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CURRENT APPROACHES TO DISTANCE TEACHING OF EXACT DISCIPLINES IN UKRAINE UNDER MARTIAL LAW

MORMUL M.F., SHCHYTOV D.M., SHCHYTOV O.M., ROMANCHUK L.A. **Current approaches to distance teaching of exact disciplines in Ukraine under martial law.** *The article examines modern platforms designed for distance edu-cation, its advantages and disadvantages, and features in wartime conditions. The nuances of this form of education in teaching mathematical disciplines are analyzed. A number of improvements to the platforms used for this kind of training are proposed, which will help to significantly improve the process of preparing and conducting mathematics classes in distance form.*

Keywords: *distance learning, platform, conference, webinar, chat classes, Google.classroom, Zoom, Skype, martial law, mathematics.*

МОРМУЛЬ М.Ф., ЩИТОВ Д.М., ЩИТОВ О.М., РОМАНЧУК Л.А. **Актуальні підходи до дистанційного викладання точних дисциплін в Україні в умовах воєнного стану.** *У статті розглянуто сучасні платформи, призначені для дистанційної форми навчання, його переваги та недоліки, особливості за умов війни. Проаналізовано нюанси такої форми навчання при викладанні математичних дисциплін. Запропоновано низку удосконалень використовуваних для такого роду навчання платформ, які допоможуть суттє-*

во поліпшити процес підготовки та проведення заняття з математики у дистанційній формі.

Ключові слова: *дистанційне навчання, платформа, конференція, вебінар, чат-заняття, Google.classroom, Zoom, Skype, воєнний стан, математичні дисципліни.*

I. Introduction

In the context of digitalization, mathematical education plays a crucial role in preparing future specialists. It is essential for understanding the practical application of mathematical tools and enhancing competitiveness by enabling effective communication with clients and stakeholders. A solid level of mathematical culture and intellectual development allows individuals to independently explore, analyze, and forecast the behavior of complex systems or individual processes within them.

Given this, the study of fundamental principles, methods, and models in higher and applied mathematics and statistics at higher education institutions aims to develop the following competencies in students: – The ability to engage in mathematical and abstract thinking, formulate, and investigate subject areas using mathematical methods and models. – The justification of the selection of methods and approaches for solving theoretical and practical problems. – The ability to draw logical conclusions, practice logical-mathematical thinking, and reason according to the laws and rules of mathematical logic. – Computational culture: the ability to explain results obtained during calculations in mathematical terms. – The ability to understand and utilize mathematical visualization tools (graphs, diagrams, tables, matrices, schemes, etc.) to illustrate, shape, and expand one's worldview, as well as to recognize the importance of these methods for enhancing the effectiveness of any human activity. – Innovation in not only technological development but also in personal qualities related to searching, analyzing, structuring, and selecting necessary scientific information.

An important aspect is also technological competence – the development of skills in using modern mathematical software packages for constructing computer models of the processes being studied, aiming for heuristic approximation or exact solutions, and the ability to validate models for adequacy. Finally, the mathematical component plays a significant role in the transformation of higher education in the digital economy. Therefore, it is crucial that the teaching of mathematical disciplines, whether in-person or remotely, be convenient, informative, and efficient.

2. Relevance of the Study

Distance learning has experienced rapid growth in Ukraine since 2019, particularly during the COVID-19 pandemic. Following February 24, 2022, it has

become an indispensable mode of education in schools, specialized secondary, and higher educational institutions in areas where:

1. There is a real threat of bombings or missile strikes hitting buildings or institutions;
2. Sirens frequently sound, requiring immediate suspension of classes and seeking shelter;
3. Locations are directly on the front line;
4. Areas are under temporary occupation.

Although personal safety, emotional and psychological well-being, and provision of essentials such as heating, electricity, food, and other necessities have become top priorities, education has not diminished in importance. Knowledge remains a crucial asset for students as they prepare for the future, and educated individuals will play a key role in rebuilding the nation after the conflict.

It is noteworthy that some students continue their studies even while on the front lines, during breaks between combat.

3. Literature Review

A detailed analysis of trends and prospects in the development of distance education has been conducted by N. Kentnor (2015), E. Banas (1998), W. Emory (1998), K. Harting (2005), and M. Erthal (2005). Among Ukrainian scholars, significant attention to the conceptual foundations of distance learning has been given by O. Andreyev, N. Andrusenko [1], V. Bykov [2], M. Burda [3], D. Vasilyeva [4], D. Ivanchenco, V. Glazova [5], T. Godovanyuk [6], V. Kukharenko, M. Mormul, O. and D. Shchytov's, N. Morse, E. Polat, E. Smirnova-tribulskaya, V. Lapinsky, Y. Bogachkov, P. Stefanenko, A. Khutorsky, and others.

In recent years, there has been a vast amount of literature dedicated to distance education, including numerous articles, books, collections [7] and scientific conferences [2], [8]. Most authors focus on highlighting the advantages and disadvantages of distance learning formats [1], [5], identifying general trends in the development of these formats and their connection to global distance learning practices [2], [8], [9], [10], the history of the concept of distance learning worldwide [7], [12], the specifics of organizing distance learning in particular disciplines [7, pp. 23-27], and the shortcomings of distance education in higher education institutions in Ukraine [7, pp. 37-30], among other topics.

However, in our view, there is a lack of materials specifically addressing the nuances of distance learning in mathematics. General information about distance learning methods for mathematics was provided by T. Godovanyuk [6]. The specifics and status of such learning during wartime in Ukraine have been analyzed by M. Burda and D. Vasilyeva [3], [4], V. Glazova and K. Vesela [5], as well as the authors of this article [13], [14], [15].

Moreover, we have found a scarcity of specific proposals for the improvement and enhancement of distance learning methods in mathematics, apart from the recommendations and advice presented in articles [13], [14], and [15], which underscores the relevance of this topic.

There is also a lack of research focusing on the particularities of distance learning in higher education institutions in Ukraine under martial law.

4. Research Methodology

In this study, we will employ the following methods: characterization and definition of the problem, observation, comparative analysis of sources, forms of distance teaching, their advantages and disadvantages, practical application (experiment), and hypothesis (proposals).

5. Main Content

Distance learning (or online learning) is a form of education where all or a significant portion of the course is delivered to students using modern technologies in an interactive mode, allowing instructors and learners to be located in different countries or even on different continents. However, this form of learning is not suitable for all disciplines. Specifically, it is less effective for subjects where hands-on practice is crucial, such as medicine, veterinary science, architecture, metallurgy, chemistry, and creative arts.

Before delving into the practical application of this form of learning and its specifics concerning the teaching of exact sciences, we will first examine its general advantages and disadvantages based on our own experience and feedback from learners. We will also review the convenient platforms where it is currently implemented.

Advantages of Distance Learning:

- Time Efficiency: there is no need to physically attend educational institutions, saving time on commuting, adhering to strict class schedules, and absorbing material within a limited timeframe. Individuals living outside urban areas also save significant travel expenses.
- Broader Reach: distance learning allows access to education for residents of not only large cities but also remote towns and villages, and even other countries. This is particularly important as many students have been forced to leave the country due to the Russian aggression.
- Independence from Alerts: learners are not disrupted by air raid sirens or the need to seek shelter, which can interrupt in-person classes.
- Convenient Teaching: all necessary materials for the classes are always available (both for instructors and learners).

- Attention Monitoring: it is possible to monitor each learner's attention, which is challenging in real-time settings.
- Record Keeping: communication, responses, and all class materials are saved in files, allowing for easy review of previously covered content.
- Accessibility: distance learning is highly convenient for individuals with physical disabilities.
- Enhanced Learning Materials: the active use of images, text, sound, and video significantly improves the quality of information absorption.

Researchers also highlight additional advantages, though they are not as significant as the aforementioned ones [1, c. 8-9], [2, c. 10-11], [7, c. 28].

Disadvantages of Distance Learning:

Distance learning has several drawbacks, including:

- Internet Connectivity Issues: inconsistent or poor-quality internet connection can disrupt the learning process.
- Power Outages: classes may be interrupted due to power shortages, whether planned or emergency, especially under wartime conditions.
- Limited Real-Time Interaction: the absence of real-time, face-to-face interaction with instructors can hinder the ability to ask questions or engage in discussions.
- Lack of Pedagogical Control: there is often a lack of direct pedagogical oversight, which usually serves as a motivating factor for effective learning.
- Resource and Labor Intensity: institutions and instructors face significant resource and labor demands. In addition to required technical equipment, instructors must develop distance courses [7, c. 29];
- Information Overload: learners may be overwhelmed by the volume of information presented in a short amount of time.

Types of Distance Learning:

Distance learning can take various forms, including:

- Chat-Based Sessions: conducted synchronously, where all participants access the chat simultaneously. Many distance learning institutions use chat-based classrooms for interactions between instructors and students.
- Web-Based Sessions: include online classes, conferences, seminars, business games, laboratory work, and practical exercises conducted through telecommunications and other internet-based platforms. Unlike chat sessions, web-based forums offer longer, asynchronous interactions between learners and instructors.
- Teleconferences: usually conducted via mailing lists using email. There are also distance learning methods where educational materials are mailed to regions. This method is based on the "Natural Learning

Process" approach, involving systematic study and practice through audio and video materials (where available).

Platforms for Distance Learning:

Several platforms have been developed for the first two types of distance learning (chat-based and web-based sessions):

- Skype: provides text, voice, and video communication via the internet, optionally using peer-to-peer technology.
- Zoom: offers video conferencing services that allow up to 100 devices to connect simultaneously, with a 40-minute limit for free accounts (this restriction was lifted during wartime).
- Google Meet: ideal for secure video conferences with up to 500 participants and live streaming for up to 100,000 viewers within a domain.
- Moodle (Modular Object-Oriented Dynamic Learning Environment): a free platform known for its extensive customization capabilities, also referred to as a Learning Management System (LMS) or virtual environment.
- Ilias: a free platform for creating forums and personal blogs, widely used in higher education institutions, particularly in Germany. It is based on Apache, PHP, MySQL, and XML and conforms to SCORM standards.
- Spring Learn: a platform for employee distance learning, online testing, and webinars.
- WebTutor: a talent management system offering tools for recruitment, training, competency assessment, career planning, and knowledge management.
- Teachbase: a platform for creating courses, tests, and conducting webinars.
- Spring Market: a software platform for creating and selling online courses.
- Memberlux: a service for creating courses based on WordPress.
- Microsoft Teams: a corporate platform integrating chat, meetings, notes, and file sharing in a unified workspace.
- EdApp: a virtual classroom that integrates seamlessly with Zoom and Microsoft Teams for video conferencing.
- Google Classroom: a free web service for educational institutions, designed for creating, distributing, and assessing assignments paperlessly, as well as for distance testing and exams.

In Ukrainian educational institutions, platforms such as Skype, Moodle, Zoom, Google Classroom, and Google Meet are commonly used. There are several types (forms) of distance learning:

1. Correspondence Learning: students receive educational materials, tests, or exam questions via email or through a link to a file in Google Classroom. They work on these materials and receive assistance from instructors through email, phone, or chat.

2. Electronic Learning: this involves using computers, Google Drive, compact discs, or DVDs, along with specific computer programs to deliver educational content.
3. Online Learning in a Dialog Format: this form involves real-time interactive learning through dialogue, typically conducted via video conferencing platforms [6, c. 142-143].

Typically, all three methods are used at different stages of the learning process. When it comes to teaching exact sciences (such as mathematics, physics, computer science, economics, etc.) remotely, instructors need to do more than just deliver text—they must also write formulas, draw graphs, and create diagrams. This can be achieved in one of three ways:

1. Using a Tablet or Online Whiteboard: this method involves using a tablet or online whiteboard with a mouse. While this approach allows for writing and drawing, it can be challenging to manage if there are many formulas and graphs. Adapting to this method might require some practice.
2. Positioning the Webcam to Focus on the Instructor's Desk: instead of focusing the webcam on the instructor, it can be directed at their desk. This setup allows students to see everything the instructor writes or draws, which can facilitate understanding of the material. However, the quality of the video depends on the webcam and internet connection. For platforms like Skype, a regular pen can be used, but on platforms like Zoom, markers are often required due to lower video quality. This method provides a faster pace of teaching compared to using an online whiteboard and has the additional benefit of saving written materials for future use.
3. Providing Pre-Prepared Materials: materials such as text, formulas, graphs, diagrams, and tables can be prepared in advance and shared via platforms like Google Classroom or method 2. While this approach provides static information, it lacks the dynamic, interactive element of live teaching and may diminish the immediacy of student-instructor interaction [12, c. 133-134].

Since distance learning is expected to expand worldwide, new platforms and services will be developed. Based on our own experience, we would like to propose improvements to existing platforms to make them more suitable for teaching exact sciences. Specifically, the Google Classroom platform, which is used for testing and exams, requires the following enhancements:

1. Enhanced Support for Graphical Content: Google Classroom forms are currently designed more for the humanities (though some lecture materials may also use diagrams, tables, drawings, or photographs). However, exact sciences frequently require the insertion of graphical materials such as formulas, diagrams, and graphs. In subjects such as mathematics (algebra and geometry, probability

theory and mathematical statistics, discrete mathematics, mathematical analysis, numerical methods, mathematical modeling of various processes, materials resistance, etc.), physics, chemistry, economics, etc., this need is more prevalent. Unfortunately, Google Classroom forms do not have the capability to directly input formulas, drawings, or graphs. Instead, these need to be first converted into image formats such as jpg or jpeg using a graphic editor like Paint and then uploaded to the form as a file (see Fig. 1), which is very inconvenient and time-consuming.

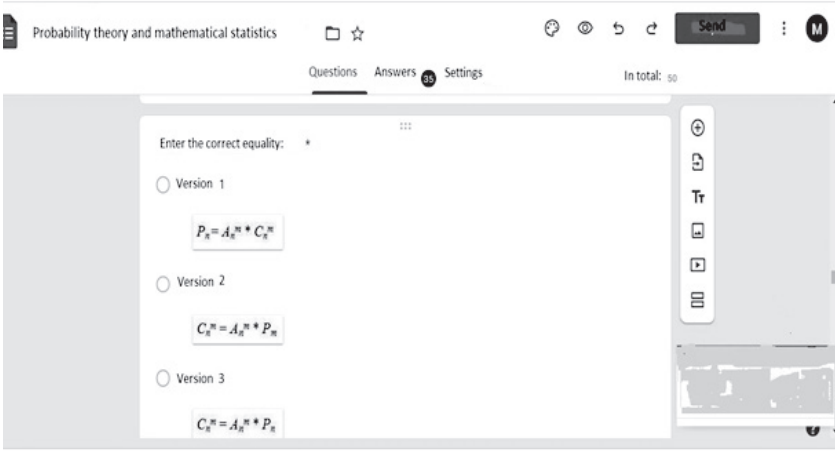

Fig. 1. The method of inserting formulas into Google Classroom "forms" is not very convenient.

Moreover, a drawing (both in the task text and in the answer options) can only be inserted once per question. However, the task text may contain multiple formulas (converted into drawings). In this case, it is necessary to convert the entire task text (or all the answer text) into a jpg or jpeg image format. It would be preferable to allow instructors to simply insert a formula directly into the «Option» or «Task text» fields, rather than as a drawing placed below these fields.

2. Additionally, text that includes superscripts, subscripts, or other special symbols and letters must also be converted into image format. It would be better to enter these directly into the task text.

3. The same applies to inserting drawings into the «form» – they first need to be converted into a jpg or jpeg file using a raster graphic editor like Paint, and then uploaded to the «form» via cloud insertion, which is time-consuming (see Fig. 2). It would be more convenient to insert them directly into the task text [12, c.139-140], [13, c. 26].

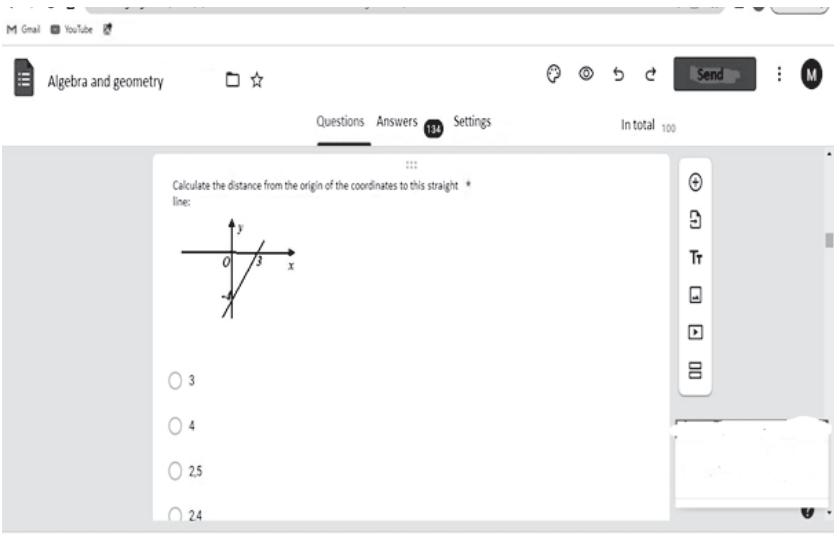

Fig. 2. Entering the "form" of the drawings takes a lot of time

4. There is no indication on the Google Classroom platform about how students should record their full names to facilitate sorting for the instructor: first name followed by last name. Sorting by last name is done based on the second word, and by first name based on the first word.

5. All technical information in Google Forms and Classroom is provided only in Russian, while we teach in Ukrainian.

6. There are issues with checking assignments as there is no sorting by completion time; instead, assignments are marked as either just submitted or submitted late.

7. If a student resubmits an assignment, there is no notification about this (one must check the history for each student or carefully review student comments, which they might not leave).

8. When new assignments are submitted on time or late, this can only be determined by the difference between the number of submitted and reviewed assignments, which requires manual counting, and identifying to whom these new assignments belong (partially aided by information indicating who submitted late).

9. Google Classroom allows only 20 photos to be uploaded per assignment. Therefore, extensive calculation work does not fit, and information is sent as a Word document, which degrades the quality.

10. There are occasional issues with reading and the quality of information presented in a convenient format for review.

11. Information submitted to Google Classroom is often distorted or unreadable, leading to the necessity of submitting it in PDF format.

6. Discussion

Current online learning platforms used in Ukraine, such as Zoom, Google Classroom, Moodle, and Google Meet, are not entirely adequate for teaching precise disciplines, particularly mathematics, due to several shortcomings. This article proposes ways to address some of these issues, including:

1. Inserting Graphs and Images: it is recommended to improve the functionality for directly embedding graphic materials without the need to convert them into image files beforehand.
2. Inserting Formulas: there is a need to develop the capability to directly input mathematical formulas into assignment text, rather than embedding them as images.
3. Using Superscripts, Subscripts, and Special Characters: platforms should allow the direct entry of superscripts, subscripts, and special characters without converting the text into a graphic format.
4. Informing About Sorting of Students: clear instructions should be provided on how student names are sorted by first name and surname to facilitate list organization.
5. Ukrainian or Multilingual Version: platforms should support Ukrainian or multilingual versions to comply with language requirements.
6. Sorting by Time: it is necessary to provide a sorting option for assignments based on the time they were submitted.
7. Notifying About New Versions of Work: a mechanism should be implemented to notify instructors when new versions of assignments are submitted by students.
8. Notifying About New Assignments: a notification system should be in place to inform instructors about newly submitted assignments.
9. Increasing Photo Upload Limits: platforms should allow uploading more photos in assignments to accommodate large calculation tasks.
10. Improving Information Quality and Ease of Review: there should be enhancements to ensure high quality and ease of information presentation for smoother review processes.
11. Avoiding Distortion and Non-Readability of Information: systems should be improved to prevent distortion and unreadability of information submitted to the platform.

Modifying the interface of online learning platforms will help speed up and simplify the process of entering tests or exam questions for mathematics and

related disciplines, make the presentation of tasks more convenient, and improve management of student lists and tests.

Additionally, it is advisable to consider providing concessions or special provisions for students who are mobilized and serving at the front or in military units but wish to continue their studies. Instead of automatically granting academic leave, as is currently done, special arrangements could be made for such students.

Given the frequent power outages at different times in various cities and districts, as well as the threat of a total collapse of the country's energy system, it would be prudent to shift to a rolling schedule for online learning. For students who cannot attend a session due to valid reasons, sending an electronic copy of the session (preferably in an automatic mode) would be beneficial.

7. Conclusions

This article has reviewed contemporary platforms designed for distance learning, analyzing their advantages and disadvantages. A comparative analysis of platforms and methods for conducting classes in mathematics and other exact sciences has been conducted. Several suggestions have been made to improve the process of preparing and conducting online lessons, as well as specific recommendations for teaching mathematics and other precise disciplines through distance learning.

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DIRECTIONS FOR IMPROVING THE DISTANCE TEACHING OF EXACT DISCIPLINES UNDER MARTIAL CONDITIONS