

## О ВОЗМОЖНОСТЯХ ИЗУЧЕНИЯ МАТЕМАТИКИ В ФОРМАТЕ ДИСТАНЦИОННОГО ОБУЧЕНИЯ

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***Аннотация.** В статье рассматриваются аспекты организации учебного процесса при обучении математике в Белорусском государственном технологическом университете. Описаны трудности, возникающие при внедрении онлайн-обучения. Рассматриваются подходы к разрешению подобных трудностей с целью сохранения и повышения качества образования. В качестве методов исследования использованы результаты анкетирования, проведенного среди студентов Белорусского государственного технологического университета. Информационные технологии необходимы и важны в обучении математике, но оптимальным для обеспечения качества математического образования в современных условиях является сочетание классических подходов к обучению с использованием информационно-коммуникационных технологий. Отмечается необходимость использования информационных технологий для развития самообразования.*

***Ключевые слова:** дистанционное обучение, информатизация, самообразование, классический подход в образовании, Moodle, Microsoft Teams*

## ABOUT TRUE OPPORTUNITIES OF STUDYING MATHEMATICS USING DISTANCE LEARNING

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***Abstract.** The article deals with the aspects of organization of the educational process in teaching mathematics at Belarusian State Technological University. The difficulties arising from the implementation of online learning are described. The approaches to resolving such hardships in order to maintain and improve the quality of education are considered. The research methods use the results of a survey conducted among students of the Belarusian State Technological University. Information technologies are necessary and important in teaching mathematics, but optimal for ensuring the quality of mathematical education in modern conditions is a combination of classical approaches to teaching using information and communication technologies. The necessity of information technologies for the development of self-education is noted.*

***Keywords:** distance learning, informatization, self-education, classical approach in education, Moodle, Microsoft Teams.*

Teaching mathematics one of the core disciplines of a fundamental engineering education in the 21st century [1,2,3] has been significantly undermined recently in both Belarus, and Russian Federation [4]. It all begins in mid and high schools where a metric's centric approach dominates, paired with an overwhelming amount of paperwork required from teachers. The above leads to students lacking understanding of basic mathematics concepts and mathematics objects operations. Unfortunately, virtually none of the school's systems consider theorems, proofs and logical reasoning in senior high nowadays, despite those being at the core of understanding the essence of mathematical methods, playing a formative role in logical thinking. Geometric construction problems which would develop spatial thinking and reasoning – all of those have virtually disappeared from a highschool mathematics curriculum. In recent times, one is focused on learning the approaches to solving standard problems for passing tests only. That borders on developing the ability to blind-guess an answer. No effort spent on understanding how the problem can be defined, the skill which may prove to be harder to master than actually solving a given problem. The tendency to reduce high school students' load and simplify their curriculum leads to a gap between their knowledge of theory and what is required for mastering university level curriculum. As a result, some students see no relevance of mathematical knowledge in solving their future professional lives problems.

The contemporary development stage of a university level education is characterized by an increased level of teachers' creativity. Perpetually, a colleague's education has been distinguished by its methodology along with a certain degree of student's self-study. The aim of the educational process has always been in development of students' ability of a continuous self-education, striving to replenish and improve their level of knowledge.

Belarusian State Technological University (BSTU) experience in setting up educational processes in mathematics shows that the level's approach is effective in increasing mathematical education quality leading to a formation of student's research skills. The main purpose of the approach is:

- supporting students' self-study efforts;
- nurturing students' genuine interest to acquiring new knowledge;
- supporting students through hardships in studies;
- accelerating first-year students' adaptation to the university study environment.

2020 brought certain adjustments to the education methodology. A demand for information and communication technologies (ICT) has strongly increased in the educational process as a whole. The above is explained by certain complications in applying more traditional classroom led teaching. Over the past year, most of the

educators have faced a transition to remote teaching, caused by the COVID19 global pandemic. A variety of platforms as well as other colleagues' experiences from different countries have been instrumental in the process. For example, in Poland, all of the study materials are posted at universities portals. Czech Republic features online classes offering students to draft essays on various subjects interactively.

Evidently, principles of remote education have been applied first in the 18th century, long before the emergence of the Internet. The methods of organizational approaches have been changed over time. Today, such a form of education resolves an issue of significant physical distance between a teacher and a student using ICT. Since television systems have become widespread, certain colleagues in the US have been using TV sets for delivering lectures and other study materials. Some proponents of such approach were of the opinion that television would replace both lectures and practical lab exercise in the near future. However, before long that has become clear that such theoretical constructions were quite far from reality. Ideally, each student would receive in advance a set of lecture notes electronically or in hardcopies. Such practice would allow for more attention to be paid during a lecture broadcast session, when the subject would be delivered in a structured and concise manner using presentations, and explaining complicated parts.

Thanks to IT, it is possible to deliver larger volumes of material, highlighting and explaining the core ideas of the lecture, giving the main principles and approaches, offering material for self-study using supplementary materials. Such way of delivering lectures animates a great deal of educational process, making it more dynamic and diverse. At the same time, the most significant challenge, especially in teaching mathematics remains to be an issue of a sufficiently good understanding of material presented, a development of the right techniques enabling the application of the given material in solving practical problems, using mathematical models for the courses of engineering disciplines.

A dominant approach in teaching shifts from offline teaching through lectures and on premise labs to courses delivered through online platform like LMS Moodle, Microsoft Teams, Zoom, etc., coupled with student's self-study, mastering material individually. The above puts stronger focus on preparation of various materials for distance learning by the faculty staff whilst delivering remote studies at the same time. Such rapid onset of the pandemic in 2020 left no time for a detailed examination of any given online platform. Educators are facing a multitude of questions, including amongst others – how to build a distance learning system, how to control the process, how to ensure the assumption of educational material by quarantined students, etc. The most urgent questions remain as actual as ever: "What do we teach?", "How do we teach?" and "What do we get as a result?"

The most important precursors for a high-quality online education are the material, technical support of the educational process and finally – the availability of broadband Internet connection. Despite the fact that about 70% of the students surveyed (155 students of the Department of Organic Substances Technology participated) have their personal laptops – an absolute majority prefer their smartphones when dealing with online study platforms. A notable portion of the users experience different technical issues in the process, such as Internet connection stability, sound quality and lack of support for educational platforms.

The remote learning system of BSTU based on LMS Moodle has been in use since for more than one year by now. During the initial stage of its implementation in the educational process, it has presented a set of new opportunities in supporting traditional education, combining a full-time study with distance-based lessons taught remotely, motivating students further. Online versions for a variety of courses were developed with the respective their materials published within the remote learning system of BSTU. A set of interactive capabilities of the system were used, however, only a fraction of students has ever benefited from accessing those materials [3].

The transition from a traditional lecturing process to an online format required both time as well as a certain upskilling in use of technology. Originally, lecture scripts for each stream were stored publicly accessible within the Moodle system. In the course of a scheduled lesson, the teacher would hold a chat session, having previously shared a list of questions using elements of the teleconference. Unfortunately, the approach described did not support material to be comprehend well. Availability of various materials on the Internet for retrieving correct answers did not imply that finding such answers would lead to better understanding of a lecture. Information obtained via open Internet search proves to be volatile and does not commit to memory well. With time, lectures moved to be held in an almost traditional format: a videoconference mode using Moodle or Microsoft Teams, the lecturer would present new material, ask questions, support a chat session, while the questions from the audience would remain open. When surveyed over the most appropriate mode of presentation – 54% of the students preferred Microsoft Teams – online. The students have attributed the following to the advantages of such modus operandi:

- flexible choice of student venue (dormitories, home, classroom, etc.);
- no travel time;
- flexibility in study time.

The list of drawbacks was as follows:

–teachers have no control over the process, some students would not bother with taking notes.

–lack of student’s motivation –the atmosphere outside of the lecture hall would not support the student spirit (ex: in the dormitories)

–when online and offline modes were mixed, some of the lectures were skipped all together.

Labs and practical classes were held as usual for a portion of students. Others were receiving assignments through a distance learning system. The results and solutions to the assignments were expected to be submitted in time as a MS Word or picture (JPG) format. The lecturers and especially the assistants had excessive load in validating submissions. One may have had their own comments which needed to be added to the student’s submissions and sent back to the students.

With regards to epidemiological quarantine restrictions, in the course of the second half of the semester, only part of the practical classes was held online with tests, examination and laboratory studies were held at University premises. It has become clear that conducting 3-4 consequent lectures behind the screen was a challenge for both the teachers as well as students. The lecturers of the department lead online training in the form of conferences in the remote learning system of BSTU, as well as by means of Microsoft Teams and Zoom. Those platforms support video and audio communication, screen sharing (the entire desktop or one application), the use of a virtual whiteboard (Teams, Zoom), video recording. Before and/or after practical classes, the teachers would always leave some time for an open dialogue with students discussing any difficulties steaming from the new form of education. It is worth noting that those self-motivated portions of students persistently mastered the material given, and generally coping with the task, despite the objective hardships. Unfortunately, for many a lack of live, practical classes led to significant difficulties in solving problems, hampering their skills of reasoning logically.

Answering the questionnaire over the preferences for following practical classes 80% of respondents claim that nothing could replace "live" communication with a teacher. Platform-wise – Microsoft Teams and Zoom were the choice of 88% recorded responses.

Intermediate control of the assimilation of knowledge (on the topics of the course) was carried out in the classroom, mainly in the form of control works. Written form was recommended for examinations to comply with epidemiological requirements. That has required teachers to consider examination tickets content carefully. To assess the level of knowledge objectively, the tasks must be recognizable and assume certain independent cognitive inferences. Every teacher has generated significant additional experience in the course of the last examination session, which would come helpful in the future.

The following conclusions were drawn from such experience:

–a well-trained student with a high level of motivation manages to overcome hardships of remote form of education, demonstrating a good level of answers at exams. Clearly one has to do a lot of self-study. Such an educational mode prominence grows immensely. When arranged well, combined frequent interactions with a teacher (using both electronic form and a “live” approach), one can achieve a high degree of material comprehension;

–in the preparation phase, students' qualities like the ability and the desire for an independent processing and understanding the offered information come to fore. A pleasant "surprise" is observed during the exam – when the teacher wishes to tell a student "This is better than one could expect." It is worth mentioning that among such "average" students there are many who have reported sick for extended periods of time, undergone a quarantine and came out with a stronger desire to study, not weaker. The desire for self-development, learning "for oneself" is sometimes a much more motivating factor than others;

–those students with less prominent initial training, combined with a weaker level of communication with the rest of the group showed that the remote form of education is incompatible with their abilities, leading to a "failure" during the exams. Such a student cannot move forward in preparation and generally loses motivation. When identified on time, the teacher can try (given the student's initiative in place) to help in setting up their self-study, conducting a series of consultations in a traditional face to face format. When possible, such consultations should be carried out. A midterm control in classrooms is highly informative for that. Most students act engaged during remote classes, signifying their presence. The experience shows that this is only a visible side of their act. Truth is –the level of those students' knowledge is so low that the material is not comprehended at all, leading to the unsatisfactory results at exams.

Note that the remote form of conducting classes combined with a "live" format of consultations requires teacher's full potential in applying their methodological and technical skills, as well as their fitness level should be well up to scratch for the pressure and stress levels are significant.

What was shown by the use of distance learning? Yet again it has been vividly confirmed that the studies outcome depends on the student's desire and their ability to assume information more than on the forms of presentation of material. So long as one has the possibility to conduct classes in a traditional "live" format, it is paramount to lay down the foundation of self-education, independent study and time management with students. The skills of demonstrating initiative and taking independent decisions are significant to be promoted for student's further self-development. When remote (online) tutoring would be required, the teacher must use every opportunity helping students by providing them with the required support in

their study. Such cooperation strategy should aim to maintain and improve quality of education at times of challenging epidemiological periods.

Thus, when setting up online teaching, the following are considered as the primary tasks for teachers at this stage: teach (mentor) in the broad sense of this word [5]. Despite rapid Artificial Intelligence (AI) domain development, humans are to remain leading figures in the field of education, especially within the area of fundamental sciences.

A diligent student, the one interested in the quality of their education, and engaged in student research work –such student finds information technology as a necessary and practical support. Such students with their teachers' advice may research modern branches of applied mathematics using the Internet. Such branches could include number theory, optimization methods, the theory of Fourier series, the theory of elliptic curves and their applications in cryptography [6,7]. In such scenarios the teacher can, within the framework of distance communication, consider solutions received from a student as well as advice on their analysis and further research as well as explain new mathematical concepts. It is becoming obvious that the role of distance education will increase, especially in the context of the need to move toward continuous education. Having an ever-increasing flow of information, the education process should become an integral part of anyone's life. With the above it is instrumental for every individual to lay a solid foundation of knowledge first, providing an opportunity to replenish it in the system of lifelong education.

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