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## 2. Challenges and prospects of blended mathematics education for agricultural students during martial law

**Abstract.** Against the backdrop of the COVID-19 pandemic and the introduction of martial law in Ukraine, the use of blended learning has become increasingly relevant in the training of specialists at agricultural institutions of higher education. The forced and rapid transformation of the educational process required both teachers and students to adapt to new learning formats that combine traditional and digital components.

This article focuses on the importance of implementing blended education as an essential component of professional, particularly mathematical, training for first-cycle (bachelor's) students at Vinnytsia National Agrarian University. The role and condition of mathematics education under crisis circumstances are analyzed.

It is shown that the integration of online technologies into the educational process ensures continuity of learning at a high level of quality and safety, provides constant access to educational resources, and is generally positively perceived by students. However, successful implementation of blended learning requires teachers and students to possess strong information and communication technology skills and to adopt a flexible approach to teaching and learning.

The study substantiates that the use of blended learning supports the professional growth of future specialists, promotes independent work, fosters information culture, and enhances the ability to apply innovative tools for acquiring and processing knowledge. Before implementing blended learning, students should be prepared to work with academic sources, analyze and systematize information, identify key ideas, and draw conclusions.

**Purpose of the study.** The aim of the article is to present the experience of implementing blended learning, particularly in mathematical disciplines, at Vinnytsia National Agrarian University.

**Research methods.** To achieve this goal, a combination of theoretical and empirical methods was applied: analysis of scientific and methodological literature, examination of educational resources, and pedagogical observation of students' learning processes. The paper presents the experience of teaching higher mathematics under blended learning conditions, outlining key requirements, principles, and technologies for designing and supporting blended learning courses. A blended course in higher mathematics was developed for students majoring in 208 Agricultural Engineering.

The article also considers major challenges and possible solutions, particularly in organizing students' independent work during online sessions. The importance of teacher supervision at various stages of students' work is emphasized as a key factor in maintaining learning effectiveness. Both the advantages and limitations of blended learning are discussed, along with recommendations for further research on enhancing students' independent learning in hybrid educational environments.

It is also noted that the issue of teacher readiness for blended instruction is often underestimated. Contrary to common belief, many educators face significant challenges in adapting to new formats. Therefore, systematic training in blended learning organization and pedagogy is urgently needed.

**Conclusions.** Blended learning provides students with access to diverse sources of information, enhances independent work, fosters creativity, strengthens professional competencies, and enables teachers to implement innovative forms and methods of instruction in mathematics and related disciplines.

## Introduction

The academic period of 2022-2025 will be remembered in the history of Ukrainian higher education for the unprecedented challenges it has faced. These challenges include, first and foremost, the ongoing state of war in Ukraine [1]; secondly, the lasting impact of the COVID-19 pandemic on teaching, learning, and academic mobility; thirdly, the disruptions and uncertainties surrounding the admissions campaigns during times of instability; fourthly, the reduction of sustainable

funding for educational institutions; and finally, the heightened social, psychological, and emotional pressures experienced by all participants in the educational process.

Currently, the Ukrainian higher education system is confronted with a critical question: how to maintain the integrity, cohesion, and functionality of both student and academic communities under the combined pressures of martial law and pandemic-related restrictions, while simultaneously ensuring the delivery of high-quality education. Educators and administrative staff bear substantial responsibility toward multiple stakeholders – students, parents, employers, the state, and society at large – which necessitates carefully coordinated strategies, flexible planning, and adaptive approaches to teaching and management.

During times of war, the demand for highly qualified professionals becomes even more urgent. Their expertise is crucial not only to avert potential food crises within Ukraine and globally but also to contribute to the post-war reconstruction and sustainable development of the nation. This creates an immediate need for specialists capable of restoring and advancing key sectors of the economy, including the agro-industrial complex, environmental protection, processing industries, and food production chains. In addition, there is a growing demand for experts in digital technologies, logistics, public health, and crisis management, all of which are essential to the resilience and modernization of the national infrastructure.

Consequently, the primary mission of higher education institutions, particularly agricultural universities, is to ensure the continuity and quality of the educational process, to train competent and adaptable professionals, and to safeguard the physical and mental well-being of students and educators under extraordinarily challenging conditions [2]. Achieving this requires innovative approaches to teaching, including blended and distance learning technologies, restructuring curricula to prioritize practical competencies, implementing flexible assessment and monitoring systems, and providing psychosocial support for students and staff.

Moreover, this period has highlighted the importance of fostering resilience, self-directed learning, and digital literacy among students. Higher education institutions must cultivate a learning environment that not only imparts knowledge but

also develops critical thinking, problem-solving skills, and the ability to adapt to rapidly changing circumstances. At the same time, educators are called upon to demonstrate creativity and flexibility in delivering instruction, designing interactive and accessible learning resources, and sustaining motivation and engagement despite physical and psychological barriers.

In summary, the 2022-2025 academic period represents a pivotal moment for Ukrainian higher education. The combined pressures of war, pandemic consequences, and social instability have forced universities to innovate rapidly and adopt adaptive strategies that ensure the continued preparation of professionals who can meet the urgent and evolving needs of the country. The lessons learned during this period will not only inform immediate educational practices but also shape the future resilience, inclusivity, and global competitiveness of Ukraine's higher education system.

## 2.1 The Role and Transformation of Mathematics Education Before and During the War

Even before the outbreak of war, Ukrainian society had been actively discussing what mathematics education should look like in the modern world. Many statements were made about the importance of quality education as the foundation of the nation's future. Today, this truth has become particularly evident. Modern warfare is, above all, a war of technologies. The most advanced equipment becomes useless if one does not understand its principles of operation. Likewise, an artillery specialist cannot determine a projectile's trajectory without solid mathematical knowledge.

Qualified professionals with a sound foundation in the natural and mathematical sciences will be urgently needed both during and after the war – for rebuilding the country, developing industry, construction, and advancing technology. Even journalists and humanities specialists, many of whom are now serving or supporting the Armed Forces, rely on mathematics when analyzing statistical data, technological information, or writing about military and economic developments. In today's reality, mathematical illiteracy, once tolerated or even joked about, is no longer acceptable.

The war has clearly demonstrated the importance of mathematics education. Yet, Ukraine continues to face serious challenges in this area. Long before the invasion, the

results of the international **PISA** assessment revealed that the majority of Ukrainian teenagers lacked basic mathematical literacy. National monitoring also indicated significant gaps at the primary level, and external independent testing showed that many prospective students could not solve elementary problems. The current simplified multi-subject national test, introduced under wartime conditions, risks perpetuating these deficiencies at the secondary level.

Some may argue that the quality of education is a secondary issue during wartime. However, war has exposed systemic problems that must be addressed if Ukraine is to build a sustainable future. Defending the country today also means **defending its educational and intellectual potential**.

Before the war, Ukrainian education – particularly higher education – tended toward simplified, game-based learning with limited focus on genuine intellectual development. Excessive tolerance toward academic dishonesty, neglect of homework, and inflated grading became widespread practices. Effort and discipline were often replaced by a "comfort-oriented" philosophy, emphasizing psychological ease over intellectual challenge. This approach fostered in students an illusion that life would always be effortless and that success required no personal responsibility or hard work.

It is therefore critical to rethink educational priorities and recognize the nation's urgent need for engineers, scientists, and specialists with solid mathematical foundations. Basic competencies – such as calculation skills, practical geometry, understanding of functions and graphs, and the ability to solve equations, inequalities, systems, and proportions – are indispensable. The limited number of graduates proficient in mathematics is insufficient even to meet the needs of the information technology sector. Meanwhile, many of Ukraine's brightest physics and mathematics talents are being recruited by top international universities.

## 2.2 Methodological Specifics of Distance Learning in Higher Education

Long before the war, discussions were already taking place in Ukraine about the desired form and purpose of mathematics education. Many statements were made about

the importance of high-quality education as the foundation of the nation's future. Today, society can clearly see why these conversations mattered. Modern warfare is, above all, a war of technologies. The most advanced equipment becomes useless without an understanding of its principles of operation, and even a skilled artillery specialist cannot calculate a projectile's trajectory without mathematical knowledge.

Qualified professionals with a solid grounding in the natural and mathematical sciences will be critically important both during and after the war – for rebuilding the economy, revitalizing industry, developing technologies, and ensuring national security. Even journalists and representatives of the humanities – many of whom have joined or support the Armed Forces – rely on mathematical competence when analyzing data, reporting on events, or interpreting technological information. In today's context, mathematical illiteracy, once sometimes accepted or even joked about, is no longer permissible.

At the same time, the war has exposed the weaknesses of Ukraine's mathematics education system. Well before the invasion, the international **PISA** assessment revealed alarming results: most Ukrainian teenagers demonstrated insufficient mathematical literacy. National monitoring data confirmed similar problems at the primary level, while external independent evaluations showed that many prospective students were unable to solve elementary problems. Due to wartime conditions, the current national multi-subject test in mathematics has been simplified, which risks transferring unresolved educational gaps to the higher education level.

Some may argue that wartime is not the moment to discuss educational quality – that the country's primary focus should be on defense. However, the war has merely illuminated problems that have long existed. Now, when we are defending the future of Ukraine, it is impossible to do so without rethinking and improving the **quality of education.**

Before the war, Ukrainian education – particularly higher education – was increasingly characterized by simplified, game-based approaches that often lacked genuine educational depth. Excessive tolerance toward academic dishonesty, neglect of homework, and inflated grading standards became common practice. The value of

effort, discipline, and intellectual rigor was downplayed in favor of maintaining psychological comfort and avoiding any form of challenge. This "cult of ease" fostered in students an illusion that life would always be simple, that someone else would solve their problems, and that success required no personal responsibility.

It is now vital to reconsider national educational priorities and focus on preparing engineers and skilled specialists with strong mathematical foundations. Core competencies – such as computational skills, elements of practical geometry, understanding of functions and graphs, and the ability to compose and solve basic equations, inequalities, systems, and proportions – are essential. The small number of graduates proficient in mathematics is already insufficient even for the information technology sector. Meanwhile, the most talented students in physics and mathematics continue to be recruited by leading universities abroad.

The rapid advancement of computer and information technologies has catalyzed the creation and implementation of innovative educational methodologies. One of the most significant trends in this development has been the progressive shift from conventional face-to-face instruction toward electronic (e-learning) and mobile (m-learning) learning environments. This evolution has given rise to **blended learning**, which integrates traditional classroom instruction with online components [3].

Vinnytsia National Agrarian University (VNAU) has been successfully implementing blended learning for several years, employing a wide array of modern tools and technologies that allow the university to adapt to contemporary educational demands. Blended learning offers greater flexibility compared to traditional learning formats, enabling educational institutions to provide instruction under diverse conditions. It merges face-to-face teaching with digital resources, including online materials, submission of assignments electronically, collaborative group work, continuous feedback mechanisms, interactive classroom sessions, and electronic monitoring of academic progress.

Importantly, blended learning is not merely the use of electronic resources within the classroom, such as multimedia presentations or computer-based testing. Rather, it emphasizes active student participation and ongoing feedback, both online and offline.

This approach allows for the distributed utilization of informational and educational resources within traditional learning settings while incorporating both asynchronous and synchronous elements of distance education.

**Distance learning**, as a key component of blended learning, provides students with the opportunity to acquire knowledge remotely and at an individualized pace. There is no universal model of distance learning applicable to all students, as the educational process depends on the institution, faculty, academic schools, and program focus. Distance education is inherently personalized, enabling students to design their own learning pathways, concentrate on areas of interest, and progress according to their individual pace.

The benefits of distance learning are widely acknowledged, including cost-effectiveness, adaptability, and the ability to engage in learning remotely. Nevertheless, its success heavily relies on students' prior knowledge, motivation, self-discipline, and prior educational experience. Certain disciplines that require extensive practical training, such as veterinary medicine, food engineering, and agricultural engineering, cannot yet fully transition to distance formats due to the necessity of sophisticated simulators and AI-supported instructional tools.

Experience from higher education institutions indicates that effective implementation of distance learning requires careful attention to legislation, regulatory frameworks, labor market requirements, technological infrastructure, and technical support. The initial stage involves selecting an appropriate model of distance or blended learning capable of adapting to future educational needs. Subsequently, a regulatory framework must be established, including institutional regulations and admission rules, to ensure effective governance of the educational process.

During the COVID-19 pandemic, approximately 60% of courses for both full-time and part-time Bachelor's and Master's students at VNAU were delivered as online electronic courses (ELCs). On January 24, 2022, the large-scale Russian invasion necessitated a renewed shift to distance learning. By this time, instructors had accumulated experience in online teaching; however, wartime conditions introduced additional complexities.

Students were organized according to their location: those remaining at home (in either occupied or unoccupied territories) and those who had been displaced (internally or externally). While individual circumstances varied, common challenges included limited access to technological resources, unstable internet connections, diminished physical and psychological well-being, and fluctuating class attendance. Synchronous online sessions were often disrupted by bomb shelter drills, power outages, and technical constraints, including insufficient devices, cameras, and microphones.

Distance learning during wartime also highlighted significant differences in student motivation. Students with strong intrinsic motivation were able to adapt effectively to blended and distance formats, whereas students with extrinsic or situational motivation required structured guidance, monitored learning, and additional incentives. Despite the relative independence afforded by distance learning, students continued to rely on teachers for support, guidance, and assessment; the teacher's role as a traditional instructor remained central, rather than being replaced entirely by a tutor-like function.

In conclusion, the implementation of blended and distance learning under wartime conditions has revealed both opportunities and limitations. Ensuring effective education requires flexibility, robust technological support, consideration of students' emotional and physical well-being, and careful organization of the learning process to accommodate the dynamic and challenging context of ongoing military operations in Ukraine.

The rapid and intensive advancement of computer and information technologies in the contemporary world has become a key driver for the development and implementation of modern educational technologies. One of the most notable trends in this evolution is the gradual shift from traditional, face-to-face learning methods toward electronic (e-learning) and mobile (m-learning) components within the educational process. This transformation has led to the emergence of a new paradigm in educational technologies – **blended learning** – which combines conventional classroom instruction with online and digital tools [3].

Vinnytsia National Agrarian University (VNAU) has been successfully implementing blended learning for several years, employing a broad spectrum of modern tools and technological solutions. This approach enables the institution to remain adaptive to the current demands of higher education, ensuring that both teaching and learning processes align with contemporary educational requirements. Blended learning is relatively new in the context of Ukrainian higher education but has proven highly effective in providing flexibility relative to purely traditional learning formats. It allows educational institutions to offer instruction under a variety of delivery conditions, effectively integrating traditional educational methods with elements of online education.

In practice, blended learning typically involves multiple components: instructional materials are provided in electronic form, students can submit assignments electronically, ongoing assessments with detailed feedback are conducted, collaborative group work is facilitated, electronic tracking systems (such as learning logs) monitor student progress, and face-to-face sessions are designed according to interactive principles. Importantly, blended learning is not merely the presence of electronic resources in the classroom; rather, it represents a structured integration of technology with active student engagement and continuous feedback. For example, a class that relies solely on a multimedia presentation controlled entirely by the teacher, or a computer-based test conducted in a laboratory setting, cannot be considered blended learning. The blended model is fundamentally about the distributed use of informational and educational resources within traditional instruction, complemented by asynchronous and synchronous distance learning elements.

**Distance learning**, as a key component of the blended learning approach, provides students with the opportunity to acquire necessary knowledge remotely and at their own pace. It is important to note that no single, universal distance learning model exists that fits all students. While similar methods and forms may be applied, the actual learning experience will always vary. These differences reflect the unique circumstances of each educational institution: the specific faculty members involved, the academic schools represented, and the particular emphases of individual programs.

Within this framework, distance education offers a highly individualized and flexible learning process. Students have the ability to design their own curriculum, progress through material at a self-determined pace, and concentrate on subjects or topics that align with their personal interests.

Historically, distance learning has been regarded as a highly attractive alternative to conventional education. Numerous studies have highlighted its advantages, such as cost-effectiveness, flexibility, and the opportunity for learners to study remotely, thereby reducing the need for physical workspaces. The software and technical infrastructure required for distance learning are primarily managed by teachers and students themselves, contributing further to efficiency. Moreover, the cost of educating a single student in a distance learning system is typically lower than in traditional formats. However, the effectiveness of distance learning depends significantly on multiple factors, including students' age, prior education, professional training, previous educational experience, capacity for self-organization and independent study, and level of intrinsic motivation.

Despite its advantages, distance learning presents limitations for certain disciplines that require substantial practical training, such as veterinary science, food engineering, and agricultural engineering. At the current stage of educational and computer technology development, fully transitioning such programs to distance formats remains impractical. Effective training of specialists in these fields necessitates the creation and regular updating of advanced, often expensive simulators, frequently incorporating artificial intelligence, to provide the necessary hands-on experience.

Experience from numerous higher education institutions demonstrates that the successful implementation of distance learning requires careful consideration of multiple factors, which arise in accordance with contemporary demands, current legislation, and regulatory documentation governing the educational process and all its participants. These requirements originate both from the Ministry of Education of Ukraine and the leadership of individual higher education institutions.

Additionally, educational institutions must account for the modern labor market, the current state and development of information technologies, the provision of

technical support, and various minor factors that may be influenced by the specific location of each user, including teachers, students, and administrators. The initial stages of introducing distance learning are particularly critical and challenging. The foremost task is to select a type and technology of distance learning that not only meets these requirements but can also adapt seamlessly to the changes that inevitably occur during implementation. Blended learning, combining traditional instruction with digital and online components, is particularly well-suited to meet these needs, offering several advantages over other forms of distance education.

The subsequent stage involves the creation of a regulatory framework to guide and control all aspects of distance learning within higher education institutions. This framework typically includes admission rules, relevant institutional regulations, and additional policies to ensure the effective management and monitoring of the educational process.

During the COVID-19 pandemic, students at VNAU had already been engaged in remote learning to a significant extent. Approximately 60% of the total courses for full-time and part-time Bachelor's and Master's programs were available as online electronic learning courses (ELCs). However, on January 24, 2022, the large-scale invasion of Ukraine by the Russian Federation necessitated another rapid transition to distance learning. By this time, teachers had accumulated some experience in organizing remote education, yet the wartime context introduced unique challenges that further complicated its implementation.

During the war, students were divided into several groups according to their circumstances: those remaining in their homes (in occupied or unoccupied territories) and those who had relocated (internally displaced within Ukraine or externally displaced abroad). While each student's situation was unique, these groups shared certain commonalities. Students who remained at home had some access to educational resources but were often forced to frequently move to bomb shelters and endure severe emotional stress, which inevitably impacted cognitive processes. Students who had relocated within Ukraine lacked the familiar conditions for study but were often able

to communicate more actively with peers and teachers and were in relatively calmer emotional states.

The proportion of students without reliable internet access during wartime is higher than it was during COVID-19 distance learning. Moreover, student groups are dynamic: attendance fluctuates significantly, with some students participating one day, more joining the next, and others being absent entirely. During synchronous online classes, students frequently join or leave sessions, for example, due to the need to descend to a bomb shelter where internet access may be unavailable.

In the context of ongoing military operations in Ukraine, significant disparities in the capabilities of educational participants have emerged, which result in particular challenges for organizing distance learning of mathematics. These include: the absence of distance learning infrastructure in certain territories; periodic or prolonged absence of some participants; a substantially larger proportion of participants experiencing technical difficulties, such as lack of electricity, insufficient devices, or unreliable internet; deteriorated physical and psychological health of participants, including limited access to food, water, fresh air, movement, and sunlight, and heightened emotional stress; markedly reduced motivation, self-organization, and self-efficacy among both students and teachers; limited time for teachers to prepare instructional content and for students to complete assignments; varying conditions for students (remaining at home, internally displaced, or externally displaced), which influence their sense of security and learning opportunities; the negative impact of stress on students' cognitive processes, complicating their ability to learn effectively; the dynamic nature of student groups, with frequent absences or partial attendance; a demand from students for synchronous online classes, which help them temporarily divert attention from wartime events and facilitate communication with teachers and peers.

Numerous studies on distance learning highlight a potential shift in the role of the teacher, suggesting that they might transition from a traditional instructor to a consultant or tutor. However, recent experience indicates that such a transformation did not occur in practice. Teachers largely retained their traditional instructional roles,

despite the increased independence gained by students. While students became more autonomous in their studies, they still required guidance, advice, and evaluation from teachers in their conventional capacity. Although the modes of communication and interaction with students have evolved, the fundamental role of the teacher remained unchanged.

It is also important to note that students did not automatically become highly motivated, self-directed learners. Many continued to rely on teacher guidance rather than engaging in autonomous, advisory-driven learning. A significant challenge was the lack of motivation among certain students, who perceived distance learning as an opportunity to relax or enjoy additional free time. Many struggled with self-organization, independent study, and exhibited dependence on traditional in-person instruction. Students with strong intrinsic motivation and a genuine desire for knowledge were able to adapt effectively to the transition, organizing their educational activities within the new temporal and spatial dimensions imposed by distance learning. Conversely, students with primarily external or situational motivation – those heavily reliant on direct teacher interaction and grade-focused evaluations – were less adaptable to these new conditions and required structured guidance and additional incentives to sustain their learning.

Technical challenges further complicated the process. Shared access to a single computer within a household, reliance on smartphones as the primary device for learning, unreliable internet connections, power outages during classes or assessments, and the lack of quality microphones and cameras for video communication created additional obstacles for both students and teachers.

Despite these difficulties, positive outcomes emerged. Initially, students experienced confusion and anxiety, and some approached online learning with a casual attitude. Over time, however, most adapted and began to recognize the benefits of distance learning, including: the ability to attend classes from home in a comfortable and convenient environment; flexibility in completing assignments according to personal schedules, allowing both early risers (“larks”) and late-night workers (“owls”) to follow their natural biorhythms; the option to participate in classes partially when

technical issues, such as non-functioning microphones or poor connectivity, prevented full interaction; involvement in selecting web resources and video materials for assignments, enhancing engagement and relevance to students' future specialization.

The effectiveness of distance learning largely depended on students' self-organization, awareness, and intrinsic motivation. This dependence led to a noticeable decline in effectiveness for younger learners. For instance, high school students enrolled in university preparatory courses often showed limited benefits from distance learning, with parents frequently demonstrating greater interest in outcomes than the students themselves.

Consequently, it is essential to develop innovative approaches to task design, individual instruction, and overall learning processes, with particular attention to motivating younger learners. Gamification, for example, can be especially effective for high school and junior students, who often exhibit weak intrinsic motivation, limited understanding of broader learning objectives, and underdeveloped self-regulation skills. For this age group, distance learning tends to be driven more by external motivation from teachers and parents than by internal student initiative.

Overall, feedback from university students regarding online learning was largely positive. Virtual classrooms facilitated the systematization of learning, simplified assessment, and enhanced transparency. Students regularly received automated notifications with their scores, and teachers could efficiently provide individualized feedback or group-wide clarifications. Additionally, reminder systems ensured timely submission of assignments, reducing the likelihood of missed deadlines and promoting accountability in the learning process.

During the transition to distance learning, coordinating the activities of teachers and students proved to be a complex and challenging task. Many teachers increased the number of assignments, justifying this by the fact that, being at home in self-isolation, they had more time and therefore could assign 1.5-2 times more work for their subject. Some teachers approached distance learning by attempting to replicate traditional classes in real time using various online platforms in the form of video sessions. At times, teachers, considering their subject to be the most important and themselves as

the only instructors working with students, neglected the need for students to complete assignments from other subjects or to schedule online classes and consultations at convenient times, disregarding the overall timetable. This lack of coordination created disorder and chaos in the educational process, causing nervous exhaustion among conscientious students who tried to meet all requirements. Additionally, there was a general tendency to schedule classes later in the day, as some students, feeling relatively relaxed, were unwilling to begin work before 10 a.m. This lack of coordination among teaching staff and the uneven organization of distance learning, combined with inconsistent requirements for students, resulted in dissatisfaction and complaints of total overload.

Engaging students in distance learning unexpectedly emerged as another significant challenge. While students generally possessed sufficient computer literacy and access to high-speed internet, their integration into virtual classrooms required extensive guidance. Many explanations and training sessions were needed to familiarize students with social networks, messaging applications, emails, and chat platforms, consuming substantial time. Teachers had to respond to numerous inquiries throughout the day regarding virtual classroom operations.

Several specific difficulties arose at the outset. Some students did not take online participation seriously, registering under pseudonyms or nicknames, creating confusion and requiring significant effort to identify them. Traditional class formats proved ineffective and unengaging in the online environment. Independent textbook exercises were often uninteresting, necessitating the rapid development of interactive tasks using multimedia tools such as video assignments, Google Forms, and other digital resources.

Some teachers interpreted the transition to distance learning as simply conducting traditional-style classes via Zoom, Google Meet, Skype, or similar platforms. This approach, while familiar, imposed additional burdens on both teachers and students and introduced technical challenges, such as the inability to hold long sessions on Zoom or difficulties joining Google Meet classes without additional invitations.

Adapting to communication with cameras and microphones turned off was also unusual for many participants. Both students and teachers had to adjust to limited visibility and overcome periodic communication issues. A new rationale for absenteeism emerged: poor internet connection or power outages. Furthermore, students initially submitted completed assignments through various channels that seemed convenient to them, increasing the teacher's workload and making it challenging to track and organize submissions. Some assignments were lost, creating further dissatisfaction and chaos. Only after the creation of detailed step-by-step instructions for each group did students fully understand how to navigate the virtual classroom and submit assignments correctly, which subsequently reduced the teacher's workload and the volume of daily inquiries.

Student assessment became more complicated, as key points had to be presented in the virtual classroom, duplicated in the electronic office, and recorded in paper-based journals, generating additional administrative tasks. The shift to online learning and self-isolation also reduced the self-discipline of certain students, who sometimes behaved inappropriately or insulted peers during online sessions. The ability to remove such students from virtual classrooms became a necessary, though infrequently used, function.

Identification of students during assessments or exams posed another challenge, especially for teachers who had not yet memorized all faces. Students were required to display their grade books or identification documents to the camera. Conducting simultaneous tests for all students proved difficult, as it was hard to verify the identity of each participant and ensure independent work. To counteract potential cheating, some teachers designed creative assignments that could not be easily answered using online resources or required students to answer questions without viewing the screen.

The shift to remote instruction also increased the volume of reporting documentation. Teachers had to demonstrate the effectiveness of their work weekly, with each report requiring two or more hours to complete. Prolonged computer use led to vision deterioration, physical fatigue, and reduced mobility among all participants in distance learning.

Despite these challenges, virtual classroom work proved stimulating. It encouraged creativity, promoted a fresh perspective on education, and necessitated the development of innovative methods for engaging students and organizing systematic learning. Key tools employed by university instructors included: virtual classrooms for group organization, such as Moodle and Google Classroom; real-time platforms for synchronous sessions resembling in-person classes (Zoom, Google Meet, Skype); online resources for tests, surveys, assignments, and other materials; digital textbooks; multimedia audio and video materials compatible with the chosen virtual platform.

This experience yielded important results: highly motivated and well-prepared students were able to overcome the challenges of remote learning and demonstrate strong performance on exams. Independent work became increasingly critical, and student qualities such as self-motivation and the ability to process and assimilate information emerged prominently. In some cases, students who had experienced prolonged illness or quarantine demonstrated remarkable resilience and a renewed desire to learn.

Conversely, students with weak initial preparation and limited interaction with peers struggled with remote learning, often leading to poor exam performance and diminished motivation. Teachers could intervene in such cases, provided students demonstrated initiative, by offering consultations in traditional formats and helping organize independent study. Whenever feasible, intermediate assessments conducted in physical classrooms provided valuable insights into students' understanding.

Overall, distance learning reinforced the understanding that learning outcomes depend not solely on the method of content delivery, but significantly on the student's motivation, initiative, and capacity for self-directed learning. In situations where in-person classes are feasible, it remains crucial to cultivate self-education skills, time management, independence, and a desire for personal development in students. When online instruction is necessary, teachers should leverage all available tools to support students, ensuring continued acquisition of knowledge and maintaining high-quality education under challenging circumstances.

## 2.3 A distance course as a means of forming motivation during education

A successful transition from traditional education to distance learning requires the resolution of a wide range of psychological, pedagogical, organizational, and technical challenges. First and foremost, it is essential to design and develop a distance learning course that aligns with the higher mathematics curriculum, considers students' prior knowledge and general mathematical training, and accounts for their individual characteristics.

A distance course is a comprehensive set of educational and methodological materials and services created within a virtual learning environment to facilitate distance education using information and communication technologies (ICTs). Its purpose is to organize student learning activities, develop structured informational, didactic, and methodological materials, and leverage available digital tools, including multimedia components such as audio, video, animation, and modeling [4].

The planning and development of a distance course is a lengthy process, typically taking several months and requiring coordinated efforts among teaching staff, consultants, and technical specialists. Such a course should be guided by the following pedagogical principles [5]: transition from teacher-centered learning to self-directed learning; placing the student at the center of the educational process; creation of an accessible and comprehensible learning environment; Identification and application of effective learning strategies; anticipation of students' methods of self-organization, self-control, and self-management; formation of relevant competencies; ensuring interactivity and collaboration among all participants in the learning process.

During the planning and development of a distance course, ICTs should serve as tools for creating, storing, and accessing digital resources, while supporting the educational process through specialized software, telecommunication means, and psychological-pedagogical approaches. Distance learning is conceptualized as a system of methods, tools, techniques, and actions, whose deliberate implementation ensures the quality and effectiveness of training while considering the characteristics of the learners [5].

The initial steps in transitioning to full-scale distance learning during martial law involved selecting an educational platform, creating new materials, adapting and systematizing existing resources for virtual classrooms, and addressing the specific needs of individual student groups based on the curriculum and students' personal characteristics. Given the limited time, it was impossible to develop a fully comprehensive distance course covering all subject material; therefore, the bulk of the course relied on previously planned face-to-face class materials, which had to be rapidly converted for online delivery.

Subsequently, students needed to be oriented to the virtual classroom environment, trained to use electronic communication tools in both synchronous and asynchronous modes, and guided in accessing educational resources.

On a daily basis, preparing, conducting, analyzing, and supervising classes required between 6-8 to 18 hours of effort, effectively erasing distinctions between working days and weekends. Teachers reported that their working day became practically endless. It took approximately two weeks to create, organize, and properly design remote classes for all groups.

Although theoretical sources describe distance learning as supported by multiple structural units – dministrative units for organizing and monitoring distance education, customer service units managing contracts, units for educational process organization and content creation, technical and ICT support units, and others directly involved in web resource development – the reality was that most responsibilities fell to teachers. They served simultaneously as instructors, consultants, group curators, and authors of didactic content. While distance learning ideally required methodologists, administrative staff, and technical specialists, teachers were largely left to manage the transition themselves.

Consequently, it is understandable that some educators initially attempted to transfer traditional teaching materials to online platforms without significant modification, leading to challenges in adapting to the demands of distance education. The need to rapidly develop new materials and discover innovative pedagogical methods proved stressful for many teachers.

In general, the functional responsibilities of teachers in distance learning include: planning the educational process; developing, adapting, and regularly updating didactic and methodological materials; conducting educational activities – including lectures, seminars, practical sessions, consultations, discussions, and role-playing games – in both synchronous and asynchronous modes using ICT tools; individualizing tasks to increase student motivation and engagement; organizing assessment, self-assessment, and peer evaluation; advising students on study progress, graduation projects, assessments, and examinations; compiling reports on students' performance and learning outcomes.

At the outset of course organization, teachers must anticipate student demographics, prior knowledge, work experience, task requirements, motivation levels, and physical and cognitive characteristics. They must estimate the required teacher working hours, prepare external and internal resources, provide technical support, acquire or develop appropriate software, and allocate time for course study – tasks that were nearly impossible to predict during the quarantine.

During course creation, it is essential to define the objectives, duration, target audience, task types, deadlines, reporting methods, and instructional support. This involves revising the curriculum, planning class types and quantities, selecting appropriate educational methods, developing exercises, and designing assessment systems. Ideally, a course presentation should be prepared to familiarize students with the content and generate interest.

The process of distance course planning typically includes: developing a course program; structuring the sequence of topics; facilitating student adaptation to distance learning; determining delivery methods for educational materials; creating conditions for student engagement and motivation; developing assessment, self-assessment, and knowledge control systems; writing a course preface; estimating time required for preparation and for students to complete tasks; organizing independent student work; planning technical support for the course.

Course tasks should be logically structured, interconnected, and accessible asynchronously to accommodate individual student schedules. Task wording should be

precise, simple, and understandable, with personalization based on individual student needs. Internal materials should be adapted for distance learning, while external resources must be licensed or appropriately cited. Distance learning tools enable individualized learning and the design of tasks according to students' perceptual preferences.

A well-structured distance course should include: preface; content and organization; author and instructor information with contacts; main goals and objectives; detailed course description; course menu and map; student information and contacts; news updates; course program; tasks; knowledge tests; references and links; conclusions and reflection questions.

Individual lessons should include an introduction, goal definition, task formulation, task execution instructions, visual and multimedia materials, organizational guidance, control or self-assessment mechanisms, and reflective commentary. Development is cyclical and interactive, requiring ongoing consultation and evaluation of material implementation. During the quarantine, new materials were introduced rapidly, often updated 1-2 times per week.

Teacher-student interaction should be planned according to activity type: clarifying (lecture, webinar), interactive (practical session), or adaptive (individual consultation). Communication can be synchronous (real-time video conferences, chats) or asynchronous (forums, blogs, email, social media, messaging apps) [4].

Conducting live distance learning activities requires meticulous planning to address technical challenges, ensure stable internet connectivity, and adapt traditional pedagogy to online formats. Key considerations when organizing virtual sessions include defining learning objectives and topics, outlining tasks or problems for student engagement, structuring the session with clear timing, limiting group size (typically 4-10 students for optimal interaction), selecting an appropriate session format (seminar, workshop, discussion, role-play, or case study), identifying main activities (brainstorming, Q&A, collaborative problem-solving, or educational games), preparing written and multimedia materials for real-time sharing, anticipating potential technical issues, and incorporating reflection and feedback strategies. Clear guidance

on student participation and expected outcomes is critical for maintaining engagement and motivation throughout the session.

Effective remote instruction relies on weekly synchronous meetings using platforms such as Zoom, Google Meet, Microsoft Teams, or Skype, combined with adherence to consistent schedules and teacher availability for both academic and emotional support [6]. Regular feedback is a fundamental component, serving multiple functions: it promotes students' psychological and pedagogical adaptation, addresses individual learning needs, and informs iterative improvements to course content and teaching methods.

Monitoring the quality of distance education requires the establishment of common standards, clear evaluation criteria, effective data collection instruments, and reflective mechanisms. Teachers often maintain near-continuous communication with students to organize learning activities, provide guidance, and adapt instructional strategies. While direct interaction facilitates the resolution of specific issues, it does not always provide a comprehensive view of student progress or course dynamics. Therefore, additional monitoring methods – such as surveys, tests, interviews, analysis of submitted assignments, and peer evaluations – are essential to ensure objective assessment and feedback.

Monitoring can be performed by instructors, independent observers, peers, or designated student groups. Effective monitoring tools should be concise, clear, reliable, timely, and appropriately challenging. Distance learning assessment typically occurs at multiple levels: c**urrent (formative) assessment:** tests, open-ended questions, diagnostic tasks, and activities using information sources to check comprehension. **Intermediate (summative) assessment:** mastery of tasks, problem-solving assignments, and project work that reflect application of knowledge. F**inal (comprehensive) assessment:** evaluation of overall task completion, final tests, project submissions, and cumulative achievement metrics.

For instance, a distance course in higher mathematics for Agricultural Engineering (specialty H7) integrates a variety of resources, including theoretical materials, external reference links, interactive elements such as forums, chats, quizzes,

structured workbooks, databases, and online lectures or seminars. The course is organized into modules covering core topics such as Linear and Vector Algebra, Complex Numbers, Analytic Geometry, Mathematical Analysis, Differential and Integral Calculus, Differential Equations, and Series, enabling students to study at their own pace while following a coherent structure.

The course employs a block-based design consisting of content, control and monitoring, and information and communication units. The **information and communication unit** manages the organization and flow of the course, providing access to presentations, curriculum details, methodological instructions, consultation schedules, and announcements. The **content block** delivers educational materials, while the **control and monitoring block** (implemented via Moodle or similar platforms) tracks student performance, facilitates assessment, and supports instructional adjustments.

This includes individual assignments, methodological instructions, and test packages for ongoing, modular, and final evaluations. Computer-based diagnostics allow systematic and individualized tracking of student progress across the entire curriculum.

The course portal provides an overview of the curriculum, access to discussion forums, program documentation, recommended literature, electronic resources, tables, and a glossary of key terms. Multimedia visualization – incorporating audio, video, and lecture presentations – enhances comprehension, reinforces knowledge acquisition, and develops student intuition and imagination. Interactive elements, such as hyperlinks, terminological dictionaries, and visual cues, support structured, branched learning paths, clarify complex topics, and approximate the benefits of face-to-face interaction. Furthermore, Moodle allows for animated mathematical models that visually illustrate challenging concepts, providing students with a more concrete understanding of abstract ideas and fostering active cognitive engagement.

In addition to supporting comprehension, this approach also cultivates important skills such as self-directed learning, time management, digital literacy, and problem-solving. By combining structured content delivery, interactive engagement, and

continuous monitoring, distance courses in higher mathematics not only maintain educational rigor but also encourage students to develop autonomy, critical thinking, and professional competencies essential for careers in Agricultural Engineering.

## 2.4 Independent Learning in a Distance Education Environment

The contributions of psychologists such as P. Anokhin, N. Bernstein, L. Vygotsky, V. Davydov, A. Leontiev, S. Rubinstein, and others have played a pivotal role in shaping the development of modern didactics, particularly in the context of work-oriented education. Their research laid the theoretical foundations for understanding the mechanisms of learning, the development of cognitive functions, and the role of active engagement in the educational process.

The theoretical substantiation of independent work, as well as methods for its organization and the cultivation of students' creative and critical thinking abilities, has also been extensively addressed by foreign scholars, including A. Tom, J. Liner, J. Litt, and others. In recent years, various dimensions of organizing students' independent work have been the focus of numerous scientific studies. Dissertation research has examined these issues across a range of disciplines, including pedagogy (V. Khrypun), philosophy and political science (O. Popovych), foreign languages (M. Smirnova), mathematics (N. Vanzha), legal studies (N. Shishkina), and social sciences (A. Tsyuprik). Such research has been instrumental in informing contemporary practices in higher education and has contributed significantly to fostering both educational and cognitive autonomy among students.

Despite a long-standing interest in the concept of "independent work of students," no universally accepted definition exists. Scholars employ the term in diverse contexts, including: the completion of tasks independently by students without direct teacher intervention; autonomous thinking and self-directed navigation of the educational material; extracurricular activities carried out independently by students.

The first interpretation has been endorsed by M. Kashin, K. Gomoyunov, V. Bogdanov, B. Esypov, N. Dairy, and R. Mickelson. K. Gomoyunov describes independent work as planned student activity conducted under the guidance of a

teacher yet without direct participation. R. Mickelson defines it as "the student's performance of tasks without assistance, yet under teacher supervision." M. Gelashvili frames independent work as a distinct form of learning organization, executed according to teacher-assigned tasks and requiring active mental engagement.

Within traditional educational models, independent work has also been associated with extracurricular activity (L. Golovko, S. Zinoviev, V. Lyaudis). L. Golovko emphasizes that independent work involves activity undertaken autonomously, without external assistance, during extracurricular periods. The conceptual essence of independent work has been further explored in the works of V. Buryak, B. Yesipov, I. Unt, I. Lerner, O. Nilson, P. Pidkasysty, M. Skatkin, B. Korotyaev, and others.

B. Yesipov and O. Nilsson highlight the external, organizational aspects of independent work as decisive, whereas V. Buryak and I. Unt stress the integration of both internal cognitive and external organizational dimensions. Scholars differ in their views on the organizational aspects of independent work, encompassing learning methods, educational resources, and forms of activity organization. For instance, V. Buryak, B. Yesipov, L. Zharova, and A. Usova conceptualize independent work as a learning method, while M. Gelashvili, T. Shamova, and Ya. Kamensky view it as a form of organizing educational activity. Others, such as M. Garunov, G. Gaponov, and P. Pidkasysty, regard independent work primarily as a tool for engaging students in autonomous cognitive activity. P. Pidkasysty asserts that "independent work is neither a form of organizing educational activities nor a learning method; it should be legitimately considered a means of fostering independent cognitive activity" [6].

V. Kozakov emphasizes independent work as autonomous learning outside the classroom, with the primary goal of cultivating student independence. Conceptualizing independent work as self-directed activity allows it to be understood not merely as a didactic tool but as a structured system of actions performed independently by the student with specific tasks under suitable conditions. These conditions and tasks facilitate dynamic interaction between the student and their environment, promoting the development of independence as a key personal trait.

Analysis of scholarly sources demonstrates that the concept of independent work has retained relevance across different stages of higher education development. In early stages, independent work was regarded as an important, though limited, form of educational organization, with relatively few hours assigned. Contemporary educational standards, particularly in correspondence and distance learning, recognize independent work as a primary form of student activity and a central method for engaging with educational content.

In the context of distance learning, students' independent work can be defined as a purposeful set of actions carried out under teacher guidance, supported by rational information resources and a coordinated system of organizational, technical, software, and methodological measures. This work occurs at two levels: teacher-directed independent work and actual independent work, sometimes referred to as students' extracurricular activity.

Under distance learning conditions, independent work assumes a central role in the formation of autonomous, self-regulated learners. Unlike traditional systems, where the teacher primarily selects study topics, organizes learning resources, and monitors outcomes, distance learning places greater responsibility on students to engage actively with the material. Personality development and independence are no longer secondary; they are essential outcomes of the educational process.

Independent work in distance learning differs fundamentally from traditional independent work. It is not simply a form of learning or a type of educational activity; it becomes the principal mode of engagement with educational content and a method of study, particularly in correspondence and online learning environments. This requires students to possess not only proficiency in information and communication technologies but also advanced skills in self-directed cognitive activity, problem-solving, and critical thinking. Moreover, the integration of interactive digital resources, adaptive learning platforms, and individualized feedback mechanisms enhances the effectiveness of independent work and promotes lifelong learning skills.

Overall, independent work under distance learning conditions represents a dynamic and multifaceted approach to student engagement, emphasizing autonomy,

responsibility, and active cognitive participation. Its successful implementation depends on the careful alignment of pedagogical strategies, technological infrastructure, and continuous teacher guidance to create an environment conducive to meaningful, self-directed learning.

## 2.5 Practices in Organizing Independent Work of Students in Higher Mathematics

The organization of students' independent work within an information and educational environment is highly relevant under modern conditions. At agricultural universities, higher mathematics serves as a core discipline, forming the foundation for professional training and providing the mathematical tools necessary for studying specialized subjects. Mathematics as a discipline offers significant opportunities for implementing distance learning because information technologies enhance the applied and practical orientation of the course while enabling individualized approaches at a qualitatively new level. Consequently, students must not only possess strong theoretical knowledge but also apply it effectively to solve specific applied problems. In coordination with the graduating departments, the sections of higher mathematics that are most essential for each specialty and which students must master thoroughly are carefully selected.

In recent years, the transition to a four-year bachelor's program has led to the introduction of new curricula at agricultural universities, accompanied by a notable reduction in higher mathematics hours. Previously, to achieve the goal of visually and practically applying mathematical tools to professional tasks, students were given calculation tasks individually, which they completed and defended.

Teaching higher mathematics in agricultural universities has specific characteristics. In distance learning, independent student work assumes critical importance. During traditional lessons, students receive information through visual, auditory, and kinesthetic channels. In distance learning, students can selectively engage these channels, studying the material later in a manner convenient for them. Both positive and negative outcomes are possible. Ideally, students study posted materials

at their own pace – for example, revisiting specific moments in a video lecture or breaking down presentations to avoid fatigue and ensure maximum comprehension. Text or interactive materials can similarly be studied gradually, with students passing control points at a comfortable speed. However, this ideal scenario depends on the student's interest, motivation, and organizational skills.

Several factors often prevent optimal outcomes. First, the sheer volume of independent work, common across disciplines, can overwhelm students, making it difficult to prioritize tasks. Many students tend to complete assignments at the last minute, which hinders long-term assimilation of mathematical concepts. Mathematical disciplines, especially specialized ones, demand highly developed mathematical thinking; last-minute work based on rote actions rarely fosters deep understanding. Moreover, under time pressure, even simple tasks may be insufficient for forming basic skills.

Second, independent work and assessment materials are often inadequately adapted for remote learning. Students may access ready-made answers or rely on others who have completed tests, making evaluations less reflective of actual knowledge. Consequently, assessments may measure students' ability to quickly find information rather than their understanding of mathematics. Additionally, not all students aim for genuine learning; some prioritize merely passing. In agricultural universities, some students enter via "reserve options," without meeting required entry scores for their chosen program, leading to low motivation. From the first lessons in higher mathematics, instructors face the challenge of motivating students to engage with the discipline.

Cognitive interest is vital for effective learning. Self-study materials should be varied and presented in multiple formats: interactive manuals suitable for distance learning but also printable for students who prefer paper, video lectures, problem-solving analyses, proofs of theorems, and practical applications of the material in various fields. This approach caters to both students who prefer concise material and those who require additional information to enhance understanding and engagement, allowing each to select the most suitable learning channel or combine them.

The methodological system of distance learning in higher mathematics is an independent, open, branched system that, in interaction with the informational and educational environment, ensures the achievement of both standardized and individualized goals. Randomized generation of numerical data in typical tasks is an effective means of individualizing assignments, enabling each student to receive unique problems. Generating "appropriate" numerical data – for example, integers with no more than two digits, decimal numbers with limited precision, or fractions with numerators and denominators under two digits – facilitates problem-solving and verification. At our university, an interactive module with this functionality has been successfully used for several years to support independent student work in distance learning. Many modern learning platforms, however, lack this feature, as tasks may become obsolete after a single completion, and repeated attempts can no longer objectively reflect students' knowledge.

We recommend maintaining part of independent work in handwritten form, later scanned or photographed, or as legible digital records. For problems involving complex formulas and calculations, this method is sufficient, akin to open-ended exam responses. Strict requirements for typed submissions are unnecessary; the key criterion is mathematical correctness and legibility.

Another effective approach is dividing assignments into parts with distinct submission deadlines. This method helps first-year students structure their work, develop independent learning skills, and manage their time efficiently. Our experience shows that first-year students often struggle to organize their independent work in higher mathematics.

Control of learning in distance higher mathematics can be carried out using various tools: written surveys in synchronous mode; tests assessing comprehension of each educational element online; independent work complementing tests to assess application of mathematical concepts; homework tailored to specific learning objectives; standard calculations to verify skill mastery; control papers for comprehensive assessment of knowledge.

According to Ukrainian educational standards, integrating distance learning technologies creates an informational educational environment that fosters mathematical abilities and aligns with modern pedagogical principles. Regular use of remote technologies ensures the development of appropriate competencies and universal educational skills.

The primary goal of distance learning is to enable students to study independently without attending in-person classes. This requires developing complex training and assessment programs, which are resource-intensive. Knowledge is typically assessed through tests completed without teacher supervision. While theoretically effective, practical experience reveals challenges.

At Vinnytsia National Agrarian University (VNAU), guided independent work in higher mathematics was organized using key course sections, addressing departmental needs and improving student outcomes. Calculation and graphic tasks (RGZ) were developed – individual assignments completed independently and defended with a teacher during practical classes, effectively serving as an exam prerequisite. For first-year students in the first semester, distance learning materials were created and placed in the Socrates system across sections such as “Linear Algebra”, “Vector Algebra”, “Analytical Geometry”, “Derivative and Its Applications” and “Functions of One and Several Variables”. Students accessed this system conveniently, while teachers coordinated with methodologists and system administrators via a virtual office containing interactive tools and information resources for lectures and practical sessions.

The platform supports many distance learning elements, enabling both online and offline guidance, individual and group activities, and comprehensive evaluation based on personal abilities, thereby fostering student success. Teachers provide all necessary auxiliary materials, including manuals, lecture notes, presentations, and methodological recommendations. Theoretical materials are accompanied by problem-solving examples and control tests to ensure a structured and comprehensive learning process. For Agroengineering students, these resources were specifically

recommended for independent study to strengthen their understanding of applied mathematical concepts relevant to their field.

During the second semester, the **RGZ (course project)** assignments focused on the topics *"Indefinite and Definite Integrals", "Differential Equations",* and *"Series".* The materials were complemented by workbooks containing theoretical questions and individualized tasks with designated spaces for detailed written solutions. Thirty distinct task versions were developed to ensure equivalence in complexity and fairness in assessment. Students submitted their completed assignments in digital format, and errors or misunderstandings were discussed during follow-up consultations or practical sessions. Successful completion of these assignments led to an oral defense of the RGZ, confirming that students had acquired genuine problem-solving skills rather than relying on memorization or external assistance. The emphasis on the correct mathematical interpretation of solutions significantly reduced opportunities for academic dishonesty, while cognitive activity and analytical thinking were continuously reinforced during lectures and practical classes.

Although the RGZ framework and supporting materials facilitated independent learning, the results of final control tests revealed several limitations of purely distance-based instruction. The most common challenges included the potential for plagiarism, excessive dependence on external digital resources, and reduced authenticity of individual student performance. These findings suggest that effective remote teaching, especially under crisis conditions, remains possible but requires substantial effort from both instructors and learners. It also necessitates the availability of **high-quality technical infrastructure**, stable communication channels, and, ideally, initial **face-to-face interaction** between teachers and students to establish trust and academic integrity.

To achieve sustainable results, materials designed for distance learning in **agricultural mathematics** should meet several essential criteria:

- they must **adapt easily** to both traditional and distance learning formats;
- they should provide **sufficient interactivity**, allowing students to engage with dynamic content rather than static text;

- and they need to be **highly individualized**, particularly in the design of tests, control tasks, and analytical exercises, to reflect students' diverse levels of preparation and learning pace.

Furthermore, the integration of **advanced platform functionalities** – though not yet universally available—could significantly improve the quality of independent work and assessment. Examples of such functions include automated generation of numerical data, the creation of randomized task variants from an extensive task bank, and systems capable of **automatic recognition and partial evaluation of handwritten mathematical text**. The introduction of these tools would not only enhance academic integrity but also streamline the feedback process, allowing instructors to focus more on the conceptual understanding and less on repetitive grading tasks.

In the broader context, the ongoing refinement of digital learning environments in technical and agricultural education offers a valuable opportunity to combine **technological innovation with pedagogical insight**. By doing so, institutions can ensure that distance education not only compensates for emergency situations but also evolves into a complementary and sustainable component of modern higher education.

## Conclusions

The implementation of distance learning as the primary mode of education during martial law has revealed both its strengths and limitations to students, teachers, and the broader public. Despite its novelty and unfamiliarity for the majority of participants, distance education has generally proven to be an effective substitute for traditional face-to-face learning in higher education. In our assessment, while distance learning will likely never completely replace conventional classroom instruction, its advantages should continue to be integrated into traditional education models, given its demonstrated pedagogical value. In particular, distance learning has facilitated: The systematic organization of group work and independent tasks, enabling the creation of both general and individualized feedback, as well as the synthesis and summarization of results; extensive use of multimedia resources, which enhance student engagement and comprehension; the ability to conduct certain classes and consultations from home,

offering increased convenience and flexibility; a streamlined system for evaluating and summarizing the progress and achievements of each student; a more flexible, personalized approach to education, taking into account the unique needs and learning styles of individual students.

However, the experience of the past months has also highlighted significant challenges. Many educational institutions were unprepared for large-scale distance learning, revealing the absence of a unified, systematic approach to technical and educational support. There is a notable shortage of electronic textbooks and teaching materials, limitations within educational platforms, and a lack of sufficient training for many instructors, many of whom are unfamiliar with remote teaching methodologies and struggle to effectively deliver content online.

This situation underscores the urgent need for the development of national standards for distance education. Such standards should include the creation of a unified informational and educational environment to support the functioning and continuous improvement of the distance learning system. While these standards should provide a coherent framework applicable to all institutions, they must also be flexible enough to allow educators to adopt innovative, creative approaches in their teaching practice.

It is also essential for institutions to establish specialized units – such as electronic educational centers – responsible for organizing the distribution of learning materials, monitoring the activities of both students and teachers, and managing educational resources through effective software and digital tools. These units should reduce the administrative burden on individual teachers, prevent the mere imitation of educational processes, and eliminate excessive reporting requirements. Ensuring access to reliable technology and the Internet for students in remote or under-resourced areas, as well as equitable access to educational resources for all teachers, is crucial for fostering inclusivity and equal opportunity in the educational process.

The practical application of distance learning has challenged several assumptions commonly held in theoretical research. For example, the notion that distance learning reduces the teacher’s workload has proven to be incorrect. Even after

the adaptation of materials to digital formats, the preparation, organization, and management of distance courses demand significantly more time and effort, which largely falls on the instructor. Similarly, the idea that one teacher can manage large student groups remotely has not been substantiated in practice. Effective distance learning, particularly for interactive and problem-solving sessions, is best conducted with small groups of 4-6 students to ensure meaningful interaction, timely feedback, and clarification of complex points.

Moreover, the creation, updating, and adaptation of educational materials for online instruction require continuous effort, which will only intensify if institutions aim to remain competitive in the global education landscape. The implementation of distance learning has also shown that significant capital investment is needed, alongside targeted professional development programs, to prepare and retrain educators for new teaching conditions and to develop digital competencies essential for effective instruction.

Overall, the experience of deploying distance education during crisis conditions has underscored both its potential and its limitations. While distance learning can maintain the continuity of education in extraordinary circumstances, its success depends on strategic planning, adequate technical infrastructure, comprehensive teacher training, and thoughtful adaptation of learning materials. Moving forward, a blended learning approach – integrating the advantages of both traditional and digital education – appears to be the most effective strategy for fostering a flexible, individualized, and high-quality educational environment that meets the diverse needs of students.

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