







Use of Information and Communication Technologies in the Organization of Blended Learning of Future Vocational Education Professionals

Svitlana L. Kucher¹^a, Roman M. Horbatiuk²^b, Olga Yu. Serdiuk³^c, Mykhailo M. Ozhha²^d,
Natalia M. Hryniaieva⁴^e and Mark M. Fridman⁵^f

¹Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine

²Ternopil Volodymyr Hnatyuk National Pedagogical University, 2 M. Kryvonosa Str., Ternopil, 46027, Ukraine

³Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine

⁴Kryvyi Rih College of Economics and Management of Kyiv National Economic University named after Vadym Hetman, 37A Vatutin Str., Kryvyi Rih, 50096, Ukraine

⁵State University of Economics and Technology, 5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine

Keywords: ICT, Blended Learning, Online Learning, Vocational Education.

Abstract: The ability to use the means of modern communication at different stages of the educational process, combining technical means with the latest educational technologies, is now a prerequisite for modern education. The methodological features of the use of ICT in information retrieval, project development, evaluation and self-evaluation are highlighted. Options for the appropriate use of public computer programs and means of communication to support online and blended learning, optimize feedback between the subjects of the educational process, an innovative approach to complex tasks. Mastering the tool software should become a fundamental part of the methodological system of education at the University.

1 INTRODUCTION


Due to the introduction and dissemination of innovations in the field of education, an educational system of open, flexible, individualized, creative knowledge, continuous education of a person throughout his life is formed. This system should combine the following components: modern educational technologies, new methods and techniques of teaching and learning (pedagogical innovations) and new means of interaction in the educational process, i.e. information and communication technologies.


Conceptual principles of continuous professional training of future specialists in vocational education are based on the paradigm of personality-oriented education (Ball, 1997; Ziaziun, 1989); theory of professional pedagogical education (Horbatiuk et al., 2020;


Lavrentieva et al., 2021); theory and methods of use of information and communication technologies (ICT) in the educational process of higher education (Osadcha and Osadchyi, 2014; Striuk and Semerikov, 2012; Zakharova, 2003) and others. The concepts of “quality of training” and “competence of a specialist” are although related, but they are not identical and reveal different aspects of the educational process. Thus, the quality of education and the competence of the specialist may be in the relation “condition-goal”. The formation of a competent specialist is the result of quality implementation of all stages of the educational process.


The expansion of the Internet, the rapid increase and “rejuvenation” of the audience of users of global electronic resources leads to the spread of the use of Internet-oriented technologies in education, in particular in the training of bachelors of vocational education. On the other hand, the process of technologicalization of education is accompanied by the involvement of students in mastering the techniques of using the capabilities of computer technology.


Computer-based technologies of professional


^a <https://orcid.org/0000-0003-0662-9777>

^b <https://orcid.org/0000-0002-1497-1866>

^c <https://orcid.org/0000-0003-0505-0800>

^d <https://orcid.org/0000-0002-6954-0318>

^e <https://orcid.org/0000-0001-5361-7803>

^f <https://orcid.org/0000-0003-3819-2776>

training of the future specialist can be divided into three areas (means of searching and exchanging information; electronic educational resources and instrumental art; technical software) which should have a comprehensive interaction on the personality of the future specialist. In the developed model of formation of professional and pedagogical competence of the future master of technological education, Yashchuk (Yashchuk, 2007) singled out pedagogical (design, interactive, positional, contextual, trainings) and information (networks, computer multimedia, Web-technologies, electronic textbooks) technologies.

Based on the existing psychological and pedagogical concepts of professional development of a specialist in the system of vocational education and taking into account their own considerations, we believe that the formation of his professional competence (as a set of key, general and specialized) occurs in four stages:

- 1) development of universal key competencies common to all disciplines in the context of future professional activity;
- 2) formation of general professional competence (reflects the modern understanding of the main tasks of professional activity of the specialist) according to professional standards on the basis of the key competence (show ways to solve them);
- 3) formation of specialized competence on the basis of developed general professional competence (in relation to the specifics of a particular professional activity);
- 4) development of specialized competencies.

The main task of the study is the use of information and communication technologies for the organization of blended learning (in distance or blended education), when the learning process can take place in various forms (online and offline), the purpose of which is to form the competence of the specialist. In addition, there are now significant opportunities in the implementation of educational activities at anytime, anywhere, with the condition of interaction between teacher and students by means of mobile learning, which is one of the subtypes of distance learning or e-learning (Gorbatyuk and Potapchuk, 2017; Vlasenko et al., 2020).

The *purpose* of the paper is to identify the versatile capabilities of using ICT in conditions of distance and blended training, which provides the basis for the implementation of all stages of educational projects. Formation of professional special competences of future bachelors of vocational education related to willingness to exercise and guide of design, modeling and

manufacturing of clothing, is an expected result of the use of modern capabilities of ICT.

2 RESULTS

Research using project method by future bachelors of vocational education were used some methods: analysis, synthesis, modeling; pedagogical experiment.

The practical implementation of the competence approach in higher education brings to the fore the task of developing a methodological system for each discipline, which would correspond to the pedagogical model of forming the professional competence of a graduate of a higher education institution.

Based on the key competencies of the future vocational education specialist, we have developed criteria that will determine the effectiveness of our research: K 06. Skills in the use of information and communication technologies; K 07. Ability to learn and master modern knowledge; K 14. Ability to manage training / development projects; K 16. Ability to use modern information technologies and specialized software and integrate them into the educational environment; K 17. Ability to implement learning strategies based on specific criteria for assessing academic achievement (MON, 2019).

3 MATERIAL

In modern conditions, the future specialist must be able not only to use a computer, but also to set and solve professional practical problems with its help. He must have a sufficient level of mastery of technologies for access to local and global network information resources; to know the tendencies of development of modern computer technologies and possibilities of their using in further professional activity.

Basic skills of the organization of distance learning using ICT include that all participants in the educational process have the skills to use a personal computer, Internet skills, experience using office programs, etc. CAD technologies as automatic design systems are a necessary means of achieving a professional level in the execution and graphic design of projects of various kinds.

We believe that a certain pedagogical model of the formation of professional competence of a graduate of an educational institution should correspond to a special methodological support of academic disciplines, which will be aimed at forming the subject results of a particular educational program.

ICT and distance learning technologies have been long recognized as modern pedagogical technologies, the most used in the training of future professionals, as well as design, integrative-modular, modular rating, problem-based learning case technology, development cooperation technology, etc. (Sapozhnikov, 2016). The ability of the teacher to innovate is, first of all, the desire and ability to develop their interests and ideas, to seek their own non-traditional solutions to problems that arise, to perceive and creatively implement existing non-standard approaches in education.

The introduction of ICT in the education system has become a key element of the education reform of the world's leading countries. The concept "Internet-oriented pedagogical technology" Zhuk (Zhuk, 2017) interprets as a means of learning that contributes to the realization of the pedagogical idea.

Today the most successful form of organization of the educational process in higher education is blended learning. Blended and online learning under quarantine restrictions have become an integral part of educational practice (Polhun et al., 2021). Developing in this direction, domestic teachers have the opportunity to benefit from the experience of other countries, where online learning has been developing strongly since the early 2000s. Potential advantages of online education: student-oriented approach (the teacher does not control the learning process alone, but acts as a facilitator); joint interactive learning (priority of learning in small groups, receiving tasks for discussion in advance); metacognitive awareness (students' understanding and application of models and strategies for effective learning); increased flexibility (independent control of students of their pace and time); instant feedback (discussion to understand complex concepts, search and correct misconceptions about the subject of study); combined content (a combination of different ways of presenting multimedia content) (Smith and Brame, 2014). But the role of the teacher is still important, which create an interactive atmosphere of support and collaboration in which students can reap the benefits of online learning.

The use of mobile technologies provides an opportunity to expand educational tasks, in particular, the professional content and joint activities of teachers and students at different stages of learning disciplines, creating conditions for giving a mass character to individual learning. The combination of traditional forms of learning and mobile learning has features (Gorbatyuk and Potapchuk, 2017):

- 1) students use mobile devices for learning in cases where they can not use a computer;
- 2) the use of mobile technology allows students to

use free time to study;

- 3) the opportunity to carry out joint online work on group projects, equal access of all participants to training;
- 4) the ability to perform individual time-discrete learning activities of students;
- 5) organization of webinars – a way to organize meetings online, the format of seminars, trainings and other events via the Internet, for their organization using video conferencing technologies using services such as Viber, Skype, WatsAp and others.

Objective social factors contributed to the rapid development of e-learning and blended learning in all educational institutions in Ukraine. As you can see (figure 1), the number of developed electronic training courses for bachelors in vocational education in specialty 015, locally presented on the Moodle (<https://moodle.kdpu.edu.ua/course/index.php?categoryid=5>), has grown significantly.

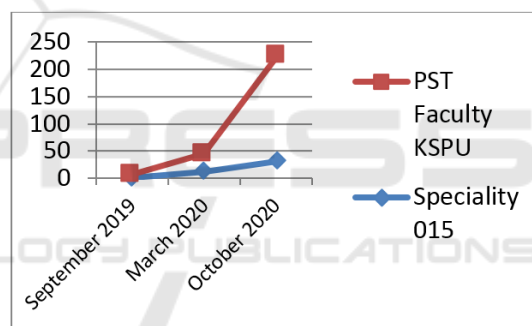


Figure 1: Number of developed e-learning courses on the platform Moodle KSPU.

For example, Moodle is the main LMS at Kryvyi Rih State Pedagogical University (KSPU) (Mintii, 2020). But distance and blended learning on e-learning platforms (Moodle, Google Classroom, local educational sites) do not in themselves provide student activity. Lack of personal contacts reduces the activity of students in performing tasks. Therefore, we are convinced that innovative media are particular value during distance learning, as they provide opportunities:

- diversification of forms of presentation and acquisition of educational material;
- communication, cooperation in groups;
- mutual evaluation and self-evaluation and feedback.

The main task of the teacher is to select information and methodological material that corresponds

to the program and the level of students and directs them to use the appropriate resources. In designing blended learning, special attention should be paid to the coverage and accessibility of e-courses (which includes materials, tasks, ability to take, discuss, etc.), providing students with a sense of community (rather than isolation and anxiety), student-centered learning, blended content within electronic course.

Consider the possibilities of modern ICT according to the main stages of development of educational projects (because it is the project approach we consider appropriate for the construction of professional training courses).

In our opinion, the special competence of the bachelor of vocational education, which is associated with the use of ICT in professional activity, is the ability to create materials for online learning, the ability to ensure the interaction of participants in the design process, ICT skills in organizing almost all stages of design.

At the stage of organization and preparation of the project tasks there is an active exchange of views, which requires communication of student groups with each other and with the lecturer. The simplest solution for this can be a forum or group chat. But we consider electronic boards in which it is possible to accumulate information in a visual form and to transfer the best means.

Electronic boards that are indispensable in addition to online learning platforms ("Padlet" electronic board, "Miro" online board, "SMART" Board interactive, "Blackboard" mobile application). E-boards can be built into a ready-made training course to ask questions in a group, download files (doc, pdf, jpg, png), and disseminate research results (individual and group). There can be downloaded module, treasury of resources or tools needed to work on the course, additional tasks with the ability to obtain additional points (Litvin, 2020).

We consider that interactive whiteboard SMART Board (developed by SMART Technologies (Canada) can be used to implement the concept of blended learning as a basic tool. The interactive whiteboard is an ideal solution for classroom work of all age groups, including students. The interactive whiteboard uses the latest developments in Touch technologies with surface type recognition. The capabilities of SMART Notebook software allow you to create quickly the highest quality and visually enjoyable lesson, without much effort and specialized knowledge. The teacher has the opportunity using a gallery of images and multimedia files (which is already partially embedded in the software), interactive tasks, page templates and themes (SMART, 2020).

Most often, the interactive whiteboard in the classroom is used as a means of frontal work with students and involves careful preparation and development of the necessary set of slides with learning materials and tasks. At the stage of designing slides in the SMART Notebook program, it is important to anticipate the methods of working with the interactive whiteboard at different stages of the lesson.

Among the methods of working with an interactive whiteboard, the most suitable for activating the cognitive activity of students in lectures may be: the reception "Write by hand" (with the help of the "Magic Pen" tool on the slides, the teacher makes notes, making graphic comments, and students perform the same task on the interactive whiteboard in turn insert missing symbols and words, sign, underline, circle, establish a connection); the reception "Drag and Drop" (allows you to move the object on the board from one place to another, to match objects, group, sort, restore the correct sequence, arrange the elements in ascending or descending order, to construct objects from a set of details) (Ivanova, 2012; Kiurshunova, 2017). Such work is successfully used in mastering the thesaurus of professional disciplines, such as designing and modeling clothes. It is also advisable to use these techniques in the study of foreign languages for professional purposes.

The Blackboard mobile application is quite affordable. It presents the teacher and students with all the possibilities of online learning in one place: view course materials, complete tasks and tests, evaluate tasks, lead discussions and collaborate in the Blackboard Collaborate. The site of the platform provides quite detailed instructions that help users quickly learn to work in the apps.

The stage of design and technologically sound product development is marked by a close correlation with the professional activity of a design engineer and the specifics of graphic activity. The specificity of graphic activity is due to the variety of ways of forming graphic information, its forms, functions, the nature of graphic problems and the conditions for their solution.

The software package is the main means of solving practical problems for future teachers of any specialty, providing opportunities for technical processing of text and visual material. Usually, the Word text editor allows you to prepare handouts and didactic material; Access databases and PowerPoint electronic presentations are used to organize and present information at the appropriate scientific and methodological level, rationally and efficiently using learning time.

Speaking about future bachelors of vocational ed-

ucation, we pay special attention to the need to form students' constructive competence as an important component of them professional competence. One of the characteristics of design thinking is the ability to synthesize knowledge and skills acquired in the study of many special disciplines. Therefore, it is effective to train a specialist based on the principle of interdisciplinary integration, which is implemented through ICT, special engineering and psychological and pedagogical disciplines. The double professionalism of the engineer-teacher, according to (Tarkhan, 2005), allows them to work in all branches of production, where engineering activities take place not only in the system "man-machinery", but also in the system "man-man".

Object design can be successful when it is based on general intellectual and specific skills to find a basis for the integration of different subject areas, evaluate the results of their own activities, and model the transformation process. The future engineer-teacher must: conduct design analysis and synthesis of the object of transformation; build proportionally dependent relationships; transfer knowledge from one subject area to another in order to apply them to describe the system of transformation activities; determine the level of readiness of the object for the transformation process; make constructive and technologically sound decisions and implement them in practice; choose rational ways of transforming activity; plan, forecast and evaluate the effectiveness of transformation activities; to create spatial models of technological processes.

One of the professional tasks of the future teacher of vocational education is to design garments in a complex. In particular, when performing course work on the design of garments, we offered students a project development algorithm similar to the work of a clothing designer on a collection. The stages of project development were: search for current issues in the garment industry; analysis of search sources; generalization of information and formulation of the concept of the product or collection; sketch project of a perspective collection; development of the design and manufacturing technology of the experimental sample.

During the project at the stage of choosing the theme and the main design concept we use brainstorming. Initially, students were asked to create mind maps to reflect their own ideas. The next step was to create a group mind map, where all the ideas were collected and in some way completed in separate sectors. As a result, several or one idea was selected to serve the solution. Thus, the interim and final results of the "brainstorming" were recorded and streamlined, so

that the chosen decision was justified and presented by the elected representative of the expert group.

Students created mind maps using Mind Mapping (figure 2) in the Miro environment. Then, at the stage of developing sketches, design and technological sequence of manufacturing the product, the teacher can invite students to form groups in different "expert profiles". Each group of experts (designers, constructors, technologists, seamstresses, etc.) reviews the project, presenting the results in the form of grouped key concepts on the board.

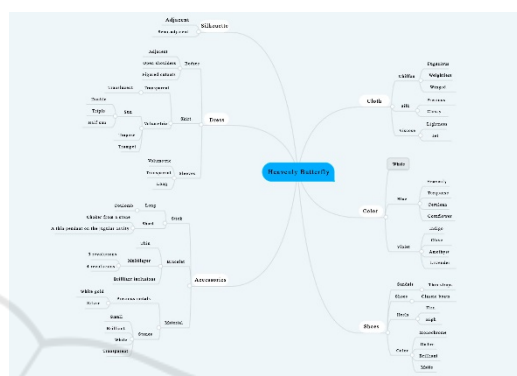


Figure 2: Mind map of brainstorming at the stage of project concept development.

In the practice of designing garments at the stage of design of the idea of the collection has become commonplace the use of moodboards (inspiration boards). Moodboard is a very convenient way to visualize an idea. It can be composed of images of natural objects (primary sources of inspiration) and works of art, design, etc. Online boards are also used to create a moodboard in the process of determining the shapes and decor of the future garment (figure 3).

In the conditions of fast-changing industrial technologies, product design it is difficult to train future specialists for work in a professional education. Disciplines such as "Systems and methods of clothing design", "CAD in the garment industry", "Design by computer graphics" play an important role in the

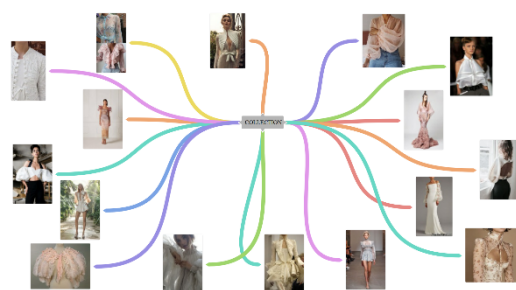


Figure 3: An example of creating a moodboard in the design process of garments.

development of professional thinking of a new type of engineer-teacher with high creative potential, engineering thinking to solve technical problems. At present, the garment industry cannot do without computer information technology. Computer-aided design systems increase the competitiveness of modern enterprises, which makes it possible to respond quickly to changing market needs. Future teachers of vocational education need to be prepared for the introduction of new technologies and develop their graphic skills and abilities in the process of designing clothes.

Designing clothes is one of the most difficult stages in creating a garment. The development of drawings of parts and the manufacture of patterns for cutting – a complex process that is facilitated by the use of CAD – automated design and calculation systems. In modern industry, several dozen computer-aided design systems are used for light industry. CAD for any industry has an identical structure and consists of approximately 10 subsystems: I/O, generation and input of information; computational process management; information retrieval subsystem; designing the basic foundations of the structure; design of new clothing models (constructive modeling); design of basic patterns and patterns of derived parts; designing sets of patterns; design of clothes of industrial production and by individual orders of the population; quality management; design of waste standards.

Of the large number of foreign companies developing software for the garment industry, it is worth noting Assyst, Zeuze (Germany); ToreyIndustries (Japan); CDIMicrodynamics, GDT, Gameo (USA); LectraSystems, Pantotus (France); InvestronicaSystems (Spain); AMFReese (UK); GIGMobil (Belgium). Julivi (SAPRLEGPROM, Ukraine), Gracia (Infocom, Kharkiv), AvtoKroy (NPP Lakshmy, Belarus) and others use sewing CAD at domestic enterprises. Special programs for clothing design are quite expensive and it is not always cost-effective for pedagogical university to purchase and maintain them.

However, there are open access programs that are available for use by educational institutions and individual users in particular. Thus, the successful use of the vector graphic computer program nanoCAD 5.1 in the training of specialists in technological education in the study of design and modeling of clothing contributed to the formation of general computer literacy in the processing of graphic objects (Kucher, 2017; Boichuk et al., 2019).

New opportunities appeared with the advent of a free program of graphic design of clothing “Valentina”, which is designed to build the basic foundations of garments for any design system (Bukhteev, 2017). The program is suitable for use in

the design of garments of any range (from coats to underwear). The main condition for its use, we consider the basic level of knowledge of the user of a particular technique (system) of clothing design.

For example, at the stage of developing the design of the future garment for third and fourth year students who have already mastered the Unified Method of Clothing Design (UMCD) when studying the course of clothing design, it is not difficult to work in the proposed program (figure 4). Construction of points and segments is carried out with the help of various tools and commands, most of which coincide with other graphics programs.

But there are some features of the program “Valentina”. Basic bases can be built on standard (standard) measurements, or on individual. The advantages of the program are the ability to build several items of clothing on one screen; change the already constructed structure according to the newly introduced measurements; to form a pattern with assumptions for technological processing and to plan the layout of parts on the fabric (figure 5). In our opinion, the presence of specific tools in the program is positive: “display the object on the axis”, “display the object on the line”, “darts”, which facilitate the manipulation of objects, bringing them closer to the familiar clothing designer operations.

The final stage in the project implementation involves reflection, self- and mutual evaluation.

Students’ implementation of the project does not require the direct guidance of the teacher, but is accompanied by his observation, consultation, monitoring and evaluation. Individual intermediate results of the project are recorded in an electronic journal, and both the teacher and the student can track them at any time. Since in the process of implementing the educational project there are individual and group forms of work, the teacher must methodically competently build assessment activities.

Feedback in the design process can occur continuously and with a certain frequency (input, intermediate, final control). During and at the end of each online lesson the short surveys that are used with the Mentimeter resource give the teacher a quick response from the participants. Periodic control activities are carried out in the form of testing as part of an e-learning course in the Moodle system. Final testing made it possible to obtain information about the level of assimilation of certain educational material.

We propose to evaluate the educational activity of students who work in small groups on the basis of the technology of collective thinking. After receiving the task, students develop their own methods of determining certain indicators (for example, establishing the

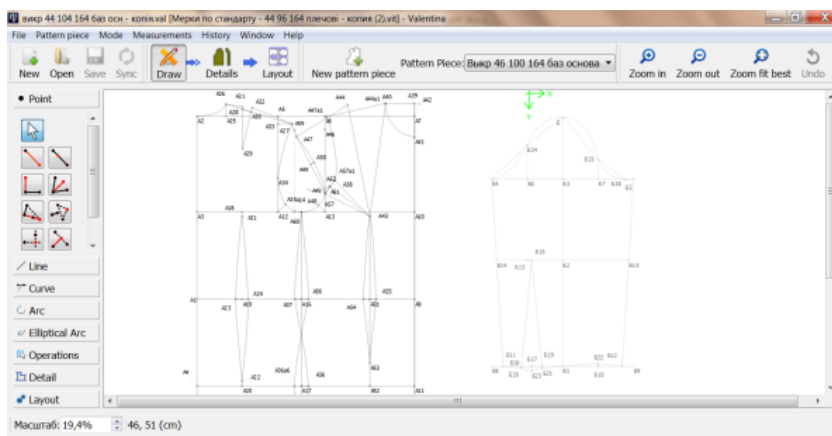


Figure 4: An example of constructing the dress basis (with sleeves) in the program “Valentina”.

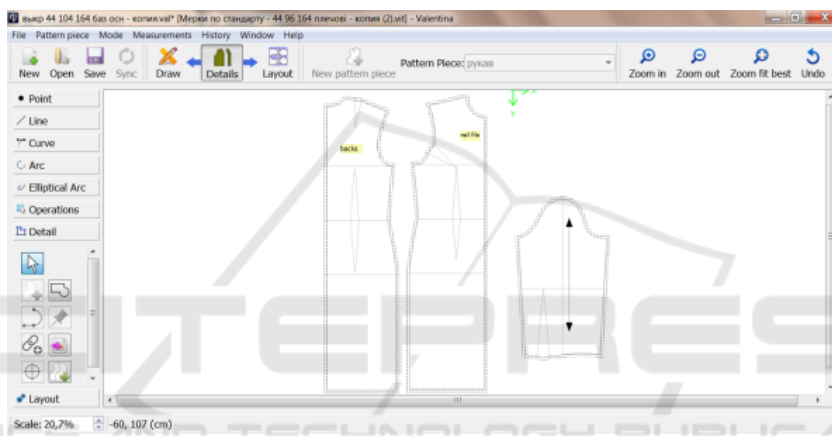


Figure 5: Preparation of patterns for printing in the program “Valentina”.

basic principle of building harmony in the pattern). Then the task is performed in three stages: individual work, discussion in a micro group, presentation of a collective decision.

In the course of project implementation, we have set a goal to demonstrate the effectiveness of the organization of blended learning using various ICTs in accordance with the tasks of each stage of the design, compared with traditional learning.

Students’ questionnaires showed that they mark the value of its own ability to create materials for e-learning.

Students noted that project development using ICT was more systematic and understandable on demands. Instead, students who performed projects in distance learning by the usual algorithm (project stages are performed by finding information on the Internet, creating a text file and presentation file) complained of difficulties in the stages of analysis, synthesis and presentation of information, design and modeling.

The dynamics of the development of professional

qualities of future professionals of professional education gives us reason to conclude on the effectiveness of using ICT at all stages of educational design.

4 CONCLUSIONS

The combination of e-learning courses with online learning and information exchange tools increases the number of students involved in active cognitive activities. The responsibility for the learning process and the feeling of being in the community during distance learning is growing. At the same time, it should be noted the student-oriented nature of this method of learning, because the teacher receives instant feedback and can make changes in the organization and content of the educational process. The ability to provide combined content in different ways significantly enriches the educational and methodological support of the course.

Thus, the use of information and communication technologies is an integral part of the modern ed-

educational process. The prospect of further exploration on the topic is related to the development of a blended learning system based on an interdisciplinary approach.

REFERENCES

- Ball, G. (1997). Personality freedom: Psychological essence and components. *Psikhologicheskii Zhurnal*, 18(5):7–19.
- Boichuk, V. M., Horbatiuk, R. M., and Kucher, S. L. (2019). Methods of using information and communication technologies in preparing future craft and technology teachers for project activities. *Information Technologies and Learning Tools*, 71(3):137–153. <https://journal.iitta.gov.ua/index.php/itlt/article/view/2838>.
- Bukhteev, V. (2017). Valentina 0.5.0.0. <https://lumpics.ru/valentina/>.
- Gorbatyuk, R. and Potapchuk, O. (2017). Modern technologies for formation of readiness professional activities future engineers-teachers in the field of computer technology. *Suchasni informatsiini tekhnolohii ta inovatsiini metodyky navchannia u pidhotovtsi fakhivtsiv: metodolohiia, teoriia, dosvid, problemy*, 48:106–109. http://dspace.tnpu.edu.ua/bitstream/123456789/8671/1/per_48.pdf.
- Horbatiuk, R., Voitovych, O., and Voitovych, I. (2020). Formation of project competence of future environmentalists. *E3S Web of Conferences*, 166:10026.
- Ivanova, I. (2012). *Methodical recommendations on the use of an interactive whiteboard in the educational process*. VIRO, Vologda.
- Kiurshunova, V. V. (2017). Methodological methods of working on an interactive board using the smartnotebook program. *Problemy sovremennoi nauki i obrazovaniia*, (17 (99)):66–73. <https://cyberleninka.ru/article/n/metodicheskie-priemy-raboty-na-interaktivnoy-doske-sredstvami-programmy-smart-notebook>.
- Kucher, Z. S. (2017). Methodological aspects of the use of innovative computer programs in graphic training of students. *Professional Education: Methodology, Theory and Technologies*, (4):130–145. <https://education-journal.org/index.php/journal/article/view/42>.
- Lavrentieva, O., Horbatiuk, R., Skripnik, L., Kuchma, O., Penia, V., and Pahuta, M. (2021). Theoretical and methodological bases of designing the educational institution information and consulting environment. *Journal of Physics: Conference Series*, 1840(1):012060.
- Litvin, O. (2020). How to organize the space of educational interaction on the Padlet? <http://ceit-blog.ucu.edu.ua/ed-tech/organizatsiya-navchalnogo-prostoru-vzayemodiyi-ta-spivpratsi-na-padlet/>.
- Mintii, I. S. (2020). Using Learning Content Management System Moodle in Kryvyi Rih State Pedagogical University educational process. *CEUR Workshop Proceedings*, 2643:293–305.
- MON (2019). Higher education standard of Ukraine: first (bachelor's) level, branch of knowledge 015 – “Vocational education (by specializations)”. <https://mon.gov.ua/storage/app/media/vishcha-osvita/zatverdzeni>
- Osadcha, K. P. and Osadchyi, V. V. (2014). Information and communication technologies in the process of development of visual thinking of future teachers. *Scientific Bulletin of Melitopol State Pedagogical University named after Bohdan Khmelnytsky. Series: Pedagogy*, (1 (12)):128–133. <https://arxiv.org/abs/1808.04893>.
- Polhun, K., Kramarenko, T., Maloivan, M., and Tomilina, A. (2021). Shift from blended learning to distance one during the lockdown period using Moodle: test control of students' academic achievement and analysis of its results. *Journal of Physics: Conference Series*, 1840(1):012053.
- Sapozhnikov, S. V. (2016). Modern pedagogical technologies for professional training of future specialists in the field of education in the countries of the Black Sea region. *Scientific works of the Petro Mohyla Black Sea State University of the Kyiv-Mohyla Academy complex*, 258(270):12–16. <http://web.archive.org/web/20171105224347/http://pednauki.chdu.edu.ua/article/download/90164/85685>.
- SMART (2020). Interaktivnaia doska SMART Board. <http://www.smartboard.com.ua/articles/115/>.
- Smith, B. and Brame, C. (2014). Blended and online learning. <https://cft.vanderbilt.edu/guides-sub-pages/blended-and-online-learning/>.
- Striuk, A. M. and Semerikov, S. O. (2012). Blended learning models. *Bulletin of Alfred Nobel University of Dnepropetrovsk. Pedagogy and Psychology*, 2(4):47–59. <https://arxiv.org/abs/1808.04893>.
- Tarkhan, L. (2005). Projective approach to methodological training of an engineer-teacher. *Humanitarian elucidation in the profile of the main mastery: problems and prospects*, 1:80–81.
- Vlasenko, K., Chumak, O., Achkan, V., Lovianova, I., and Kondratyeva, O. (2020). Personal e-learning environment of a mathematics teacher. *Universal Journal of Educational Research*, 8(8):3527–3535.
- Yashchuk, I. (2007). Peculiarities of pedagogical interaction in the conditions of humanization of educational process of higher educational institution. *Pedagogical Discourse*, 1:153–156. <https://tinyurl.com/x22xb6pa>.
- Zakharova, I. (2003). *Information technology in education*. Number 192. Academy, Moscow.
- Zhuk, Y. O. (2017). *Teoretiko-methodical bases of the organization of educational activity of senior pupils in the conditions of the computer-oriented environment of training*. Pedagogichna dumka, Kyiv. <https://lib.iitta.gov.ua/707753/>.
- Ziazium, I. A. (1989). A teacher for all seasons. *Soviet Education*, 31(8):38–54.