

PREPARATION OF FUTURE MATHEMATICS TEACHERS FOR PROFESSIONAL ACTIVITY IN THE CONDITIONS OF FORCED DISTANCE LEARNING

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INTRODUCTION

To this day the war challenged the existence of higher education institutions and the education sector in general. To continue education, educational institutions have to look for solutions that would help students receive a quality education and preserve the lives and health of all participants in the educational process. Due to the military invasion, the decision was made to introduce distance learning in Ukrainian higher education institutions. This decision has certain advantages in today's realities, but there are also certain disadvantages, the elimination of which aims to provide students with more quality education.

Distance learning technologies have been quite successfully implemented in the Ukrainian higher education system in recent years, due to the forced transition to distance learning in the context of the Covid-19 pandemic¹. That is why higher education institutions already have some experience in implementing distance learning. These already developed technologies, methods and forms of work in online learning are the basis for building distance learning today, during the war. However, they still need to be improved, as during the war, the educational process and all its participants face new challenges that did not exist during the pandemic. The effective organisation of distance learning makes it possible to preserve both the staff of the higher education institution and the student body as much as possible, and they can continue their studies in a safer environment.

There is a fairly large number of scientific papers on the organisation of distance learning in a pandemic both in Ukraine and abroad. Methodologists and scientists have studied the effectiveness of distance learning, its advantages and disadvantages, directions of development and determination of conditions for students to receive quality education in online learning. At the same time, the issue of organising distance learning during martial law is not sufficiently covered today². However, there are already

¹ Смірнова О. Несправжня освіта. Як пандемія викрила проблеми онлайн-навчання. BBC, 2020. URL: <https://www.bbc.com/ukrainian/features-54039740>

² Жуковська Е. ТОП-3 системи для онлайн-навчання. Освіта, 2020. URL: <https://osvita.ua/news/71748/>

publications where the authors draw attention to the issue of distance learning in extreme conditions, and they note that online learning in normal and extreme conditions is significantly different. However, the issue of organising distance learning under martial law remains unresolved.

On 20 April 2022, the Ministry of Education and Science of Ukraine issued an order to relocate Kherson State University to Vasyl Stefanyk Precarpathian National University, which is located in Ivano-Frankivsk. The university relocation aims to ensure that the main business processes provided by the university are under control. A student can be anywhere because the educational process is remote. They can even be in the Kherson region if they so choose. The main thing is that they participate in the educational process, which means that the quality of the educational process is maintained. Similarly, teachers are not tied to their workplace, but the most important requirement is providing a quality educational service. Despite the war, challenges and relocation, Kherson State University is constantly growing by the year and expanding. The issues of organizing distance learning under martial law and considering the technical support of the number of students at the university are currently being paid a lot of attention.

1. KSU-online distance learning platform, purpose and possibilities of using it for training future mathematics teachers

The organisation of distance learning for students of the first bachelor's degree of higher education in the educational programme "Secondary Education (Mathematics)", especially in the study of professional disciplines, is of key importance since the quality of knowledge, practical skills and the level of readiness for real professional challenges depend on its effectiveness. Distance learning allows students to access materials regardless of their place of residence. However, for professional disciplines of the mathematical cycle, it is important to create high-quality and structured learning materials that consider the specifics of the industry. Professional disciplines usually require practical learning, so the organisation of studying should include interactive tools that help compensate for the lack of physical access to resources. In distance learning, students often experience a sense of isolation, which can reduce their motivation. Using interactive elements, regular online meetings, and the opportunity to interact with teachers and classmates are important for maintaining engagement. Professional disciplines require not only theoretical tests but also the assessment of practical skills. This will require the introduction of non-standard approaches for students' assessment. For effective distance learning, it is also important to adapt the material to different formats: video lectures, webinars, interactive courses, and assignments using multimedia technologies. This makes it easier to master complex topics and

makes learning interesting. Distance learning makes it possible to better adapt the process to the needs of each student through personalised learning paths, progress monitoring and flexible deadlines. For many modern professions, the ability to work with digital tools and technologies is critical. In particular, this applies to future mathematics teachers preparing for work in distance or blended learning environments in Ukrainian schools. Distance learning integrates these skills into the process of studying professional disciplines. Thus, properly organised distance learning not only helps to maintain the quality of education at a high level but also contributes to the development of skills necessary to work in the modern digital world.

For the effective organisation of distance learning, Kherson State University has implemented the KSU-online platform developed by leading experts of the University's Digitalisation Department³. The KSU-online distance learning system is designed to:

- support the educational process of full-time and part-time students;
- organisation of distance education;
- exchange of information between the teacher and the student and between the students.

One of the strengths of the system is the wide range of opportunities for communication and interaction between participants in the learning process. KSU-online supports the exchange of files of any format. The mailing service allows you to promptly inform all course participants or individual groups about current events. An important feature of the system is that it creates and stores a portfolio for each student: all the papers they have submitted, all the messages in the forum, all the grades and comments of the teacher on these papers. When preparing and conducting classes in the KSU-online system, the teacher can operate with a large set of convenient tools in the form of course elements (glossary, resource, assignments, forum, test, etc.).

For students of the first bachelor's degree programme in Secondary Education (Mathematics), the platform has developed courses in all specialised disciplines. Each distance learning course has a syllabus, glossary, and list of references. A course syllabus is a structured document that includes a description of the course, objectives, expected outcomes, lesson plan, test schedule, assessment and other important aspects of the learning process. It provides students with a clear understanding of the course structure and expectations, helps them to plan their studies and prepare for assessments, and ensures transparency and organisation of the learning process. The glossary contains a list of key terms and definitions used in the course. The glossary can be interactive, searchable, and link to relevant sections of the course. The glossary helps students to understand new terminology and concepts

³ <https://ksuonline.kspu.edu>

better; provides quick access to definitions, promoting effective absorption of the material; and maintains the level of knowledge required for assignments and tests. The course also comes with a list of references, which contains a list of recommended books, articles, web resources and other materials for additional study. The list of references expands the sources of knowledge, allows you to delve deeper into the course topics, provides access to a variety of points of view and approaches, and develops the skills of independent search and analysis of information.

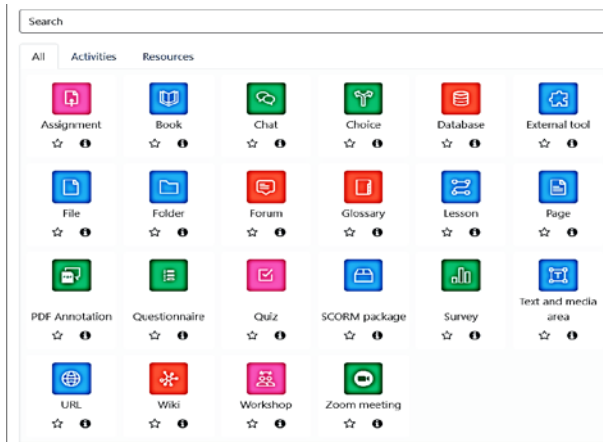


Fig. 1. Activities or resources

Each course topic has a theoretical page, which is a learning material that explains the main concepts and theories of the topic. It can include text, images, videos, graphs, and examples. The theoretical page facilitates a focused study of the key aspects of the topic, its interactive elements help to understand the material better, and the availability of the theoretical page at any time facilitates the repetition and consolidation of knowledge.

In addition, each topic in the course is accompanied by either a lesson or a practical task for each topic. These components contain exercises, projects, or cases that allow you to apply the theory in practice. They contribute to the development of skills in solving real-world problems, a deeper understanding of the material through practical application, and increase motivation through connection with real-life situations.

In addition to these components, the course includes tests for each topic, providing knowledge control in the format of test tasks (closed questions, multiple choice, open questions, etc.). Tests provide feedback on the level of learning, help identify gaps in knowledge for correction and promote better memorisation.

This structure of distance learning courses allows students to plan their time effectively. Multi-format materials cater to different learning styles (visual, auditory, kinetic), interactivity and accessibility of course elements promote self-directed learning. Knowledge control through tests and practical tasks helps to maintain high engagement and discipline. At the same time, all components work in synergy to ensure comprehensive learning.

2. Organisation of distance learning for future mathematics teachers

Let's consider the possibilities and advantages of using the KSU-online platform in the study of professional disciplines by students of the first bachelor's degree of higher education in the educational programme "Secondary Education (Mathematics)". In the first year of study, the curriculum for the study programme provides for the study of two important professional disciplines – Linear Algebra and Analytical Geometry. These two courses are fundamental to the training of future mathematics teachers for a number of reasons:

1. Deep understanding of basic mathematical concepts.

- Linear algebra helps you understand key concepts such as vectors, matrices, systems of linear equations, spaces, bases, and linear mappings. These ideas form the basis of many other mathematical disciplines, including mathematical analysis, differential equations, and probability theory.
- Analytical geometry provides teachers with tools for visualising mathematical concepts and working with geometric objects in coordinate form, which is important for integrating algebra and geometry in the classroom.

2. Development of abstract thinking.

These courses teach how to work with abstractions: from understanding the idea of multidimensional spaces in linear algebra to describing geometric objects through equations. This contributes to the development of logical thinking, which is essential for a teacher who has to explain complex concepts to students.

3. Practical application.

- Linear algebra is used in numerous applications, such as computer graphics, economics, machine learning, and physics. Understanding its concepts allows you to show students how mathematics is used in real life.
- Analytical geometry helps to solve problems that combine geometry and algebra, and prepares students to work with graphs, which are an integral part of the school curriculum.

4. Preparation for the integration of knowledge.

Future teachers need to understand the relationship between different areas of mathematics. Linear algebra and analytical geometry provide this connection, forming an idea of the unity of mathematical knowledge.

5. Preparation for teaching.

- Knowledge of these disciplines allows teachers to effectively explain complex topics to students of different levels of preparation.
- Teaching the concepts of linear algebra and analytical geometry at an accessible level develops the skills of pedagogical adaptation of complex material.

6. Formation of mathematical culture.

Linear algebra and analytical geometry contribute to the development of mathematical culture and accuracy in thinking. This is important for the development of future teachers' confidence in their knowledge and ability to pass it on to students.

7. Preparation for further study.

These disciplines are basic for mastering other areas of mathematics, such as higher algebra, number theory, differential geometry, etc. Future teachers need to have a solid foundation to develop professionally.

Linear algebra and analytic geometry not only provide future teachers with knowledge and skills but also develop their mathematical thinking and pedagogical competence. This makes them important components of the preparation of qualified and confident mathematics teachers.

Let us consider in more detail how the process of studying linear algebra and analytical geometry is organised using the developed distance courses.

A key element of the learning process is the theoretical pages of the distance course, which provide students with everything they need to successfully master the material in the disciplines of Linear Algebra and Analytical Geometry. The structure of the theoretical pages includes the following components:

1. The main textual material.

Each topic presents a structured theoretical framework: explanations of basic concepts, formulas and methods. The theoretical text is divided into sections and subsections with clear headings, which allows students to easily navigate. For example, for linear algebra: chapters on matrices, determinants, eigenvalues, and vectors; for analytical geometry: description of lines, planes in space, second-order curves, etc. Examples and brief explanations of the steps to solve problems are included.

2. Illustrations and graphic materials.

Diagrams, graphs, tables that help to visualise complex concepts, for example: a graphical representation of the basis in vector space, visualisation of the section of planes in three-dimensional space using the GeoGebra application.

3. *Links to useful Internet resources.*

Each section contains hyperlinks to electronic textbooks, academic videos, and interactive simulations for working with vectors, matrices, or geometric objects.

4. *Links to video lectures.*

For each topic, students have access to video lectures where the teacher explains the material with examples. These are either recordings of real lectures or specially prepared video tutorials with demonstrations of problem-solving methods. These videos reveal key aspects of the topic, which allows you to understand the material more deeply.

5. *Interactive elements.*

Some theory pages have interactive components, such as simple self-tests. Students can use the theory pages to study topics independently. They read the textual material, gradually learning the theoretical aspects of the topic. Thanks to the clear structure, this is convenient even for complex topics such as eigenvalues or geometric transformations. They can also use these pages as a supplement to video lectures: while learning a topic through video, students can simultaneously refer to the text version of the theory for detailed explanations or to review formulas. In addition, the available theoretical information on course topics helps in preparing for practical assignments and tests and in revising material before exams. Thus, before completing assignments, students refer to the theory to repeat methods or check formulas. Since the theory is available at any time, students can refer back to it to revise key concepts and formulas before quizzes or exams. The theory pages also help to expand students' knowledge, as they can use the links to additional resources to deepen their knowledge of specific topics, for example, to explore the use of linear algebra in machine learning or geometry in 3D modelling.

The presence of theoretical pages in developed distance learning courses has certain advantages. Firstly, students have constant access to the materials: all theoretical materials are freely available throughout the entire period of study. This means that students can work with them anytime and from anywhere, which is especially important for those who cannot attend classes regularly. Secondly, it is convenient for different learning styles: theory pages allow you to adapt the learning process to individual needs: some people prefer text, others prefer graphs, and others prefer videos. There is also the possibility of self-study: students can study independently, even without direct contact with a teacher. This is convenient for repeating material or learning a new topic. In addition, it saves time, as the availability of structured information in one place allows students to avoid searching for additional sources or rewriting formulas from lectures by hand. Another advantage of having theoretical pages in courses is that they improve the learning experience, as the combination of text, graphics, interactive elements and

videos helps to understand even complex topics in greater depth. There is also the possibility of integrating additional sources, as links to online resources allow students to study topics beyond what is covered in the core curriculum.

Practical tasks in distance learning courses in linear algebra and analytical geometry are designed to provide a comprehensive study of the theory, consolidate skills and develop professional competencies of future mathematics teachers. Students are offered the following types of tasks for practical training.

1. Tasks with automatic checking.

Students are offered tasks that require numerical or textual answers. The system automatically checks them and provides feedback immediately. Examples of tasks:

- Calculate the determinant of a given matrix.
- Enter the coordinates of a vector after a linear transformation.
- Find the point of intersection of a plane and a line.

The advantage of such tasks is that the teacher does not need to check each task, as the assessment is automatic. This allows you to focus on more complex aspects of learning.

2. Open-ended tasks.

For topics where it is difficult to offer automated checking, students are given tasks that they complete in a notebook, text editor, or software. Once completed, they attach files (images, PDFs, documents) to the platform. Examples of tasks:

- Print the solution to a system of equations using Gauss' method with explanations.
- Prove a geometric property in space.
- Analyse the properties of a matrix based on calculations.

The teacher checks these files manually, which allows to evaluate the creativity and correctness of the tasks.

3. Tasks using GeoGebra.

For the topics of analytical geometry, students complete tasks related to the study of second-order equations of curves and surfaces. Typical tasks:

- Graph a second-order surface (e.g., an ellipsoid or hyperboloid) given an equation.
- Investigate and classify a second-order curve (e.g., determine whether it is an ellipse, parabola, or hyperbola).
- Use GeoGebra to visualise plane sections and curves in space.

The results of the work are exported (images, GeoGebra files) and added to the platform for verification. The advantage of such tasks is that students learn to use modern tools that they can apply in their future teaching activities.

The use of such practical components of distance learning courses has a number of advantages:

1. Strengthening knowledge through practice.

- Practical tasks allow students to consolidate theoretical material by solving specific problems, which develops their logical and analytical thinking.

- Automatic checking instantly shows whether the answer was correct, helping to correct mistakes quickly.

2. Formation of professional skills.

Future mathematics teachers gain experience that they can pass on to students: skills in solving complex problems that may seem difficult for students; using software (GeoGebra) to visualise mathematical concepts, which makes teaching interesting and modern; analysing and classifying curves and second-order surfaces develops spatial thinking, which is important for working in geometry-related fields.

3. Development of independence.

Tasks with attachments teach students to be responsible and organise their work. They learn to explain their actions clearly and present the results of their work understandably.

4. Integration of modern technologies.

The use of GeoGebra allows students to master the tools for creating visual illustrations that they can use in their teaching.

5. Efficient use of time.

Automatic checking of problems with numerical answers significantly saves time for both students and teachers. This allows you to focus on more complex topics that require deeper analysis.

6. Development of creative abilities.

Tasks involving the construction and investigation of equations encourage students to be creative, which is important in teaching.

For future teachers of mathematics, the use of practical tasks is useful in terms of an in-depth understanding of the discipline. By completing practical tasks, students learn to analyse, investigate and explain mathematical phenomena, which is essential in teaching. Practical tasks also contribute to the development of methodological skills: future teachers learn how to organise practical tasks, which they can then adapt for students. For example, using GeoGebra will allow them to create interactive lessons. These tasks also help to build professional readiness, as by working with real-world problems and software, students acquire skills that will help them use modern technology in the classroom. And the study of equations of the curve and surface equations, their classification and visualisation, makes future teachers ready to teach even complex topics in the school geometry course.

The following additions are planned to be made to the distance courses in linear algebra and analytical geometry with current trends:

1. *Involvement of a greater number of different activities for students' independent work:*

- Inclusion of interactive exercises and tasks, discussion forums in the format of seminars that promote active participation of students in the learning process.

- The use of project assignments, where students can apply their knowledge in practice to solve real problems or develop innovative projects.

2. *Involvement of artificial intelligence (AI):*

- Use of recommendation systems to personalise learning and select materials according to individual student needs.

- Engaging interactive chatbots or virtual assistants to support students in their learning and resolve their questions.

3. *Supplementing video content:*

- Creating additional video content that complements the main course material can make learning more accessible and understandable for students.

- Video tutorials that demonstrate practical applications of mathematical concepts or how to complete practical tasks can increase student interest and engagement.

These improvements will help make distance learning courses more effective and in line with current trends in higher education. They will facilitate active student engagement, personalisation of the learning process and development of key skills required for a successful career.

CONCLUSIONS

The developed distance courses “Linear Algebra” and “Analytical Geometry” for students of the first bachelor’s degree of higher education in the educational programme “Secondary Education (Mathematics)” have numerous advantages that allow students to receive quality education and actively interact with the material:

1. *Accessibility of theoretical material:* students always have access to theoretical material, which allows them to study at a convenient time and pace. Theoretical pages of a distance learning course are a convenient, effective and modern way of presenting learning materials. They provide students with constant access to the theory, allow them to study at their own pace and using different information formats. This improves the quality of the learning process and helps students to master better even the most complex course topics.

2. *Possibility to complete practical tasks during classroom sessions:* distance learning courses contain practical tasks that students can complete directly during classroom sessions or at home, receiving instant feedback from the teacher. The practical tasks of the distance learning course

effectively combine automated testing, independent research and the integration of modern tools such as GeoGebra. This provides students with in-depth knowledge and practical and methodological skills needed to teach mathematics at school successfully.

3. *Opportunity to score extra points through tests:* courses contain tests on each topic, which allows students to score extra points in the discipline and test their knowledge.

4. *Involvement of graphic applications in practical tasks:* practical tasks that involves using of graphic applications such as Geogebra to create images of curves and second-order surfaces to develop real practical skills in working with digital tools.

Distance learning courses allow students to study at a time and place convenient for them, actively interact with the material, receive feedback and develop practical skills, making it an effective learning tool.

The developed distance learning courses contribute to the training of competent professionals through several key aspects:

1. *In-depth knowledge of fundamental mathematical disciplines:*

– Students gain in-depth knowledge of courses that are directly related to their future professional fields.

– The distance learning course contains theoretical material, exercises and tasks that reveal the basics of mathematical concepts, allowing students to understand their essence and application in practice.

2. *Connection with the school mathematics course:*

– The courses can be designed to resemble a school mathematics course, but at a higher level and with additional practical exercises and tasks. This helps students to understand the material more easily and to make connections between school and higher education levels.

3. *Experience in distance learning:*

– Students gain experience of independent learning in an online environment, which is an important skill for the modern labour market.

– They learn to organise their time, study material independently and use available resources effectively.

4. *Mastering the skills of working with graphic applications:*

– The courses include assignments that involve the use of graphic applications. This allows students to acquire not only theoretical knowledge but also practical skills that can be useful in their future professional activities.

Thus, the developed distance learning courses help to prepare competent specialists who have in-depth knowledge of mathematics, experience in distance learning and practical skills in working with graphic programs, which is important in the modern world and for the future activities of a mathematics teacher.

SUMMARY

The article deals with the issues of organising the work of Kherson State University under martial law and distance learning for students. The topic's relevance is due to the introduction of martial law in Ukraine and the forced relocation of the university to Ivano-Frankivsk region. These circumstances prompt us to pay more attention to the peculiarities of organising distance learning, the problems for participants in the educational process that arise in this case and ways to overcome them. The study aims at the peculiarities of distance learning for students of the education programme "Secondary Education (Mathematics)" of the first bachelor's degree in higher education under martial law on the example of Kherson State University. The article shows the directions of practical solutions to the problems of distance learning in wartime; highlights the challenges of organising distance learning during wartime; identifies ways to overcome these problems associated with the technical capabilities of the educational process on the part of the higher education institution and the learning opportunities on the part of students.

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