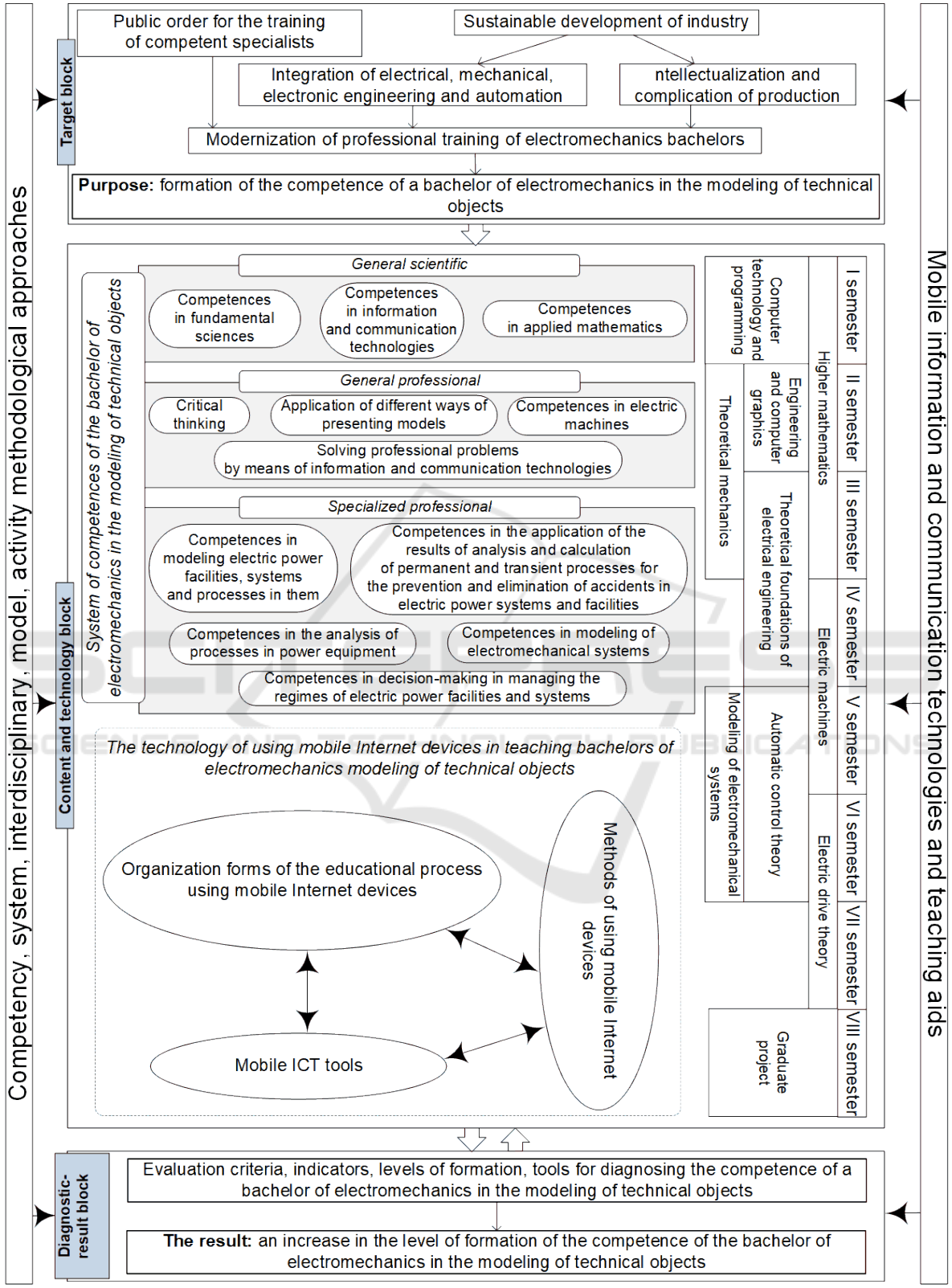

Figure 2: The model of the mobile Internet devices using process in teaching bachelors of electromechanics modeling of technical objects.

The leading methods of using mobile Internet devices in teaching bachelors of electromechanics modeling of technical objects: the method of problem presentation, in which mobile Internet devices are used as a means of obtaining information from various sources related to the subject of the lesson; partial search method, in particular, the techniques of symbolic and figurative vision, which correspond to different ways of presenting the model of a technical object – mathematical and structural; the method of errors, which is advisable to apply when presenting the model both as a program in a mobile computer mathematical system and as a structural diagram in a visual modeling system; the research method is used as the main one in the process of forming the competence of a bachelor of electromechanics in the modeling of technical objects; the project method is used to organize joint educational and research activities of modeling students; the method of demonstration examples is used in lectures, demonstrations and in practical classes to study the adequacy of ready-made models and their further development; computational experiment (as one of the stages of modeling) and programming (as one of the methods of implementing the model); lecture method.

In table 1, the MID software tools, which are leading to the formation of each component of the competence of a bachelor of electromechanics in the modeling of technical objects, are highlighted with a "√" mark.

5 EXPERIMENTAL WORK

The development and testing of the theoretical provisions of the research took place in three stages.

The task of the *analytical-declarative stage* of the research (2007 – 2011) was to study the current state of training in the modeling of technical objects of bachelors of electromechanics, the use of mobile Internet devices as a means of learning, and the selection of the starting points of the research. To implement the tasks, the scientific and methodological literature on the use of mobile ICT in education, domestic and foreign experience of training specialists in electromechanics was analyzed, which made it possible to formulate the relevance of the research and its hypothesis. Developed, tested, and improved training programs, virtual laboratories for modeling technical objects and systems; studied modern domestic and foreign methods of using ICT in the training of bachelors of electromechanics; a theoretical analysis of domestic and foreign psychological-pedagogical literature was carried out to find out the degree of study and development of the problem, the ascertaining stage of the pedagogical experiment was carried out.

At the *design and research stage* of the research (2012 – 2015), the system of competences of the bachelor of electromechanics in the modeling of technical objects was determined, the educational course "Modeling of electromechanical systems" was designed and developed, mobile Internet devices and software tools for learning the modeling of electromechanical systems were selected, a model of the use of mobile Internet devices in teaching bachelors of electromechanics modeling of technical objects was developed. As a result of an expert survey aimed at determining the contribution of each component of the competence of a bachelor of electromechanics in the modeling of technical objects to its formation, it was determined that the contribution of general professional and specialized professional competences is the same – 35.3% for each group, while the contribution of general scientific – 29.4%. Among general scientific competences, competence in applied mathematics was the leading one, among general professional competences – critical thinking, and among specialized professional competences – competence in modeling electromechanical systems. Processing the results of the survey made it possible to determine quantitative indicators of the formation of each of the components of the competence of the bachelor of electromechanics in the modeling of technical objects and an integral indicator reflecting the level of the formation of competence in general.

At the *formative and generalization stage* of the research (2016 – 2018), a method of using mobile Internet devices in teaching bachelors of electromechanics modeling of technical objects was developed, the formative stage of the pedagogical experiment was conducted; the obtained results of experimental work were analyzed and summarized; general conclusions are formulated and prospects for further research are determined.

201 students majoring in "Electromechanics" took part in the formative stage of the pedagogical experiment: the control group (CG) – 150 students of the Kryvyi Rih National University, who studied according to the traditional method, which did not involve the systematic use of mobile Internet devices, and the experimental group (EG) – 51 a student of the National Metallurgical Academy of Ukraine, who studied according to the developed method of using mobile Internet devices in the process of teaching bachelors of electromechanics modeling of technical objects. Processing of the results of the experimental work was carried out using the Kolmogorov-Smirnov criterion. It was established that before the beginning

Table 1: The use of mobile Internet devices in the process of forming the competence components of the bachelor of electromechanics in the modeling of technical objects.

Software tools	General scientific component	General professional component	Special professional component
mobile computer math systems	√	√	√
mobile communication tools	√	√	√
cloud-oriented table processors	√	√	
visual modeling systems		√	√
mobile tools of augmented reality	√		
cloud-oriented text editors	√		
mobile CAD-systems	√		
specialized systems for calculating electric circuits, means of modeling dispatch control and data collection			√

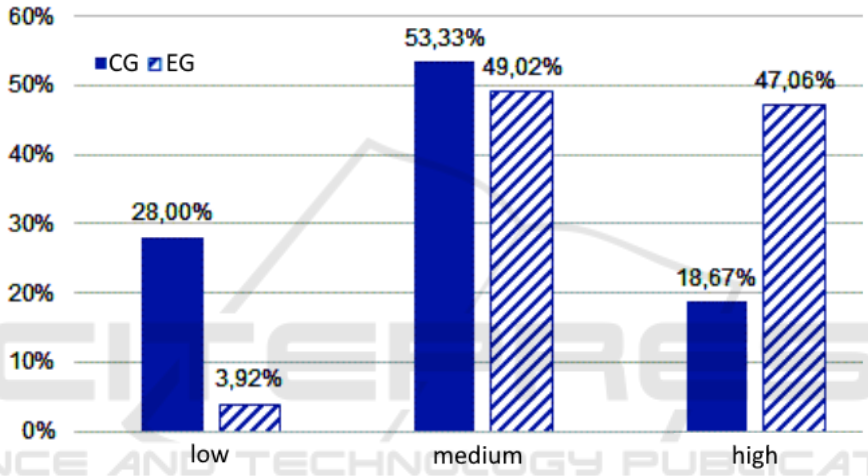

Figure 3: Distribution of CG and EG students according to the level of formation of the competence of the bachelor of electromechanics in the modeling of technical objects after the completion of the formative stage of the experiment.

of the formative stage of the pedagogical experiment, there were no statistically significant differences in the distributions of CG and EG students of one year of admission based on the results of the entrance exams.

After the completion of the formative stage of the pedagogical experiment, the integral level of competence formation of the bachelor of electromechanics in the modeling of technical objects was diagnosed, and the distribution of CG and EG students by level was compared (figure 3). Statistically significant differences at the level of 0.99 in the distributions of students of the control and experimental groups were established ($\lambda = 1.752 > \lambda_{crit}(0.01) = 1.63$).

Based on the fact that the experimental group used the developed method of using mobile Internet devices, we come to the conclusion that this was a factor in increasing the level of formation of their competence in modeling technical objects, and therefore, the research hypothesis is proven.

6 CONCLUSION

The obtained results of the research give grounds for making the following conclusions:

1. Analysis of the experience of professional training of electromechanics bachelors in Ukraine and abroad made it possible to determine that one of the leading trends in its modernization is the synergy of mechanical, electrical, electronic engineering and automation in mechatronics for the purpose of designing, manufacturing, operation and maintenance of electromechanical equipment. The study of mechatronics involves the content integration of various disciplines of professional and practical training of electromechanics bachelors based on the concept of modeling and the technological integration of various forms of organization and training methods based on the concept of mobility. According to this approach, mo-

bile Internet devices – multimedia mobile devices that provide wireless access to information and communication Internet services for the collection, systematization, storage, processing, transmission, presentation of all kinds of messages and data – become the leading means of education for bachelors of electromechanics. The work reveals the main possibilities of using mobile Internet devices in education to ensure equal access to education, personalization of education, instant feedback and assessment of learning results, organization of mobile learning, effective use of time in classrooms, formation of mobile learning communities, support of situational education, the development of continuous "seamless" education, ensuring the connection between formal and informal education, minimizing the consequences of the destruction of the educational process in areas of military conflicts or natural disasters, assisting in the education of persons with special educational needs, improving the quality of communication and management of an educational institution and maximizing efficiency of its costs.

2. The competence of a bachelor of electromechanics in the modeling of technical objects is a personal and professional education that includes a system of knowledge, abilities, skills, experience in modeling mechatronic systems and a positive value attitude towards it, and is manifested in the readiness and ability to apply methods and software-hardware modeling tools for process analysis, system synthesis, assessment of their reliability and efficiency for solving practical problems in professional activity. The competence structure of a bachelor of electromechanics in the modeling of technical objects is reflected in three groups of competences: general scientific (in applied mathematics; in ICT; in fundamental sciences), general professional (application of various ways of presenting models; critical thinking; solving professional problems by means of ICT; in electric machines) and specialized professional (in modeling of electric power objects, systems and processes in them; in the analysis of processes in power equipment; in decision-making on the management of modes of electric power objects and systems; in the application of the results of analysis and calculation of permanent and transient processes for the prevention and elimination of accidents in electric power systems and objects; in modeling of electromechanical systems). The content of each competency is defined in the competency matrices allowed to develop criteria for evaluating their formation according to cognitive, praxeological, informational and communicative components at the levels of unformedness, low, medium, and high.
3. The model of the process of using mobile Internet devices in the training of bachelors of electromechanics in modeling technical objects is built on the basis of competence, system, interdisciplinary, model and activity approaches and consists of three blocks: the target, which specifies the goal – the formation of the competence of bachelors of electromechanics in modeling technical objects; content-technological, which reflects the connection of the content of education with the formation of individual components of competence and the technology of using mobile Internet devices in teaching bachelors of electromechanics modeling of technical objects (a system of forms of organization of the educational process using mobile Internet devices, methods of their use and mobile ICT means); and diagnostic results, containing evaluation criteria, indicators, levels of formation, and tools for diagnosing the competence of a bachelor of electromechanics in the modeling of technical objects.
4. The implementation of the technology of using mobile Internet devices in the training of bachelors of electromechanics in the modeling of technical objects is an appropriate method of use, the components of which are partial methods of using mobile Internet devices in the formation of general scientific, general professional components of the competence of a bachelor of electromechanics in modeling technical objects, disclosed on the example of the academic disciplines "Higher mathematics", "Computing technology and programming", "Engineering and computer graphics", "Theoretical mechanics", "Electric machines", "Automatic control theory", "Modeling of electromechanical systems", "Theoretical foundations of electrical engineering", "Electric drive theory". The leading forms of organizing the educational process using mobile Internet devices are demonstrations, laboratory work, lectures, business games, work in pairs and small groups, project form and consultations; the leading methods of using mobile Internet devices in the teaching of bachelors of electromechanics modeling of technical objects are lecture, partial research, problem, research, error method, project method, method of demonstration examples, computing experiment and programming, and the leading means are mobile computer mathematical systems (universal tools used at all stages of modeling training), mobile communication tools (for

organizing joint modeling activities), cloud-based spreadsheet processors (as modeling tools, including neural networks), visual modeling systems (for structural modeling of technical objects), mobile tools of augmented reality (for visualizing the structure of objects and modeling results), cloud-based text editors (for software description of models), mobile automated design systems (for creating and viewing the physical properties of models of technical objects), specialized systems (for calculating electric circuits), means of modeling dispatch control and data collection (for simulation modeling of processes in electric power systems).

5. In order to verify the effectiveness of the method of using mobile Internet devices in the training of bachelors of electromechanics in the modeling of technical objects, a pedagogical experiment was conducted, at the formative stage of which 150 students of electromechanics studied according to the traditional method, which did not involve the systematic use of mobile Internet devices (control group), and 51 electromechanical students studied according to the developed methodology (experimental group). With the application of the Kolmogorov-Smirnov criterion, it was established that before the beginning of the formative stage of the pedagogical experiment, there were no statistically significant differences in the distributions of students of the control and experimental groups of one year of admission according to the results of the entrance tests. After the completion of the formative stage of the pedagogical integral level of in the modeling of technical objects, statistically formation significant of the experiment differences of the bachelor of were the electromechanics competence of established at the level of 0.99 in the distributions of students of the control and experimental groups. Considering that the experimental group used the developed method of using mobile Internet devices, it can be concluded that its implementation became a factor in increasing the level of formation of their competence in modeling technical objects, and therefore, the research hypothesis is proven.

7 FUTURE WORK

The performed research does not cover all aspects of the analyzed problem. Further scientific searches for its solution are expedient in the following directions: the use of augmented reality tools in the training of future mechatronics specialists; virtualization of the environment for professional and practical training of future mechatronics specialists; SCADA systems as a means of teaching bachelors of electrical engineering and electromechanics.

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