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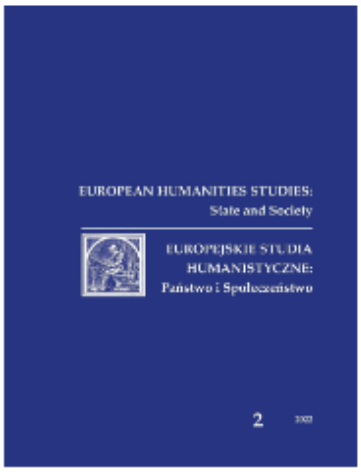

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Technology of blended learning in institutions of higher education in war conditions

OLENA LEVCHUK, KOSTIANTYN LEVCHUK, LYUDMILA HUSAK, NATALIIA HAVRYLIUK. **Technology of blended learning in institutions of higher education in war conditions.** *The aim of the research is to develop an adaptive technology of mixed learning that will provide flexible training of future specialists in war conditions and experimentally verify its effectiveness.*

Research materials and methods. *A systematic literature analysis was carried out; study of the conceptual apparatus; modeling; generalization of pedagogical experience. The pedagogical experiment was conducted on the basis of Vinnytsia National Agrarian University. Groups of 278 and 281 students were allocated. The following activities were used:*

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observation, data analysis, questionnaires, interviews, student testing, the method of diagnostic control works, mathematical processing of research results, qualitative and quantitative analysis (with Mathcad tools).

The results obtained. *All performance indicators of the developed technology (knowledge, skills, communication, autonomy and responsibility) increased in the experimental groups. Indicators of the ability to carry out independent and collective activities have significantly been improved.*

It was found that effective means of technology implementation are: the Moodle learning management system, the "Socrates" electronic management system, the Zoom service, the Telegram messenger, and the electronic board (Whiteboard). In the mathematical training of specialists, it is advisable to use the Drawchat web service, Texas Instruments and Casio graphic calculators, Matcad, Maple and Mathematica computer algebra systems, GeoGebra and Cabri interactive geometry software, virtual and augmented reality (VR/AR) technologies, online – math textbooks and resources from Khan Academy, Wolfram Alpha and Coursera.

Conclusions. *Taking into account the ongoing conflict in Ukraine, the implementation of traditional methods of face-to-face education in some regions may be difficult. Universities will need to be flexible and, where necessary, adapt their traditional educational models to ensure students have access to quality education and support. The implementation of a blended learning model will allow students to take advantage of both online and offline learning. It will also provide a flexible and adaptable approach that takes into account the needs and constraints of students and the university.*

A student-centered approach is the basis for designing an educational environment. Scientific and pedagogical workers should focus not only on the achievement of such program results as "knowledge and understanding" and "application of knowledge and understanding", but also "the ability to form judgments and formulate conclusions", "communicative abilities", "learning skills or abilities to study".

The technology of mixed learning involves the following design stages: preparation, design, implementation.

Technology design will be effective under the following pedagogical conditions: compliance with the principles of systemic individualization, differentiation and creative activity of students; personal orientation of education; integration of fundamental and special knowledge based on the professional focus of the disciplines.

Practical application: *the developed technology can be applied in the study of other disciplines. The results of the research can be used to design the content of blended learning or distance education.*

Originality: *theoretically justified and developed an adaptive model of designing a student-centered technology of mixed learning in war conditions.*
Keywords: *war in Ukraine, education during the war, blended learning, learning technologies, educational resources, student-centered education, professional training, mathematical training.*

1. Introduction and formulation of the problem

Russian aggression against Ukraine causes irreparable damage to all spheres of Ukrainian society. Tens of thousands of dead and wounded civilians, millions of refugees to the European Union countries and internally displaced people, destroyed social infrastructure, including thousands of secondary schools and institutions of higher education. Schoolchildren and students, being in forced social isolation during the COVID-19 pandemic, faced a number of problems related to the lack of physical and psychological safety, loss of loved ones, limited access to technology and energy resources.

Under the conditions of martial law, the situation is complicated by a number of new challenges:

- threats of air and missile strikes throughout the country;
- establishment of educational ties between a teacher and a student under the conditions of their stay in the status of a refugee or a temporarily displaced person;
- the unsuitability of traditional training models in the conditions of the destruction of the energy infrastructure and the lack of access of the population to permanent power sources;
- partial disintegration of the Internet network due to the unpreparedness of Internet providers to work in conditions of blackout;
- unpreparedness of educational institutions for work in the absence of alternative sources of electric current (generators) and free access of teachers to the Internet;
- partial filling of student dormitories (campuses) by internally displaced persons;
- placement and use of the material base of universities in relatively safe territories of other higher education institutions relocated from the war zone.

Therefore, the primary task of the national education system is to create conditions for unimpeded access to a high-quality educational process in safe places [1].

At the beginning of the 2022-2023 academic year, the Ministry of Education and Science of Ukraine recommended that educational institutions start the educational process depending on the security situation in a remote or mixed format [2].

Currently, we have experience in organizing training during the COVID-19 pandemic. But then the rapid transition to distance education took place without an in-depth analysis of its characteristics, taking into account the peculiarities of professional education. War requires consideration of other security circumstances.

In this case, it is important to rethink the educational experience gained during the COVID-19 pandemic, to understand the advantages and disadvantages of distance learning technologies, to review the available various methodological materials that would provide flexible forms of learning, to use adequate educational technologies that would best meet the unpredictable conditions of learning.

It should be taken into account that in institutions of higher professional education there is a shift of emphasis in the organization of the educational process to productive educational and cognitive activities. More and more attention is being paid to interpersonal, intellectual, practical skills and ethical values of future specialists, which, first of all, will contribute to the formation of their suitability for employment [3].

It is also necessary to take into account the specifics of studying disciplines, and namely, natural sciences and mathematics. In particular, students in online mathematics courses are emphasized on the effectiveness of self-regulation strategies during learning and their mutual exchange with fellow students in order to encourage students to study together in a circle of friends, share their problem-solving skills, and evaluate the success of their peers [4].

Students usually have the lowest academic performance in science and mathematics disciplines and engineering. However, given the development of technology and engineering, STEM educational programs are of great importance [5].

In our opinion, the sudden and organizationally unprepared transition to a distance form of education in higher education institutions of Ukraine during the COVID-19 pandemic gave rise to a number of contradictions between:

- social and personal needs for learning flexibility and traditional unified training programs;
- students' personal needs, which provide variability in education and conservative training forms;
- unpredictable learning conditions and lack of resources for alternative educational directions;
- various distance learning educational technologies availability and the lack of a model for their implementation;
- an increase in the volume of material for independent study and a limited number of hours for disciplines studying;
- purely theoretical content of training and future specialists' practical needs;
- students' need for collective learning and their limitations in communication with peers;
- the need to increase the digital competence of higher education teachers as soon as possible and their psychological and technological unpreparedness for this;
- the lack of gadgets for many students and some teachers, which are highly desirable for distance education (laptops, graphic tablets, etc.).

In our opinion, blended learning, which achieves an optimal combination of traditional and distance learning, is an effective means of eliminating these contradictions. In the conditions of the war in Ukraine, this method became a forced and almost the only emergency alternative to the classical organization of the educational process. In unforeseen circumstances, there is an opportunity to use the material resources of the institution of higher education and to choose the best methods of communication in the process of preparation, focusing on the needs and individual abilities of the student. The creation of a person-oriented informational and educational environment will allow the future specialist to master the necessary set of competencies on an individual trajectory, which will develop individual abilities and are considered useful and necessary for the academic or professional sphere.

In this regard, the problem of developing technologies for the introduction of blended learning into professional education in the conditions of a specific educational system is urgent.

This led to the selection of the research topic "Technology of blended learning in institutions of higher education in war conditions."

2. Recent research and publications analysis

Problems of lack of Internet and electricity are the main limitation for online learning in developing countries [6].

In China and Zambia, during school closures due to COVID-19, more than 56% of respondents did not have sufficient access to information and communication technologies, electricity and internet services. Therefore, scientists conclude that in such countries it is necessary to create an infrastructure that will support the model of blended learning [5]. At the same time, there is a lack of organizational resources, adequate training of teachers, insufficient access to technology, lack of technical means for students from rural areas. In this sense, it is emphasized that the infrastructure of the educational institution must be prepared for the implementation of digital learning [7].

Scientists note the usefulness of flexible technologies in blended learning for university students. They allow you to develop certain skills that will be important for the labor market: teamwork, motivation, involvement in tasks.

There are a number of examples of how an online learning platform can provide reflective practice that systematically supports students in evaluating their learning experience [8].

With the help of the integration of an interactive online approach in education in universities, a positive effect on the critical and reflective thinking of students is noted. A positive effect is achieved by creating opportunities for mutual observation and comments [9].

The analysis of research allows us to conclude that the gamification of the educational process is effective in remote forms. The specified technology has a number of advantages: it promotes enthusiasm, provides feedback, satisfies students' needs for recognition, and allows defining goals. Also, research results confirm a significant effect size in favor of gamification compared to learning without it [10].

It is proven that virtual and augmented reality can facilitate the study of such subjects as mathematics [11].

But online learning of mathematics has its essential features. In mathematics education at the university during distance learning, the attention of specialists is focused not only on the ability of students to get correct answers to tasks, but primarily on methods that activate students' mathematical thinking. Effective methods of its formation are the creation of a personalized situation that encourages reasoning and structuring of thoughts during a discussion among like-minded people [12].

At the same time, it should be taken into account that during online education, students have different profiles in terms of activities, goals, involvement, from highly engaged independent participants to less interested, guided ones [13].

Although mathematical knowledge is a necessary condition for mastering various fields of science and technology, students usually make more efforts to study them [4]. During the remote synchronous study of natural sciences and mathematics, difficulties in understanding the content, technical problems, difficulties in interacting with the lecturer, and the quality of the selection of illustrative tools were noted [5]. For example, 78.5% of high school students in the UAE would prefer face-to-face mathematics if given the choice [14]. It was also established that most students cannot learn mathematics effectively without the guidance of a teacher in an in-person environment and communication with peers [15].

The difficulties are explained by the fact that the study of natural and mathematical disciplines requires logical abstract thinking, synthesis, modeling and generalization. Therefore, an important feature of their teaching methodology is communicative universal actions, which involve the deployment of thought in a logical development accompanied by words and actions, formulas, schemes, drawings, illustrations. However, studies of distance learning mathematics in Finland, Germany, and the Netherlands show that the use of mathematics-specific tools, which were used by teachers before the pandemic began, has significantly decreased [16].

Therefore, at the same time as standard video conference tools (Zoom, Google Meet, Youtube Live, Facebook Messenger and WhatsApp Rooms), such learning management systems as Canvas, Google Classroom, Blackboard, Edmodo, Moodle will be effective. They will contribute to the visualization of educational content and create the effect of writing on a familiar blackboard in the classroom [17, 18]. The study allows us to conclude that with a certain level of basic knowledge, the presence of a stable motivation to study mathematics, it is possible to achieve better results in education using educational software, in particular, Moodle [19].

Mobile learning technologies are successful in supporting contextual learning. In this case, the personal qualities of students, availability of stable technologies and compatibility of educational content play a decisive role [20].

In online and blended learning, the flipped classroom model is effective. In the process of learning mathematics, during the rapid transition

to online learning, students prefer the controlled model of the flipped classroom compared to traditional teaching methods. However, adequate methodology (forms, methods, means of teaching) is of crucial importance [21]. Scientists have found a significant effect of this technique, which increases the academic success of mathematics students at several stages [22, 23]. In this case, the key point is the possibility of structured active learning and solving problems that have arisen before students [24].

In the context of our study, the conclusions about the relationship between academic success in mathematical disciplines and the level of basic knowledge, self-efficacy related to cooperation in learning and the use of the flipped classroom method [25] are important. In general, the following advantages are noted: improvement of academic performance, motivation and involvement in learning, improvement of self-regulation, independence, creativity of students, strengthening of cooperation and interpersonal relations, satisfaction with the course [21,22].

However, a meta-analysis of mathematics education technologies, for example, Ellington calculators, graphing calculators, computer technologies, confirms the overestimation of true effects in some cases [26].

Studies have shown that online learning has an extremely high dropout rate, even in developed countries. The authors emphasize that it will be even higher due to socio-economic inequality. Due to the unequal access to educational technologies in southern Africa, the adaptive version of blended learning, which uses interactive online and offline resources, was the most successful [27].

In general, scientists agree that with adequate methods, mixed study of fundamental disciplines is effective. However, it is necessary to take into account the peculiarities of professional education and a number of infrastructural, institutional and personal problems [5].

The aim of the article is to develop the technology of mixed teaching of mathematical disciplines in institutions of higher education in the conditions of war and experimentally verify its effectiveness. To do this: evaluate the possibilities of the technological infrastructure of higher educational institutions and personnel, outline the problem of mixed learning, analyze the existing practice of using distance and mixed learning technologies in the process of training specialists, theoretically substantiate the psychological and pedagogical conditions for designing professional education based on mixed learning technology, develop a technology design model blended learning, determine the principles of

selection of subject-content information in the mathematical training of specialists, develop a student-centered technology of blended learning (using the example of the "Higher Mathematics" course), identify optimal educational platforms for distance learning, prepare information resources and educational materials, experimentally test the effectiveness of the technology.

3. Methodology description

Systematic literature analysis; study of the conceptual apparatus; modeling; generalization of pedagogical experience; observation, data analysis, questionnaires, interviews, student testing, method of diagnostic control works; mathematical processing of research results, their qualitative and quantitative analysis.

Main material presentation. Blended learning technology has a large arsenal of tools for forming a student-centered informational and educational environment. However, it requires a serious approach to the development of its components and implementation: assessment, goal, content, means, forms, organization, technical support, etc. It is necessary to develop psychological and pedagogical conditions for the design of student-centered education under mixed learning.

In our opinion, the design of professional education based on the technology of mixed learning will be effective under the following pedagogical conditions:

1. Training design should be based on the principles of systematic individualization, differentiation and creative activity of students;
2. Personal orientation of education;
3. Integration of fundamental and special knowledge on the basis of the professional orientation of the disciplines.

The next stage is the development of a student-centered blended learning technology design model (Fig. 1).

In the process of developing the model, we built such a system of components that could show the connections between them and ensure the fulfillment of the set goal. Our model is causal in nature. This model takes into account the specific challenges and needs of students, such as limited access to technology or physical space. It provides a combination of online and offline training of future specialists.

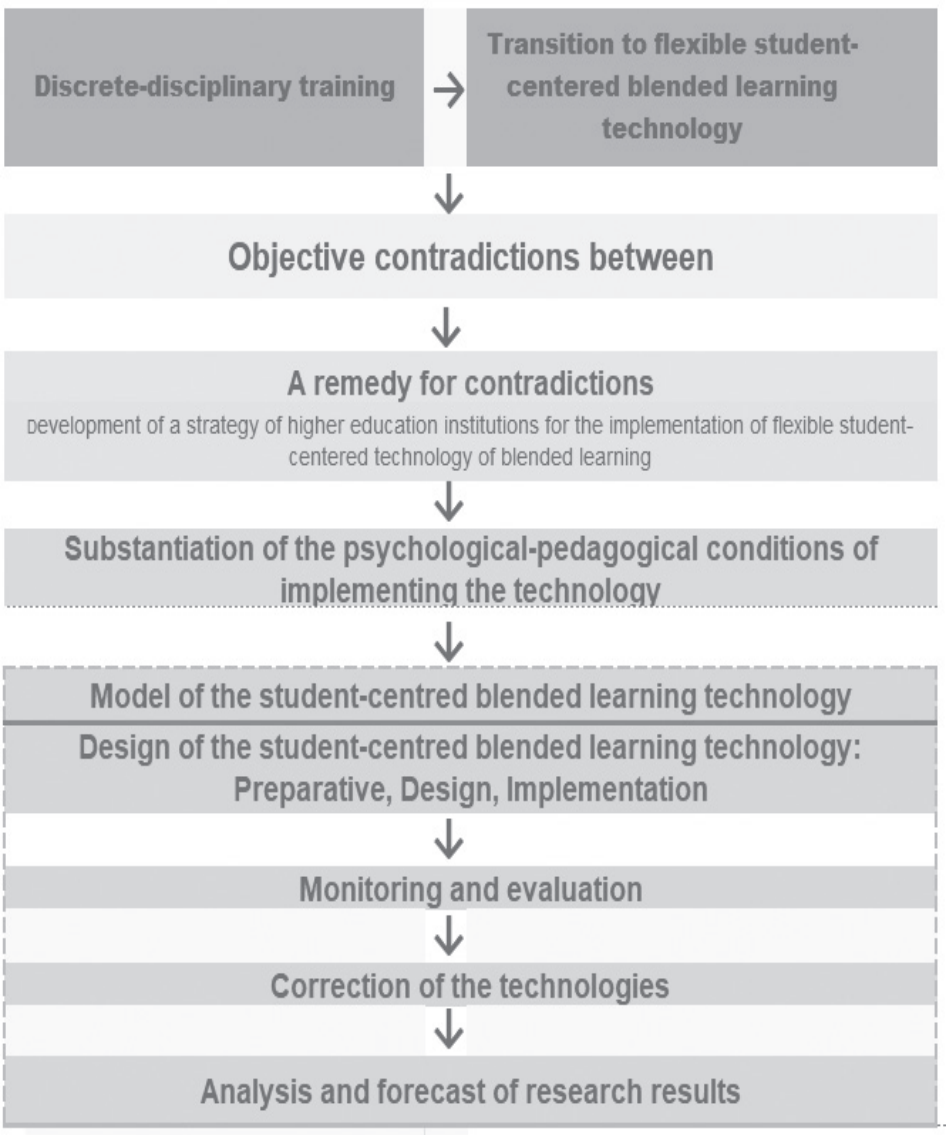

Fig. 1. Model of designing the student-centred blended learning technology

The design of mixed learning technology embodies a didactic system, the elements of which are the following components: preparatory, target, design (model, content, methods and forms), implementation

(implementation technology), monitoring and evaluation, technology adjustment, analysis and forecasting of research results (Fig. 2).

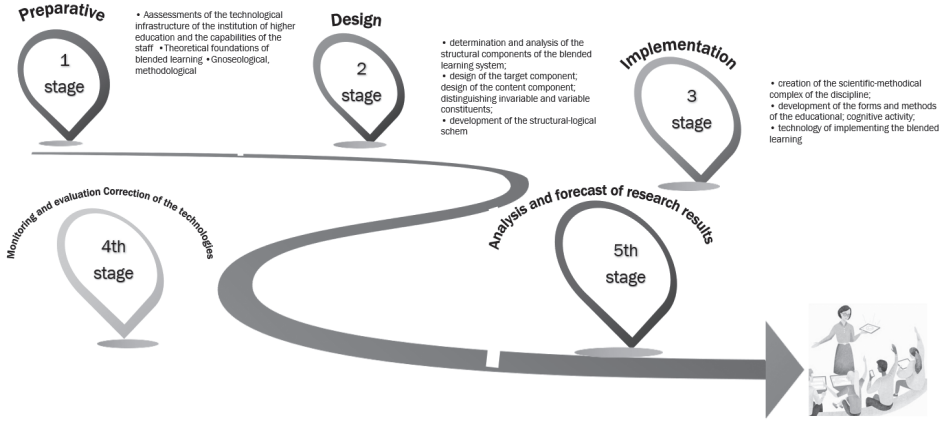

Fig. 2 . Design of the student-centred blended learning technology

In the preparatory phase, universities will need to assess their existing resources and capabilities, including technology infrastructure and staff, to determine what modifications and investments will be needed to support blended learning.

In our opinion, it is necessary to develop methodical requirements for building a content-targeted component of educational disciplines. The content of educational disciplines should focus on specific learning outcomes and contribute to the formation of productive professional thinking. Therefore, we share the views of those scientists who distinguish the concepts of the fundamental (unchanged) component of the educational subject and the variable one. It is important that under crisis conditions, the delayed nature of studying the variable component is allowed.

Since structured selective blocks of disciplines or individual trajectories appeared in educational programs under a personalized approach, additional learning outcomes should be correlated with them accordingly. Due to limited access to educational resources, it is allowed for a student of higher education to learn a purely invariant part of the course.

Therefore, the content of the variable part is aimed at providing a personal component and is formed by the teacher together with the student, focusing on his accessibility to educational resources, personal goals, professional experience and taking into account individual qualities.

In view of the above, we consider it necessary to build such a model of an educational subject, which will contain an invariant component (general, theoretical), which will take into account the logic of the relevant science and a variable (partial, specific) component.

In our opinion, the most appropriate scientific basis for such a process will be a combination of integrated technology with information technology based on a modular approach. At the same time, integration, both substantive and procedural, will act not only as a consequence of contradictions between the purely theoretical content of training and practical needs, between traditional conservative forms of training and personal trajectories of a specialist (caused by crisis conditions), but will also serve as a means of eliminating them.

We implemented the idea of variability in the blended learning model based on the construction of the course structure in the form of a system of meaningful modules, which, as is known, are a logically completed part of the educational material. The content of each part was selected with an orientation towards the optimal achievement of a specific goal. We also adhered to: flexibility of the structure, relative independence, operational control. In view of the above, we have developed a structural and logical scheme of the content of the training course, shown in Figure 3.

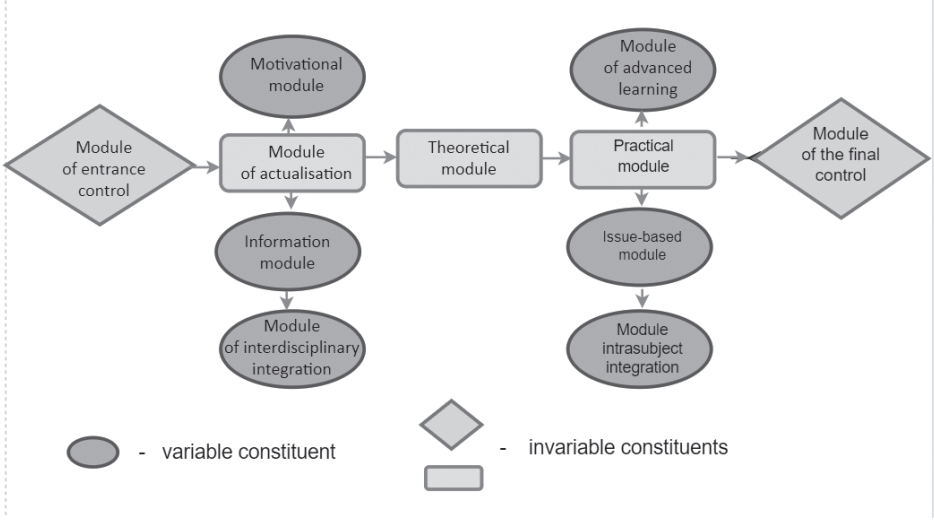

Fig. 3. Structural-logical scheme of the content of the training course in blended learning

Thus, we believe that the modular approach is the basis of individualisation of learning, as the dynamic structure of the course allows you to present didactic information, focusing on a student's individual trajectory. The student prepares for each meeting with the teacher on the basis of the content of the offered modules due to the individual programme which contains the target programme of actions, information bank, methodical materials to achieve the didactic goals.

The content of the didactic complex was formed on the basis of education standards, educational and professional programs, curricula, study of the areas of industrial activity of graduates, and opinions of stakeholders. First of all, we complied with the internal logic of mathematics in accordance with the prospects of scientific and technical development.

In the process of designing the didactic complex of the discipline, we took into account the features of blended learning, adhering to the following principles: scientific relevance, information capacity and prognostic value of the educational material, integrity of learning, systematic presentation of the material, updating of the previously studied material, flexibility, modularity, complexity, multi-functionality, content variability.

Adherence to the above made it possible to widely use the system of concentrated training, which requires a holistic, intensified presentation of the material under certain organizational forms. In this case, the informational part of the methodical materials is aimed at organizing the student's independent systematic cognitive activity.

The developed didactic complex includes such traditional resources as: discipline program, lecture notes, electronic manual, methodical instructions, manual for the basic course "Mathematics", presentations, information resources (discipline card, electronic journal, repository in the "Socrates" system).

To organize, deliver and evaluate online content, we used a virtual classroom for real-time video conferences Zoom (as an alternative to Google Meet and Microsoft Teams), a learning management system Moodle (mainly as an online evaluation tool), an interactive board Drawchat, which allows you to create and display multimedia content in class, Google applications (bank of video classes saved on Google Drive, shared documents for group performance of creative tasks), for mobile learning in Telegram chats.

In addition, technologies specific to the study of mathematics were used: graphing calculators, such as Texas Instruments and Casio, which

can be used for complex mathematical calculations and visualization of graphs and data; computer algebra systems (CAS) such as Matcad, Maple and Mathematica which provide symbolic computation and visualization capabilities for higher mathematics and engineering, interactive geometry software such as GeoGebra and Cabri which allow students to explore and experiment with geometric concepts through interactive visualizations, virtual and augmented reality (VR/AR) technology that can be used to create immersive learning and modeling of math concepts such as 3D geometry and calculus, online math tutorials and resources such as Khan Academy , Wolfram Alpha, and Coursera, which provide students with access to a wide range of mathematical concepts and problem-solving strategies.

The technology developed by us involved the variable use of the following classical models of blended learning, tested all over the world:

- The "Inverted Class" model, which provided for preliminary independent preparation for the lesson;
- The "Flex" model, where students have a combination of online and face-to-face learning and can switch between them as needed;
- "Self-Blend" model, where students are given the freedom to choose their own combination of online and face-to-face learning;
- "Flipped Classroom" model, where students watch recorded lectures or read online;
- Station Rotation model where students rotate between different stations or centers that focus on different learning activities.

An important component of the described technology is the variability of forms and means of learning. These materials were used in an emergency manner depending on the security situation and students' access to energy resources.

One of the examples of application in the "Flex", "Inverted Class" and "Flipped Classroom" models is a bank of video classes that duplicate the content of the face-to-face training course. Students were given access to them on the teacher's Google Drive (Fig. 4).

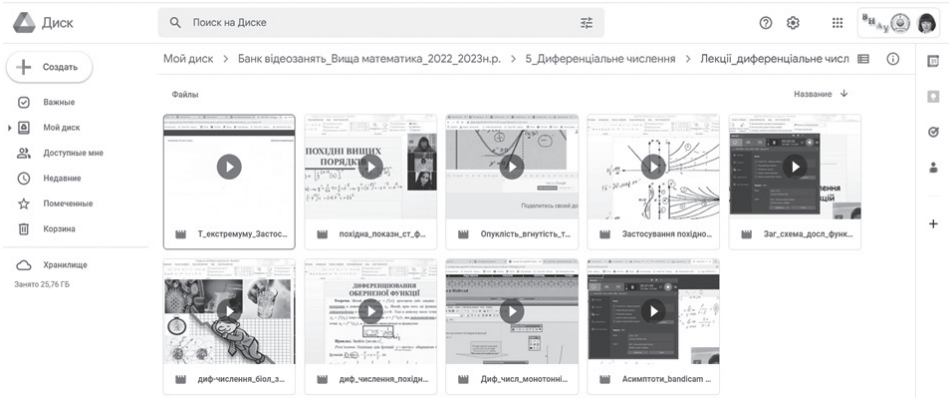

Fig. 4. Bank of video lessons of the course "Higher Mathematics"

The described mixed learning technology involves the use of the electronic educational process management system "Socrates". It has been tested for a long time at the Vinnytsia National Agrarian University as a component of traditional forms of education.

An electronic board (Whiteboard) is an effective tool for the implementation of personal-oriented distance learning. This resource allows the participants of the educational process to communicate virtually, switching to active-activity forms, reproducing images in a common document (board) that all participants can see.

In our work, we preferred the free web service Drawchat, because in the context of our research, it is important that in the technological aspect, the service contributes to the integration of the content of educational information with the help of the following methodological techniques: modeling in subject, graphic and symbolic forms, use of reference notes, development of mental maps.

A special feature of this complex is the well-chosen illustrative material. Practically every abstract theoretical topic is accompanied by a professional interpretation.

Since the didactic complex is primarily oriented to the possibility of its use in the system of mixed learning according to an individual program, it expresses an open subsystem of the didactic system. Thanks to this, it can be supplemented with additional materials (specialized literature, materials for in-depth study, reference materials). For example, at the Faculty of Agronomy and Forestry, we used educational materials on

mathematical statistics for processing data obtained in field research, the reference book "Correlation-regression analysis in Mathcad", methodological guidelines "Higher mathematics: differential equations, series".

In view of previous research, we have developed the following organizational stages of mixed learning of the "Higher Mathematics" course in the process of preparing correspondence students (Fig. 5):

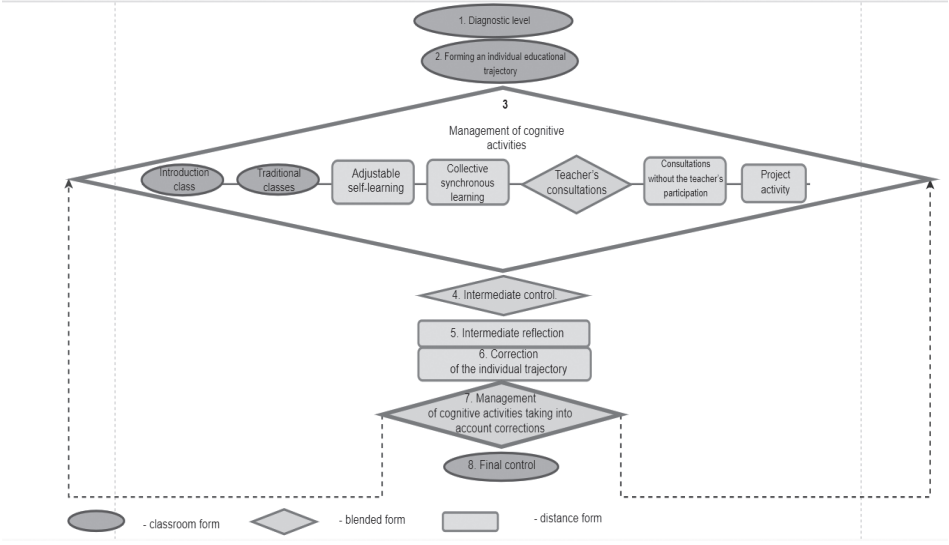

Fig. 5. Organizational stages of blended learning course «Higher Mathematics (specialisation)»

1. Diagnosis of the level of knowledge and capabilities of students (psycho-emotional state, cognitive communication skills, self-organization, information competence, availability of educational resources). Form – auditorium. Means: multilevel tasks, from the reproductive to the creative level, which involve, in addition to independent performance, collective forms of work; survey; interview.

2. Formation of an individual direction of movement (choice of content, forms, pace of learning) based on the outline of real and prospective training goals in compliance with the described pedagogical conditions (differentiation, individualization, personal orientation, integration). Form – auditorium. Means: interview.

3. Management of the student's cognitive activity includes the following components:

3.1. Introductory class: definition of real goals and promising ones, actualization of basic knowledge, creation of positive motivation, organizational and instructional measures (familiarity with the system of working under mixed learning, an approximate schedule of classes, consultations, control measures, basic and alternative methodical and informational resources, reference to useful resources, including Internet resources, Socrates and Moodle system, Google applications, web services (organization of video communication and web conferences in Zoom, virtual interactive whiteboard Drawchat), mobile learning opportunities (creating chat groups in the Telegram messenger), basics of working in the system Mathcad). Form – classroom, group. The teacher's role is both a carrier of information and an advisory one.

3.2. Traditional lectures and practical classes that cover more complex topics. Form – classroom, group. The teacher's role is mainly as a source of information.

3.3. Regulated asynchronous self-learning. Independent cognitive activity at an individual pace: the use of educational materials from the didactic complex of the discipline, located in the Moodle and Socrates systems. The form is remote.

3.4. Collective synchronous learning. Online lectures using the capabilities of the Zoom service and the virtual interactive board Drawchat, which involve preliminary independent training of students using the "inverted class" method. The teacher's role is mainly consultative. The form is remote.

3.5. Consultations of the teacher. Tools – Zoom service, Drawchat virtual interactive board, Telegram messenger. The form is remote, if necessary, classroom.

3.6. Consultations without the participation of a teacher. Independent creation by students of temporary or permanent groups of mutual support through educational and cognitive activities. Tools – Zoom service, Drawchat virtual interactive board, Telegram messenger. The form is remote.

3.7. Project activity. Case technologies based on the activity approach. Collective forms of independent work, seminars, webinars, chat conferences. Tools – Zoom service, Drawchat virtual interactive whiteboard, Google applications for

creating joint documents. The form is remote, asynchronous and synchronous.

3.8. Intermediate control. Means – alternative tasks of different levels (test, open, creative). Tools – Moodle system, Telegram messenger, "Socrates" system e-mail (correspondence exchange), Zoom service, Drawchat virtual interactive whiteboard. The form is remote, if necessary classroom.

4. Intermediate reflection – self-monitoring (test tasks), self-analysis, evaluation of opportunities and intermediate learning results. The form is remote.

5. Correction of individual movement direction. Tools – Zoom service, Form – remote.

6. Management of the student's cognitive activity, taking into account corrections.

7. Output control. Form – auditorium. Self-assessment, work analysis, long-term planning.

The final stage was the experimental verification of the model of implementation of the student-centered technology of mixed learning. The indicators of the effectiveness of the implementation of the model of student-centered mixed learning technology in the process of mathematical training of students became the following learning outcomes: knowledge, skills, communication, autonomy and responsibility.

The pedagogical experiment was conducted on the basis of Vinnytsia National Agrarian University. We have allocated streams of students with approximately the same basic level of mathematical training (school course). In some cases, the analysis of the obtained results and their reduction to a visual form was carried out by means of Mathcad.

In order to test the methodology, which is the implementation of the main conceptual studies outlined in the work, a control experiment was carried out. Students of the control group (K) studied according to the methodology, which involved alternating traditional face-to-face and distance learning using the Zoom service for online classes and testing in the Moodle system, and students of the experimental group (E) – according to the technology described in our work. The control group consisted of 278 people, and the experimental group – 281.

For formalized data processing, we converted the nominal scale into an order scale by matching the average values of performance indicators (knowledge, skills, communications, autonomy, and responsibility) on a 100-point scale.

In the experimental groups, it was possible to achieve an increase in all indicators (knowledge, skills, communication, autonomy and responsibility). Indicators of the ability to carry out independent and collective activities, which is revealed by the nature of the behavior of the participant in the educational process (communication, autonomy and responsibility) have significantly improved (Fig. 6).

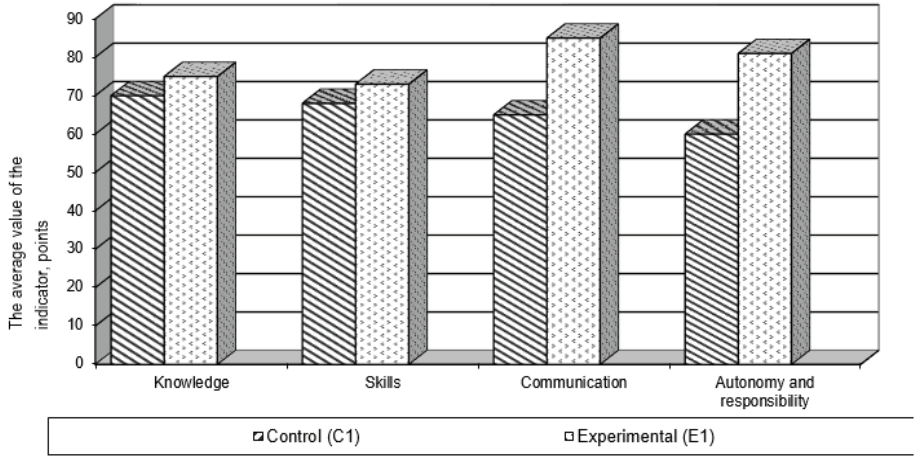

Fig. 6. Diagram of the distribution of students according to the average values of the efficiency indicators of the implementation of mixed learning technology in the process of mathematical training of specialists

So, the pedagogical experiment confirmed the hypothesis about the feasibility of implementing the developed technology.

4. Conclusions

Given the ongoing conflict in Ukraine, implementing traditional face-to-face learning methods in some regions may be difficult. Universities will need to be flexible and adapt their traditional educational models as needed to ensure students have access to quality education and support. Implementing a blended learning model will allow students to take advantage of both online and offline learning. The model will provide a flexible and adaptable approach that takes into account the needs and constraints of students and the university.

1. Based on the analysis of scientific, scientific and methodological literature, Internet resources, it was determined that an adaptive

combination of face-to-face and remote forms of training of future specialists should become the basis for designing an educational environment, which involves adjusting the components of the educational process through the prism of the student's personality. In the process of designing the content of courses of educational disciplines and selecting appropriate educational tools, scientific and pedagogical workers should focus not only on achieving such program results as "knowledge and understanding" and "application of knowledge and understanding", but also "the ability to form judgments and formulate conclusions ", "communicative abilities", "learning skills or learning abilities".

2. On the basis of a comparative analysis of the existing practice of using traditional and distance forms of education, it was concluded that the technology of mixed learning has a large arsenal of tools for the formation of a student-centered informational and educational environment. However, it requires a serious approach to the development of its components: preparatory, target, design (model, content, methods and forms), implementation (implementation technology), monitoring and evaluation, technology adjustment, analysis and forecasting of research results

3. The design of student-centered education based on the technology of mixed learning will be effective under the following pedagogical conditions: the design of training should be based on the principles of systematic individualization, differentiation and creative activity of students; personal orientation of education; integration of fundamental and special knowledge based on the professional focus of the disciplines.

4. A model of student-centered mixed learning technology was developed, which includes the following design stages: preparation, design, implementation.

5. In the process of designing the didactic complex of the discipline under mixed learning, it is advisable to adhere to the following principles: scientific relevance, information capacity and prognostic value of the educational material, integrity of education, systematic presentation of the material, updating of the previously completed material, flexibility, modularity, complexity and compactness of the presentation of the material, generalization and systematization of knowledge, polyfunctionality, content variability.

6. On the basis of the defined principles of selection of subject-content information in the training of specialists, a flexible student-centered technology of mixed learning has been developed (using the example of

the "Higher Mathematics" course). It is substantiated that the variable and invariant content of the course for mixed education should be built according to the modular principle.

7. The organizational stages of mixed training of the "Higher Mathematics" course have been developed, which allow to realize the individual ditection of the specialist's movement depending on the level of access to information and technical resources, his basic knowledge, communication skills, self-organization, and information competence.

8. Based on the implementation of the student-centered technology of mixed learning (using the example of the course "Higher Mathematics"), it was demonstrated that effective tools for its implementation are: the Moodle learning management system, the electronic management system "Socrates", the Zoom service, the Telegram messenger, the electronic board (Whiteboard), Google applications (shared documents with a link to Google Drive). In the mathematical training of specialists, it is advisable to use the Drawchat web service, Texas Instruments and Casio graphic calculators, Matcad, Maple and Mathematica computer algebra systems, GeoGebra and Cabri interactive geometry software, virtual and augmented reality (VR/AR) technologies, online – math textbooks and resources from Khan Academy, Wolfram Alpha and Coursera.

9. Information resources and educational materials have been prepared regarding the implementation of elements of distance learning in the process of mathematical training of specialists: instructional mind maps, a discipline card, a bank of video lessons that duplicate the content of the discipline, test tasks for knowledge control, presentation materials, a journal of student success, an electronic manual. Higher mathematics: differential calculus, a series of manuals and methodological instructions on mathematical disciplines for applicants and students of agricultural higher education institutions, which contain elements of mathematical modeling in the Mathcad environment, professionally oriented tasks and tasks with an applied orientation; didactic materials for use in electronic board mode, an experimental work program that involves the introduction of elements of distance learning to the subject "Higher Mathematics".

10. The conducted pedagogical experiment confirmed the hypothesis about the expediency of implementing the developed blended learning technology based on a student-centered approach. In the experimental groups, it was possible to achieve an increase in all performance indicators (knowledge, skills, communication, autonomy

and responsibility). It is worth noting that the indicators of the ability to carry out independent and collective activities, which is revealed by the nature of the behavior of the participant in the educational process, have significantly improved.

11. It is important to note that the effectiveness of the developed technologies depends on the quality of the provided resources and materials, as well as on the students' own motivation and discipline. In addition, it is important to ensure that the technological infrastructure and connectivity of educational stakeholders are adequate to support online learning in war-affected areas.

12. The developed technology of mixed teaching of mathematical disciplines can be applied in the study of other disciplines. The results of the research can be used to design the content of mixed learning or distance education, to conduct scientific and pedagogical research on the chosen problem.

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Abstract

ОЛЕНА ЛЕВЧУК, КОСТЯНТИН ЛЕВЧУК, ЛЮДМИЛА ГУСАК, НАТАЛІЯ ГАВРИЛЮК. **Технологія змішаного навчання в закладах вищої освіти в умовах війни.** *Мета дослідження – розробити адаптивну технологію змішаного навчання яка забезпечуватиме гнучку підготовку майбутніх фахівців в умовах війни та експериментально перевірити її ефективність.*

Матеріали і методи дослідження: *здійснено системний аналіз літератури; дослідження понятєвого апарату;*

моделювання; узагальнення педагогічного досвіду. Проведено педагогічний експеримент на базі Вінницького національного аграрного університету. Виділено групи студентів обсягами 278 і 281 осіб. Використовувались: спостереження, аналіз даних, анкетування, бесіда, тестування студентів, метод діагностичних контрольних робіт, математичне опрацювання результатів дослідження, якісний та кількісний аналіз (засобами Mathcad).

Отримані результати: *в експериментальних групах підвищилися усі показники ефективності розробленої технології (знання, уміння, комунікація, автономія та відповідальність). Суттєво покращились показники здатності до здійснення самостійної та колективної діяльності.*

Виявлено, що ефективним засобами реалізації технології є: система управління навчанням Moodle, електронна система управління «Сократ», сервіс Zoom, мессенджер Telegram, електронна дошка (Whiteboard). В математичній підготовці фахівців доцільно використовувати веб-сервіс Drawchat, графічні калькулятори Texas Instruments і Casio, системи комп'ютерної алгебри Matcad, Maple та Mathematica, програмне забезпечення для інтерактивної геометрії GeoGebra та Cabri, технології віртуальної та доповненої реальності (VR/AR), он-лайн-підручники з математики та ресурси Khan Academy, Wolfram Alpha і Coursera.

Висновки: *враховуючи триваючий конфлікт в Україні, впровадження традиційних методів очного навчання в деяких регіонах може бути ускладненим. Університетам доведеться проявити гнучкість і, за потреби, адаптувати свої традиційні освітні моделі щоб забезпечити студентам доступ до якісної освіти та підтримки. Впровадження моделі змішаного навчання дозволить студентам використати переваги як он-лайн, так і оф-лайн навчання. Також забезпечить гнучкий та адаптований підхід, який враховує потреби та обмеження студентів та університету.*

Студентоцентрований підхід є підґрунтям проєктування освітнього середовища. Науково-педагогічні працівники мають орієнтуватися не лише на досягнення таких програмних результатів, як «знання та розуміння» і «застосування знань та розумінь», а й «здатність до формування суджень та формулювання висновків», «комунікативні здібності», «навички навчання або здатності до навчання». Технологія змішаного навчання передбачає такі етапи проєктування: підготовка, дизайн, реалізація.

Проєктування технології буде ефективним за таких педагогічних умов: дотримання принципів системної індивідуалізації, диференціації та творчої активності студентів; особистісна спрямованість навчання; інтеграція фундаментальних та спеціальних знань на основі професійної спрямованості дисциплін.

Практичне застосування: *розроблена технологія може бути застосована у вивченні інших дисциплін. Результати дослідження можна буде використати для укладання змісту змішаного навчання чи дистанційної освіти.*

Оригінальність: *теоретично обґрунтовано та розроблено адаптивну модель проєктування студентоцентрованої технології змішаного навчання в умовах війни.*

Ключові слова: *війна в Україні, навчання під час війни, змішане навчання, технології навчання, освітні ресурси, студентоцентрована освіта, професійна підготовка, математична підготовка.*

OLENA LEVCHUK, KOSTIANTYN LEVCHUK, LYUDMILA HUSAK, NATALIIA HAVRYLIUK. **Technologia kształcenia mieszanego w szkołach wyższych w warunkach wojennych.** *Celem pracy jest opracowanie adaptacyjnej technologii kształcenia mieszanego, która zapewni elastyczne szkolenie przyszłych specjalistów w warunkach wojennych oraz eksperymentalne sprawdzenie jej skuteczności.*

Materiały i metody badań: *dokonano systematycznej analizy literatury; badania aparatu pojęciowego; modelowania; uogólnienia doświadczeń pedagogicznych. Przeprowadzono eksperyment pedagogiczny na bazie Winnickiego Narodowego Uniwersytetu Rolniczego. Przydzielono grupy studentów liczące 278 i 281 osób. Zastosowano następujące metody: obserwację, analizę danych, ankiety, rozmowę, testowanie studentów, metodę diagnostycznych prac kontrolnych, matematyczne opracowanie wyników badań, analizę jakościową i ilościową (z wykorzystaniem programu Mathcad).*

Uzyskane wyniki: *w grupach eksperymentalnych wzrosły wszystkie wskaźniki skuteczności opracowanej technologii (wiedza, umiejętności, komunikacja, autonomia i odpowiedzialność). Znacznie poprawiły się wskaźniki zdolności do prowadzenia działalności samodzielnej i zbiorowej.*

Stwierdzono, że skutecznymi środkami wdrażania technologii są: system zarządzania nauczaniem Moodle, elektroniczny system zarządzania "Sokrat", serwis Zoom, komunikator Telegram, tablica inetraktywną (Whiteboard). W kształceniu matematycznym specjalistów

wskazane jest wykorzystanie serwisu internetowego Drawchat, kalkulatorów graficznych Texas Instruments i Casio, systemów algebry komputerowej Matcad, Maple i Mathematica, oprogramowania do geometrii interaktywnej GeoGebra i Cabri, technologii wirtualnej i rozszerzonej rzeczywistości (VR/AR), podręczników matematyki online oraz zasobów Khan Academy, Wolfram Alpha i Coursera.

Wnioski: *biorąc pod uwagę trwający w Ukrainie konflikt, wdrożenie tradycyjnych metod kształcenia w formie stacjonarnej w niektórych regionach może być trudne. Szkoły wyższe będą musiały wykazać elastyczność i w razie potrzeby dostosować swoje tradycyjne modele edukacyjne, aby zapewnić studentom dostęp do wysokiej jakości edukacji i wsparcia. Wdrożenie modelu kształcenia mieszanego pozwoli studentom korzystać z zalet zarówno kształcenia online, jak i offline. Zapewni również elastyczne i adaptowalne podejście, które uwzględnia potrzeby i ograniczenia studentów i szkół wyższych.*

Podejście skoncentrowane na studencie jest podstawą projektowania środowiska edukacyjnego. Pracownicy naukowo-pedagogiczni powinni skupić się nie tylko na osiągnięciu takich efektów programu jak "wiedza i zrozumienie" oraz "zastosowanie wiedzy i zrozumienia", ale także "umiejętność formułowania sądów i wyciągania wniosków", "umiejętności komunikacyjne", "umiejętności uczenia się lub zdolności do uczenia się". Technologia kształcenia mieszanego obejmuje następujące etapy projektowania: przygotowanie, projektowanie i wdrożenie.

Projektowanie technologii będzie skuteczne przy spełnieniu następujących warunków pedagogicznych: przestrzeganie zasad systematycznej indywidualizacji, różnicowania i twórczej aktywności studentów; osobista orientacja uczenia się; integracja wiedzy podstawowej i specjalistycznej w oparciu o orientację zawodową dyscyplin.

Zastosowanie praktyczne: *opracowana technologia może być wykorzystana w nauczaniu innych dyscyplin. Wyniki badania mogą być wykorzystane do zestawienia treści kształcenia mieszanego lub edukacji na odległość.*

Oryginalność: *teoretycznie uzasadniono i opracowano adaptacyjny model projektowania skoncentrowanej na studencie technologii kształcenia mieszanego w warunkach wojennych.*

Słowa kluczowe: *wojna w Ukrainie, kształcenie w czasie wojny, kształcenie mieszane, technologie nauczania, zasoby edukacyjne, edukacja skoncentrowana na studencie, kształcenie zawodowe, kształcenie matematyczne.*