

Informatization of education as a pledge of the existence and development of a modern higher education

Elena H. Fedorenko¹[0000-0002-1897-874X], Vladyslav Ye. Velychko¹[0000-0001-9752-0907],
Andrii V. Stopkin¹[0000-0002-6130-9920], Alona V. Chorna²[0000-0002-0062-1144]
and Vladimir N. Soloviev³[0000-0002-4945-202X]

¹ Donbas State Pedagogical University, 19, General Batiouk Str., Sloviansk, 84116, Ukraine
fedorenko.elena1209@gmail.com, vladislav.velichko@gmail.com,
stepkin.andrej@gmail.com

² Bogdan Khmelnytsky Melitopol State Pedagogical University, 20, Hetmanska Str., Melitopol,
72300, Ukraine
alonachorna@gmail.com

³ Kryvyi Rih State Pedagogical University, 54, Gagarina Ave., Kryvyi Rih, 50086, Ukraine
vnsoloviev2016@gmail.com

Abstract. This article focuses on the special significance of education informatization as the main aspect of the existence and development of a modern higher education. The process of computerization of education is considered as the main basis of informatization in the historical aspect. This paper emphasizes the importance of implementing information and communication technologies (ICT) in the learning process of free software and the interest of scientists in the field of education. The interest of modern scholars is analyzed in the consideration of such problems as the application of ICT in education; problems of informatization of education and goals of informatization of education; didactic and psychological aspects of application of ICT in the educational process; problems associated with the widespread introduction of ICT in higher education institutions and informatization of education in general. The article's focus is on the importance of the acquired skills and abilities as a result of informatization of education and implementation of the educational process of ICT. The goals of informatization of education at a modern higher educational establishment are determined. The primary goals of informatization of education are singled out. The types of education that are directly related to ICT are considered. It is acknowledged that the practice of implementing ICT in the educational process of higher educational institutions are expanding every day and yields only positive results. The conclusions highlight the relevance of this study. It is noted that educational activity based on the use of ICT is a basis for changing the structure of the educational process for both teachers and students.

Keywords: informatization, education, higher education, computerization, information and communication technologies.

1 Introduction

1.1 Research problem

Currently, informatization of education is the main factor in the existence and development of a modern higher education, because its primary objective is the development and growth of the potential of each individual. Informatization of education is a set of interrelated organizational and legal, socio-economic, educational, methodological, scientific-technical, industrial and management processes. These processes are aimed at providing information, computing and telecommunication needs (other needs related to the implementation of methods and tools of information and communication technologies – ICT) of participants of the educational process, as well as those who manage and maintain this process (including those who provide its scientific and methodological support and development) [2]. Informatization of education increases the efficiency and intensification of the educational process by using information technologies and implementation of new methodological developments in learning process [39, p. 34]. Informatization of education envisions and catalyzes the general processes of development of society and education. Basic components of education and education systems such as content of education, methods, tools and technology of training and education, organization of education and training systems are gaining essential specific features [2].

1.2 Problem statement

Considering the goals of informatization of the educational process of higher education, we identified a number of problems associated with legal, economic, educational, methodological, and scientific and technological processes. Implementation and application of ICT in the training of future professionals will play an important role not only as a tool for the disclosure and development of individual abilities of the individual, but also as a catalyst for comprehensive informatization of society. ICT in education are part of pedagogical technologies aimed at the establishment of knowledge and the acquisition of acquired skills and abilities that, under the slightest effort, can be adapted to the individualities of any person who wants to study.

According to Vladyslav Ye. Velychko, the use of information technologies in educational activities will enable future specialists to use a wide range of modern methodological approaches and technologies and will help to reveal their inner creative potential, become a “visual guide” to the skills and abilities of information technology use to achieve higher learning results [39, p. 75].

Many studies are devoted to the problems of informatization of education and the purposes of informatization of education. The most significant of them belong to Valerii Yu. Bykov [2], Mikhail P. Lapchik [13], Serhii A. Rakov [25], Myroslav I. Zhaldak [42], etc. Theoretical aspects of the application of ICT in education are reflected in the writings of such researchers as Serhiy O. Semerikov [29], Vasiliy I. Soldatkin [30], Oleh M. Spirin [31], Aleksander V. Spivakovsky [3], Myroslav I. Zhaldak [4] and others.

The problems associated with the widespread introduction of ICTs in higher education institutions and informatization of education are considered in the publications of Roman S. Hurevych [6], Andrii M. Hurzhii [7], Maiia Yu. Kademiia [6], Nataliia M. Kiianovska [9], Mariia A. Kyslova [12], Alla F. Manako [14], Oleksandr V. Merzlykin [17], Nataliia V. Morze [23], Andrii M. Striuk [16], Yurii V. Tryus [38], Vladyslav Ye. Velychko [39] and many others.

Modern education requires the variety of the forms, methods and techniques of the organizational of educational activities. The preference should be given to the forms, methods and techniques that use information technology, which can personalize the process of learning, enrich the acquired knowledge and allow individuals to become effective in professional activities [39, p. 74]. The introduction of the latest ICT into the educational process will accelerate the realization of such an objective as informatization of education. Currently, it is possible to share the features of this process from the experience of other countries such as the United States, South Korea, England, Finland, Estonia, Ireland, Bulgaria, Germany, Switzerland and others [9]. Such experience gives modern scholars a clear understanding of the integrity of building a system of informatization of education through the introduction of ICT in the educational process of higher educational institutions.

1.3 Research aim

The purpose of the article is to emphasize the importance of introducing ICT into the educational process of higher educational institutions and emphasizing to highlight the special significance of informatization of education as the primary aspect of the existence and development of a modern higher education.

2 Theoretical bases of the study

Informatization of education is aimed not only at the formation of knowledge, but centered on the person who can apply the acquired knowledge and skills to work with information resources for successful activity in any sphere of public life and for the innovative development of society [2]. The level of innovation development of society directly depends on the level of informatization of education. Informatization of society is a process of education and establishment of each individual of a new generation in conditions of qualitative improvement of modern information and technical structures and processes created for the satisfaction of needs and the realization of life existing rights of a modern citizen [34; 35].

The basis of the process of informatization of education is the process of computerization of education, which started at the beginning of the XX century. In general, the process of computerization of education of scholars and researchers (Valerii Yu. Bykov [2], Nataliia V. Morze [23], Serhiy O. Semerikov [28], Illia O. Tepytskyi [27], Vladyslav Ye. Velychko [39] and others) is divided into three stages, but the initial date varies from the 20-ies XX century to the 50-ies of XX century. So, for example, Serhiy O. Semerikov, determined the beginning of the first stage is exactly

the 20-ies of XX century. According to him, the first stage (20-50th years of the twentieth century) is described as the period of application of mechanical, electromechanical and electronic individualized devices [28; 20], with which the teaching material was provided and the control and self-control of knowledge were implemented – the technology of programmed learning. The second stage (50-80s of the twentieth century) is characterized by the wide introduction of computers into practical training activities. And the third stage (since the 80s of the last century) is specified as the stage of personal computers and computer networks [29].

Informatization of education is inextricably linked with existing learning models. In the 1950s and 1960s computer technologies were actively used in the implementation of the theory of behaviorism. The cognitive model of learning inherent in the 70-80s was used to develop critical thinking. Constructivism of the 90s with the use of computer technology solved the problem of changing personal relationships and building a social model. Modern information technologies have enabled the development of a new learning model – connectionism. Connectionism is evolving due to modern trends – distance education, mobile learning, mass open online courses, e-education and cloud technologies [37].

It is important that the entire initial stage of the development of informatization, which involves the development of computers and software related to universities. The development of computer technology needed highly skilled specialists who were trained directly at universities where the first computers were built [39, p. 62]. Informatization of education is definitely connected with the development of material and technical bases and the preparation of complexes of educational methods for their use. A significant factor in the delay of the development of informatization of education, as well as the informatization of society as a whole, is the lack of sufficient financing of these projects by the state. That is why groups of programmers created free distribution software [32]. Thanks to these software products, teachers have had more opportunities to use computers in the learning process, which gradually led to the widespread use of ICT in educational activities which resulted in the informatization of education [36]. The first software products used in university education belonged to open software as there was no global software commercialization. It should be noted that such software had limited scope and was used primarily for mathematical calculations [18; 26].

Lecturers of mathematical disciplines mastering software products of the indicated orientation and using this knowledge and their own developed techniques during the training of students of mathematical specialties became the first example of the introduction and application of information technologies in university education. These actions have shown that such implementation greatly facilitates availability teaching material and the interest of students. The experience of using mathematical software products while working with students proved to be invaluable and fundamental to lecturers of other disciplines. Understanding the benefits and needs of pedagogical workers in such educational products, programmers actively create and recycle existing computer programs that effectively begin to be used during lectures and laboratory and practical classes.

Further evolution of informatization of education, which took steps from equipping educational institutions with electronic computers of the first generation to the application of the most modern tools of ICT, reflects both the achievements of scientific and technical progress. Cybernetics, computer science, IT industry, and achievements in the appropriate training of teaching and management education, computer level oriented scientific and methodological support of the educational process, automated systems of education and training led to the widespread introduction of ICT in educational practice [2]. Consequently, ICT are rapidly being introduced into the educational activities of higher education institutions and step by step, with the help of graduates of higher education, mastering other branches of education such as secondary schools, technical schools, schools, etc.

ICT of teaching are a variety of pedagogical technologies used to optimize the construction of the educational process and represent a set of educational organization programs aimed at learning and acquisition of skills and abilities, the specificity of which is expressed in the emphasis on the development of students not only to perceive and use the knowledge provided, but to independently obtain knowledge from a variety of sources of information. These technologies can radically change the function of the teacher in the educational process, as well as the attitude and perception of the educational material by those who study. ICT are one of the major factors in implementing a personal approach to each individual. Due to the combination of traditional learning technologies and ICT, the efficiency of the development of individual abilities the educational process is improved, the quality of education increases, an understanding of the importance of creating its own educational path is formed.

Through the use of ICT in education, all those who had not previously been able to afford it were given the opportunity to study and gain knowledge and skills in a variety of categories and areas. For example, people with special needs for whom, having regard to their physical condition and state of health, previously, higher education was not an achievable dream, now due to existing technologies and developed methods, they are able not only to acquire knowledge, but also desired diplomas.

Over the last four decades, a large number of educational software products, both free and proprietary, have been developed and implemented in various educational areas. Prepared educational and methodical literature, which was done to emphasize the need to use ICT at all levels and in all areas of education. Vladyslav Ye. Velychko noted that the main directions of the use of ICT in the educational activity of higher educational institutions are [39, p. 124]:

- an element of the methodology of scientific research;
- an integral part of the education management system;
- object of studying;
- a learning tool.

Each of them is in close contact with others.

Currently, there are many types of education directly related to ICT. Such types of learning as distance learning, e-learning, mobile learning, blended training, etc., expand opportunities and choices for anyone who wants to study or improve their own

qualifications or receive additional education. These opportunities are associated with the emergence of new, virtually unlimited pedagogical opportunities that have arisen as a result of the introduction of ICT in education and successfully used. For the individualization and differentiation of the educational process the use of additional information educational resources resulted in a wide range of pedagogical methods and technological training options. Changes in the nature of educational communications are increasing the procedural and multimedia characteristics of study and the expansion of the space of innovative pedagogical activity [2].

By scientists and researchers definition there is a classification of pedagogical software tools, based on which pedagogical orientation that is the realization of certain didactic functions in the learning process [39, p. 125]:

- demonstration programs (designed for a demonstration of the training material of a descriptive nature);
- training programs (aimed at the acquisition of new knowledge; implemented usually in the form of a dialogue);
- simulators (provide the formation and consolidation of practical skills, and also used in self-education activities);
- control programs (designed to control a certain level of knowledge and skills. Application of such programs enables to increase the efficiency of training, to intensify and increase the productivity of the teacher, provides the necessary stability and invariance and independence from subjective teacher settings);
- simulation and simulation programs (allowing to simulate objects, phenomena and processes of the real world. Their effectiveness is achieved when the process or the phenomenon cannot be practiced (micro and macro world). In the process of using such programs, abstract concepts become more specific and easier to perceive by those who learn);
- information and reference programs (intended for search and output the necessary information for educational, methodological and other purposes. Such programs include electronic encyclopedias, knowledge bases. Today the value of their application is to organize access to information through modern telecommunication networks);
- programs for problem learning (designed to activate cognitive activities of students through the formulation of various problems and tasks that need to be resolved through attempts and errors).

The practice of ICT implementing in the educational process of higher educational institutions is spreading every day. Many software products, techniques and technologies that were used at the beginning of the education informatization were subject to multiple changes and updates. Currently, ICT are rapidly being implemented in the educational process of higher education institutions. If the first introduction involved the use of software products for purely mathematical calculations and the teaching of disciplines in the mathematical cycle, then this range is almost limitless [15]. Educational software products are used during teaching of any discipline, from psychology and jurisprudence to philology, physical education and music. The wider the range of different software applications within a particular discipline, the more it

benefits those who study, as they get new functional capabilities that significantly affects the learning process and is more beneficial in achieving the identified goals.

ICT are innovative pedagogical technologies of the education system used to create new opportunities. The transfer of knowledge (the activities of the teacher), the perception of knowledge (the activities of students), the assessment of the quality of education and the comprehensive development of personality during the educational process [41], makes the educational process more intense and productive through the use of multimedia capabilities, intersperses interpersonal communication provides the search for information from various sources, creates convenient circumstances for communication in the most appropriate form [33].

Scientists paid much attention to the use of ICT in education and described in their doctoral dissertations. So, for example, it is noticed that a computer science teacher with fundamental knowledge in the field of informatics is needed even in secondary school [13]; the main goal of computer science students is the formation of professional informational competencies, which are based on public order, state higher education standards and personal choice of a student, the function of fundamentalization of informatics education is the basis for the formation of new qualities of a future specialist [29, p. 68]; vocational guidance function of the fundamentalization of informatics education has the following structural components: target, content, technological and the final ones [23]; multimedia in education – a promising direction in the field information processing of human activity, integration of heterogeneous data computer systems in order to more fully present the results of intellectual production in science, art, education, industry etc. [1]; informative awareness – the ability to implement the systemic knowledge, skills and abilities of acquiring and transformation of information in various fields of human activity for the qualitative performance of professional functions and conscious prediction of the consequences of its activities [24]; informational competence includes the ability to independently search, analyze and select the necessary information, organize, transform, store and transfer it using real objects and information technologies [8]. Information competence is the main component of the information culture as part of the overall culture of the individual [4]; information culture is a collection of informational worldview, systems of value orientations, knowledge, skills, providing purposeful and effective independent activity with the purpose satisfaction of own and professional needs in information products [10]; informatization of education is one of the most important elements of culture in general, characterizing the material and spiritual development of society, the level of organization of information processes, the degree of satisfaction of the needs of people in informational communication, timely, reliable and exhaustive information and provides a coherent vision of the world [4]; the use of ICT in education includes skills and work skills in the information and communication pedagogical environment, the ability apply multimedia teaching aids for the tasks of professional activity, the ability to use knowledge control with the help of a computer, the ability to use ready-made electronic tools and independently develop their own multimedia teaching aids, forms Internet communication skills [10] and many other works devoted to informatization of education and the use of ICT in education [21; 22].

Informatization of education is stipulated by branch directions. Considering the goals of informatization of education Valerii Yu. Bykov noted that at the present stage of development of society and education the main goal is to prepare those who are studying for active and productive life in the information society, to provide high-quality, affordable and effective education, to create educational conditions for life-long learning at the expense of widespread introduction into the educational practice of methods and means of ICT and computer-based technologies [2]. Informational education provides two strategic goals. The first of these is to increase the efficiency of all types of educational activities through the use of ICT. The other is in elevation the quality of training specialists with a new type of thinking that meets the requirements of the information society [11].

In accordance with the current legislation, the Law of Ukraine on National program of informatization, the informatization means a set of interrelated organizational, legal, political, socio-economic, scientific and technical, production processes aimed at creating conditions for meeting the information needs of citizens and society through the creation, development and use of information systems, networks, resources and information technologies based on application of modern computing and communication technology [40].

3 Results of the study

Every teacher who works now and in the future should know that informatization of education is a modern resource getting answers to questions that are of interest to educators and students. Possessing skills using information resources is the major way of improving their own professional ability. And this is also one of the goals of education informatization.

For the primary goals of informatization of education we have to include the following components as:

- establishment of skills of self-education and self-realization;
- advancement of the potential of each person and its development;
- development of the educational spectrum of services for people with special needs;
- increase in the quality of education;
- formation of skills for building own educational trajectory;
- raising the fundamental level of general and education [2];
- creation of new special methods, tools and educational technologies [2];
- raising the level of pre-professional training of higher education students of general school [2];
- increasing the aptitude to analyze the extended knowledge and skills of students;
- expansion of methods and means of teaching using modern scientific and technical developments;
- providing favorable conditions for those wishing to upgrade their qualifications;
- development of postgraduate education and adult education;
- expansion of limits and possibilities of self-realization [2];
- establishment of the society with the informatively experienced population [39];

- development of the intellectual potential of the nation;
- enhancement and modernization of traditional forms of training curriculum.

The degree of informatization of education is a direct reflection of the level of informatization of society, which is why the information development of education becomes the major factor in the growth of the general level of training of students. Students develop skills to create and implement the latest technologies for future professional activity and form the theoretical basis of knowledge while studying at a pedagogical higher educational establishment.

4 Conclusions and prospects of future research

Based on the evidence mentioned above and on the fact that informatization of education is the main contributor of the existence and development of modern higher education and society as an intertwined entity, we can state that the informatization of education of all levels should become one of the major and important tasks of the state. As already noted, informatization of education is the foundation of the informatization of society as a whole, precisely because the problems of informatization of objects of education should be given the highest priority at both the local and state levels. Informatization of education directly influences the content of education and the methods of its organization. Educational informatization has pedagogical goals and objectives. It provides the necessary conditions for the integration of the educational system of Ukraine into the world information space. Educational activity based on the use of ICT becomes the foundation for change in the structure of the working process of teachers and forms a new perception of the educational material by those who learn. Educational activity affects the development of self-education through the use of information learning resources, thereby gaining experience in the use of ICT both in everyday life and future professional activity. The widespread introduction and application of ICT in the educational sector is a pillar of the development of scientific research and development. The educational software products are improving constantly. There is an ongoing development of pedagogical technologies based on ICT. New educational courses and methods are being developed and implemented in educational areas, as well as various forms and technologies of training. The attention paid to the education of informatization by scientists increases the introduction of ICT into the educational process at all levels and in all branches of education. We concluded that informatization of education is a constant process, which enhances the development of society, improving the quality of life and education and the expansion of new forms and methods of teaching.

References

1. Anisimova, N.S.: Teoreticheskie osnovy i metodologiya ispolzovaniia multimediiinykh tekhnologii v obuchenii (Theoretical foundations and methodology of using multimedia

- technologies in education). Dissertation, Herzen State Pedagogical University of Russia (2002)
2. Bykov, V.Yu.: Modern tasks of informatization of education. *Information Technologies and Learning Tools* **15**(1). doi:10.33407/itlt.v15i1.25
 3. Ermolayev, V., Mallet, F., Yakovyna, V., Kharchenko, V., Kobets, V., Kornilowicz, A., Kravtsov, H., Nikitchenko, M., Semerikov, S., Spivakovsky, A.: Preface. In: Ermolayev, V., Mallet, F., Yakovyna, V., Kharchenko, V., Kobets, V., Kornilowicz, A., Kravtsov, H., Nikitchenko, M., Semerikov, S., Spivakovsky, A. (eds.) *Proceedings of the 15th International Conference on ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer (ICTERI, 2019)*, Kherson, Ukraine, June 12-15 2019, vol. II: Workshops. *CEUR Workshop Proceedings* **2393**. <http://ceur-ws.org/Vol-2393/preface.pdf> (2019). Accessed 30 Jun 2019
 4. Galdak, M., Khomik, A.: Formuvannia informatsiinoi kultury vchytelia (Creation of Information Culture for the Teacher). In: *Proceedings of International Symposium "Computers in Europe. Past, Present and Future"*, Kyiv, October 5-9, 1998. International Charity Foundation for History and Development of Computer Science and Technique (ICFCST). <http://www.icfcst.kiev.ua/Symposium/Proceedings/Galdak.doc> (1998)
 5. Gavrilo, L.G.: Systema formuvannia profesiinoi kompetentnosti maibutnikh uchyteliv muzyky zasobamy multymediinykh tekhnolohii (The system of developing professional competence of future music teachers based on multimedia technologies). Dissertation, National Pedagogical Dragomanov University (2015)
 6. Hurevyeh, R.S., Kademiia, M.Iu., Koziar, M.M.: Informatsiino-komunikatsiino tekhnolohii v profesiinii osviti maibutnikh fakhivtsiv (Information and communication technologies in the professional education of future specialists). LDU BZhD, Lviv (2012)
 7. Hurzhii, A.M.: Informatsiino tekhnolohii v osviti (Information technologies in education). In: *Problemy osvity*, pp. 5–11. IZMN, Kyiv (1998)
 8. Khutorskoi, A.V., Andrianova, G.A., Skripkina, Iu.V.: Evristicheskaia strategiiia distantsionnogo obrazovaniia cheloveka: opyt realizatsii (The heuristic strategy of remote human education: the experience of realization). *Eidos* **2**. <http://www.eidos.ru/journal/2013/0329-10.htm> (2013). Accessed 18 Oct 2018
 9. Kiianovska, N.M., Rashevskaya, N.V., Semerikov, S.A.: The theoretical and methodical foundations of usage of information and communication technologies in teaching engineering students in universities of the United States. *Vydavnychi viddil DVNZ "Kryvorizkyi natsionalnyi universytet"*, Kryvyi Rih (2014)
 10. Kolomiyets, A.M.: Teoretychni ta metodychni osnovy formuvannia informatsiinoi kultury maibutnoho vchytelia pochatkovykh klasiv (Theoretical and methodical bases of informational culture of the future teacher of primary education). Dissertation, Institute of pedagogical education and adult education of the Academy of Pedagogical Sciences of Ukraine (2008)
 11. Kryvonos, O.M.: Vykorystannia informatsiino-komunikatsiinykh tekhnolohii v navchanni (The use of information and communication technologies in education). *Vydavnytstvo ZhDU im. I. Franka, Zhytomyr* (2012)
 12. Kyslova, M.A., Semerikov, S.O., Slovak, K.I.: Development of mobile learning environment as a problem of the theory and methods of use of information and communication technologies in education. *Information Technologies and Learning Tools* **42**(4), 1–19 (2014). doi:10.33407/itlt.v42i4.1104
 13. Lapchik, M.P. *Podgotovka pedagogicheskikh kadrov v usloviakh informatizatsii obrazovaniia (Teacher training in the context of education informatization)*. Binom. Laboratoriia znaniy, Moscow (2013)

14. Manako, A.F., Sinitca, K.M.: KT v obuchenii: vzgliad skvoz prizmu transformatsii (CT in teaching: look through the prism of transformation). *Obrazovatelnye tekhnologii i obshchestvo* **15**(3), 392–413 (2012)
15. Markova, O., Semerikov, S., Popel, M.: CoCalc as a Learning Tool for Neural Network Simulation in the Special Course “Foundations of Mathematic Informatics”. In: Ermolayev, V., Suárez-Figueroa, M.C., Yakovyna, V., Kharchenko, V., Kobets, V., Kravtsov, H., Peschanenko, V., Prytula, Ya., Nikitchenko, M., Spivakovsky A. (eds.) *Proceedings of the 14th International Conference on ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer (ICTERI, 2018)*, Kyiv, Ukraine, 14-17 May 2018, vol. II: Workshops. *CEUR Workshop Proceedings* **2104**, 338–403. http://ceur-ws.org/Vol-2104/paper_204.pdf (2018). Accessed 30 Nov 2018
16. Markova, O.M., Semerikov, S.O., Striuk, A.M.: The cloud technologies of learning: origin. *Information Technologies and Learning Tools* **46**(2), 29–44 (2015). doi:10.33407/itlt.v46i2.1234
17. Merzlykin, O.V., Semerikov, S.O.: Perspektyvni khmarni tekhnolohii v osviti (Prospective cloud technologies in education). In: *Materialy dopovidei naukovo-praktychnoho seminaru “Khmarni tekhnolohii v suchasnomu universyteti” (KhTSU-2015)*, pp. 31–33. ChDTU, Cherkasy (2015)
18. Modlo, E.O., Semerikov, S.O.: Development of SageMath filter for Moodle. *New computer technology* **12**(special issue “Cloud technologies in education”), 233–243 (2014)
19. Modlo, Ye.O., Semerikov, S.O., Shmeltzer, E.O.: Modernization of Professional Training of Electromechanics Bachelors: ICT-based Competence Approach. In: Kiv, A.E., Soloviev, V.N. (eds.) *Proceedings of the 1st International Workshop on Augmented Reality in Education (AREdu 2018)*, Kryvyi Rih, Ukraine, October 2, 2018. *CEUR Workshop Proceedings* **2257**, 148–172. <http://ceur-ws.org/Vol-2257/paper15.pdf> (2018). Accessed 21 Oct 2018
20. Modlo, Ye.O., Semerikov, S.O.: Xcos on Web as a promising learning tool for Bachelor’s of Electromechanics modeling of technical objects. In: Semerikov, S.O., Shyshkina, M.P. (eds.) *Proceedings of the 5th Workshop on Cloud Technologies in Education (CTE 2017)*, Kryvyi Rih, Ukraine, April 28, 2017. *CEUR Workshop Proceedings* **2168**, 34–41. <http://ceur-ws.org/Vol-2168/paper6.pdf> (2018). Accessed 21 Oct 2018
21. Morkun, V., Semerikov, S., Hryshchenko, S., Slovak, K.: Environmental Geo-information Technologies as a Tool of Pre-service Mining Engineer’s Training for Sustainable Development of Mining Industry. In: Ermolayev, V., Bassiliades, N., Fill, H.-G., Yakovyna, V., Mayr, H.C., Kharchenko, V., Peschanenko, V., Shyshkina, M., Nikitchenko, M., Spivakovsky, A. (eds.) *13th International Conference on ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer (ICTERI, 2017)*, Kyiv, Ukraine, 15-18 May 2017. *CEUR Workshop Proceedings* **1844**, 303–310. <http://ceur-ws.org/Vol-1844/10000303.pdf> (2017). Accessed 21 Mar 2019
22. Morkun, V.S., Semerikov, S.O., Morkun, N.V., Hryshchenko, S.M., Kiv, A.E.: Defining the Structure of Environmental Competence of Future Mining Engineers: ICT Approach. In: Kiv, A.E., Soloviev, V.N. (eds.) *Proceedings of the 1st International Workshop on Augmented Reality in Education (AREdu 2018)*, Kryvyi Rih, Ukraine, October 2, 2018. *CEUR Workshop Proceedings* **2257**, 198–203. <http://ceur-ws.org/Vol-2257/paper19.pdf> (2018). Accessed 21 Oct 2018
23. Morze, N.V.: *Systema metodychnoi pidhotovky maibutnikh vchyteliv informatyky v pedahohichnykh universytetakh (Methodic system of Computer Science teacher’s training in pedagogical universities)*. Dissertation, National Pedagogical Dragomanov University (2003)

24. Petukhova, L.Ye.: Teoretyko-metodychni zasady formuvannia informatychnykh kompetentnosti maibutnykh uchyteliv pochatkovykh klasiv (Theoretic and Methods Bases for Development of Information Competences of Future Elementary School Teachers). Dissertation, K. D. Ushynskiy Pivdenoukrainskiy State Pedagogical University (2009)
25. Rakov, S.A.: Matematychna osvita: kompetentnisnyi pidkhd z vykorystanniam IKT (Mathematical education: a competency approach using ICT). Fakt, Kharkiv (2005)
26. Semerikov, S.O., Shokaliuk, S.V., Plyushh, Yu.V., Mintii, I.S., Tkachuk, V.V.: Rozrobka filtru Sage dlya SDN Moodle (Sage filter development for distance learning system Moodle). *New computer technology* **9**, 189–194 (2011)
27. Semerikov, S.O., Teplytskyi, I.O., Yechkalo, Yu.V., Kiv, A.E.: Computer Simulation of Neural Networks Using Spreadsheets: The Dawn of the Age of Camelot. In: Kiv, A.E., Soloviev, V.N. (eds.) *Proceedings of the 1st International Workshop on Augmented Reality in Education (AREdu 2018)*, Kryvyi Rih, Ukraine, October 2, 2018. *CEUR Workshop Proceedings* **2257**, 122–147. <http://ceur-ws.org/Vol-2257/paper14.pdf> (2018). Accessed 30 Nov 2018
28. Semerikov, S.O., Teplytskyi, I.O., Yechkalo, Yu.V., Markova, O.M., Soloviev, V.N., Kiv, A.E.: Computer Simulation of Neural Networks Using Spreadsheets: Dr. Anderson, Welcome Back. In: Ermolayev, V., Mallet, F., Yakovyna, V., Kharchenko, V., Kobets, V., Kornilowicz, A., Kravtsov, H., Nikitchenko, M., Semerikov, S., Spivakovsky, A. (eds.) *Proceedings of the 15th International Conference on ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer (ICTERI, 2019)*, Kherson, Ukraine, June 12-15 2019, vol. II: Workshops. *CEUR Workshop Proceedings* **2393**, 833–848. http://ceur-ws.org/Vol-2393/paper_348.pdf (2019). Accessed 30 Jun 2019
29. Semerikov, S.O.: Teoretyko-metodychni osnovy fundamentalizatsii navchannia informatychnykh dystsyplin u vyshchykh navchalnykh zakladakh (Theoretical and methodic foundations of fundamentalization teaching of the Computer Science at the high educational institutions). Dissertation, National Pedagogical Dragomanov University (2009)
30. Soldatkin, V.I. (ed.): *Prepodavanie v seti Internet (Teaching in the Internet)*. Vyshaia shkola, Moscow (2003)
31. Spirin, O.M.: Teoretychni ta metodychni zasady profesiinoi pidhotovky maibutnykh uchyteliv informatyky za kredytno-modulnoi systemoiu (Theoretical and methodological foundations for the training of future informatics teachers on a credit-modular system). Vydavnytstvo ZhDU im. I. Franka, Zhytomyr (2007)
32. Striuk, M.I., Moiseienko, N.V., Teplytskyi, O.I.: Free software development for mobile access to Wolfram|Alpha. *New computer technology* **10**, 132–136 (2012)
33. Syrovatskyi, O.V., Semerikov, S.O., Modlo, Ye.O., Yechkalo, Yu.V., Zelinska, S.O.: Augmented reality software design for educational purposes. In: Kiv, A.E., Semerikov, S.O., Soloviev, V.N., Striuk, A.M. (eds.) *Proceedings of the 1st Student Workshop on Computer Science & Software Engineering (CS&SE@SW 2018)*, Kryvyi Rih, Ukraine, November 30, 2018. *CEUR Workshop Proceedings* **2292**, 193–225. <http://ceur-ws.org/Vol-2292/paper20.pdf> (2018). Accessed 31 Dec 2018
34. Teplitckii, I.A., Evteev, V.N., Semerikov, S.A.: Lichnost v informatcionnom obshchestve (Personality in the information society). *Actual problems of mind* **5**, 179–191 (2004)
35. Teplytskyi, I.O., Semerikov, S.O.: Informatysiine suspilstvo: humanistychnyi aspekt (Information society: the humanistic aspect). *Naukovyi chasopys Natsionalnoho pedahohichnoho universytetu imeni M. P. Drahomanova, Serii 2: Kompiuterno-oriientovani systemy navchannia* **2** (9), 79–88 (2005)

36. Teplytskyi, I.O., Semerikov, S.O.: Z dosvidu vykorystannia Vilnoho prohramnoho zabezpechennia u pidhotovtsi maibutnoho vchytelia (The experience of the use of Free Software in training future teachers). *Ridna shkola* 5, 40–41 (2003)
37. Teplytskyi, O.I., Teplytskyi, I.O., Semerikov, S.O., Soloviev, V.N.: Training future teachers in natural sciences and mathematics by means of computer simulation: a social constructivist approach. *Vydavnychiy viddil DVNZ "Kryvorizkyi natsionalnyi universytet"*, Kryvyi Rih (2015)
38. Tryus, Yu.V.: Kompiuterno-orientovani metodychni systemy navchannia matematychnykh dystsyplin u VNZ: problemy, stan i perspektyvy (Computer-oriented methodical systems of teaching mathematical disciplines in higher educational institutions: problems, state and prospects). *Naukovyi chasopys NPU imeni M. P. Drahomanova, Seriiia 2: Kompiuterno-orientovani systemy navchannia* 9, 16–29 (2010)
39. Velychko, V.Ye.: Teoretyko-metodychni zasady zastosuvannia vilnoho prohramnoho zabezpechennia u pidhotovtsi maibutnykh uchyteliv matematyky, fizyky ta informatyky (Theoretical and methodical principles of the use of free software in the preparation of future teachers of mathematics, physics and computer science). B. I. Matorin, Sloviansk (2017)
40. Verkhovna Rady Ukrainy: Zakon Ukrainy “Pro Natsionalnu prohramu informatyzatsii” (Law of Ukraine “On the National Program of Informatization”). <https://zakon0.rada.gov.ua/laws/main/74/98-%D0%B2%D1%80> (2016). Accessed 11 Nov 2018
41. Zakharova, I.G. *Informatcionnye tekhnologii v obrazovanii* (Information technology in education). Academia, Moscow (2013)
42. Zhaldak, M.I.: Problemy informatyzatsii navchalnoho protsesu v serednykh i vyshchykh navchalnykh zakladakh (Problems of informatization of the educational process in secondary and higher educational institutions). *Kompiuter u shkoli ta simi* 3, 8–15 (2013)