Distance teaching: opportunities, challenges and prospects

*Tatiana Belikova**, and *Tatiana Shkil*

Don State Technical University, 344000, Rostov-on-Don, Russian

Abstract. Russian universities were forced to switch to distance teaching format in the spring of 2020 because of the Covid-19 pandemic. Such way of teaching has become a specific testing ground for the development and testing the effectiveness of new information and digital interactive technologies and online teaching methods. Detailed descriptions of the methods and technologies for conducting all types of classes remotely in various disciplines are not freely accessible. Hence, the transition to distance teaching demanded from teachers to develop new methods and forms of teaching and to establish remote monitoring of knowledge acquisition by students. The purpose of the article is to analyze and summarize the results of approbation of methods to organize and to conduct all classes types and their monitoring in a distance teaching format in the discipline “Physics” at the Don State Technical University. The article contains general information and specific recommendations on the methodology for conducting and monitoring the level of mastering competencies by students. The results of the exams for intramural and extramural students confirmed the effectiveness of the methods used. The analysis of such experiences can contribute to creating the optimal online teaching methods.

1 Introduction

In July 2020, a decree “On the national development goals of the Russian Federation for the period up to 2030” was signed. According to this decree, one of the five goals is “Digital transformation”, which implies the achievement of “digital maturity” in the basic sectors of the economy and the social sphere, in particular, in education.

The forced transition of almost all educational institutions in Russia to distance teaching because of the Covid-19 pandemic convincingly demonstrated the urgent need for “digital transformation” in the education. Actually, the pandemic raised the demands for distance education and has been a catalyst for the development of online teaching.

In distance education, the teaching process is implemented using information and telecommunication networks, with indirect interaction between students and teachers. The distance education format assumes that all educational and methodological materials are prepared and digitized in advance, the courses are presented in the form of video materials and posted on the educational portal of the corresponding educational institution. Students can log in the portal and study these materials when it is convenient for them. They can

* Corresponding author: belikts@mail.ru

consult from the teachers and take a test (exam) at a time agreed in advance with the teacher in the form of online test or individual conversation.

Massive opened online courses (MOOCs) began to be actively introduced in the Western countries since around 2012, and somewhat later they started in a number of Russian universities. Open online courses seem to be the most common form of e-learning. They are one of the types of open educational resources. A number of studies consider the prospects and forecasts for the development of distance education [1], in particular, for advanced training or obtaining a second higher education [2]. Some researchers associate the online education with risks for the higher education system and the professional development of students [3]. In Russian universities the demand for online courses among teachers is greater than among students, and the number of studies on the MOOC market and the prospects for their implementation in the existing education system is relatively small [4, 5]. Another significant factor for that is the observed inconsistency in evaluating the results of similar testing tasks conducted by different MOOCs [6]. According to a number of foreign authors, the massive open online courses can be considered as an example of the introduction of digital technologies in education, since MOOCs enable universities to increase the number of students almost infinitely only through the use of digital technologies [7]. In some cases, different online courses complement the previously received basic education [8]. The use of open educational resources significantly reduces the cost of education [9]: for example, the cost of training for a bachelor's program based on mass open courses is less than the cost of regular intramural education by about 75% [10]. It makes possible to get such an education for almost everyone [11].

There is an opinion [12, 13] that it is necessary to change the entire system of higher education using MOOC platforms. However, it is necessary to take into account the possible risks for the mental and physical health of students, since there is a real relationship between the frequency of cases of mental disorders and the number of hours spent in front of a computer or TV [14]. Obviously, the online education system must take into account the existing physiological and psychometric factors of limiting the time of working with digital devices. Medical research and experiments are needed on the basis of medical universities and organizations interested in the introduction of digital technologies, in particular, telemedicine [15].

In the transition of Russian universities to distance teaching during the pandemic quarantine, the educational process was organized in online format based on various educational technologies and programs (Zoom tutorials, Google Classroom, Microsoft Times), which ensured the transfer of information and communication with students using the Internet. At the same time, all types of classes were conducted strictly according to the schedule, as would be during intramural education, and one of the priority goals was to ensure the quality of education when operating via the remote format.

In the spring of 2020, the Ministry of Science and Higher Education of the Russian Federation published the report "Lessons from the 'stress test' of a university in the context of a pandemic and after it. 10 theses from the university rectors analytical report on the results of the first months of the spread of Covid-19 in the Russian Federation". The report draws rather harsh conclusions about the "confusion of universities in the face of new challenges" and the lack of online teaching skills and the willingness to learn them among the majority of the teaching staff. It was also noted that the greatest difficulties of remote (distance) teaching arose in such areas as the training of people in creative directions, doctors and engineers.

This situation is due to the following factors. The forced transition of intramural and extramural education to distance teaching, caused by the pandemic, had no analogues in the practice of higher education. The description of arrangements, methods and technologies of distance teaching in various disciplines, as well as methods of control during the lesson and

methods of students' knowledge checks are not in free access. The possible use of MOOCs (if they exist at all and correspond to the curriculum of the discipline) is ineffective, especially in the first years, and is unlikely. As a result, during the transition to the distance teaching format, the teachers required to develop new forms and methods of conducting classes, monitoring during classes and checking how the students perform self-study tasks, as well as ways to assess current, intermediate and final teaching outcomes objectively. They also needed stable skills in online teaching and remote information exchange, in working on large educational platforms, and in providing regular feedback to students.

The purpose of this study is to summarize and analyze the experience of conducting online all types of classes at the Don State Technical University (DSTU), as well as the results of approbation of the teaching methods and digital interactive technologies used. Such information should help to identify the best ways and methods of organizing and conducting classes for the natural science block of disciplines in the engineer training in distance format.

2 Methodology

It should be noted that in April 2020, the majority of Russian teachers had no experience in distance teaching at all. The transfer of all educational institutions of Russia to distance teaching in connection with the Covid-19 pandemic was a powerful incentive to master and develop new digital interactive methods and technologies. The distance teaching itself during this period was a kind of "testing ground" for the latest online methods and means of communication.

The authors thought it would be reasonable to identify the optimal methods and means of communication for distance teaching of the discipline "Physics" to university students. Since this area was poorly studied, it could be a search (or pilot) experiment.

At the preparatory stage of the experiment, in its diagnostic part, the problems of distance teaching of physics were identified. In the prognostic part, the purpose of the experiment and the criteria for evaluating the results obtained are determined. A theoretical concept was developed, according to which taking into account the new conditions of distance learning in connection with the Covid-19 pandemic required the development of new factors of a formative impact on students. On the basis of this concept, a program of a multifactor system pedagogical experiment was formed on the basis of an individual approach with elements of interactive learning.

The purpose of the experiment is to study the possibilities to use digital interactive technologies and teaching methods developed by the authors for distance learning of students in the discipline "Physics".

In the organizational part, the conditions necessary for the implementation of the developed program, associated with the development of appropriate methodological support and the preparation of video materials, were analyzed.

The practical stage of the experiment was performed in the course of all types of classes: lectures, laboratory and practical exercises. Formative factors of impact were the original developments of individual calculation and graphic tasks for solving problems, modified electronic lecture notes, which are different for different areas of education, videos of laboratory work performed and individual sets of experimental data for each of them, specialized problem books and teaching aids.

The experiment was carried out in two stages: in the period from 6.04.2020 to 30.06.2020 in accordance with the order of the rector of DSTU for the entire university and from 14.09.2020 to 19.03.2021 (the order was valid for a certain group of teachers).

The participants of the experiment consisted of first and second year students of intramural and extramural education of various faculties: Informatics and computer

engineering, Aircraft engineering, Industrial and civil engineering, Instrumentation and technical regulation. The total number of participants was 420 people.

At the summary stage of the experiment, the theoretical research methods were used: analysis, synthesis, comparison and interpretation.

When switching to the online format of learning, a detailed program for conducting all types of classes until the end of the semester was developed. It was posted on the websites of all student groups, and in this way each student was informed. This program was carried out directly in the course of classes and after classes. The program for each lesson contained a topic and plan, numbers of lab sessions and problems to be solved, links to all necessary information sources and tasks for self-study. In addition, educational and methodological materials developed at the department were posted on the websites of all student groups. They ensured the educational process completely and included electronic lecture notes, problem books, methodological manuals and forms to perform all laboratory work, as well as links to videos for laboratory studies.

The lectures aimed to provide students with systemic theoretical knowledge of the studied course were held on Zoom platform in the format of online conferences.

In online learning, it is most difficult to organize laboratory classes in such a way that all the set educational goals during the lesson are achieved. The authors used various methods and scenarios for conducting such sessions. On the basis of the recording studio of online courses of the DSTU and in the shooting pavilion (photo studio) of the information service of the DSTU, a video of a number of laboratory works was taken. The duration of a video of one work is 11-13 minutes; it demonstrates the teacher's performance with all the necessary comments. The results of the experiment are shown to the camera: for example, when determining the distance, a measuring scale with experimental markers is shown, a display of an electronic stopwatch when measuring time.

The class itself was conducted on the Zoom platform. The video was displayed on the screen, followed by a discussion of the video. Then the students entered the data of their version of the task into the form and proceeded to the calculations and registration of forms. To check the forms, the WhatsApp messenger was used in parallel. The errors detected during the check (as a rule, typical) were immediately discussed in Zoom with the whole group. The knowledge of the theory was tested either in the form of an oral individual quiz using any convenient service, or in the form of testing on the SKIF DSTU platform.

3 Results

A conclusion about the effectiveness of the selected online teaching methods based on the analysis of student ratings and the results of the spring exams in 2019/20 and autumn exams in 2019/20 academic years can be made as follows. The students who attended all classes online successfully passed the exams; the exam scores of the spring exams (see Fig. 1) in the overwhelming majority of cases corresponded to the results of the autumn exams of 2019/20 (i.e. for the same contingent of students, see Fig. 2); extramural students with whom classes were also conducted remotely showed similar results. The following figures 1 and 2 show the percentage of students who received "excellent" (5), "good" (4), "satisfactory" (3) and "unsatisfactory" (2) grades in the exams. Thus, the used methods made it possible to use the time allotted for conducting classes efficiently. They demonstrated their effectiveness and, according to surveys, turned out to be quite comfortable for students.

Fig. 1. Results of the spring exams in 2019/20.

Fig. 2. Results of the autumn exams in 2019/20.

The experience of teaching physics in a distance format accumulated in 2020 and 2021 allows to recommend to study lecture material on the basis of electronic lecture notes using presentations containing a minimum of textual material. As for the practical exercises on solving problems, it is recommended to use special problem books with examples of solutions to typical problems. The optimal way to conduct lab sessions is to use a kit with a video clip of laboratory work and the necessary methodological support.

As one of the ways to form students' scientific and methodological competence the virtual lab sessions can be also considered. A good stimulus for the development of creative thinking and the formation of skills in organizing students' research work can be properly built virtual experiments. All this inevitably leads to the development of the ability to predict various kinds of processes, which is of great importance in the professional activity of engineers.

The computational and graphic work become an effective type of independent work for students in practical classes. Their implementation required to solve a multi-stage problem, carry out calculations and build graphs of dependencies of physical quantities. The implementation of such works definitely motivates students to participate in research work, stimulates the development of their creative thinking, prepares them for the implementation of project assignments, term papers and theses.

4 Discussion

In a number of publications on modern trends in the digital transformation of higher education, there is a discussion about the effectiveness and feasibility of online education. But recent events, namely the transfer of universities to distance education because of the quarantine measures during a pandemic, showed that this form of education has proven its necessity and viability. But online education not only transforms the generally accepted teaching technologies, but also significantly changes the content of the teacher activity itself. A modern teacher should be an experienced teacher who has mastered modern educational technologies, and a specialist in his/her subject area. In addition, the teacher should be a skillful user of information systems and educational platforms, be able to embed online resources in the curricula of disciplines, and, if necessary, to solve organizational, technical, substantive and methodological problems arising from the use of such resources. The teacher must also be proficient in modern online assessment methods for current, intermediate and final certification.

Obviously, such an activity requires a lot of additional work and time for the development of electronic courses, methodological support for the organization of the educational process and productive feedback on the basis of educational platforms.

As many teachers say, the forms of learning and interaction in online learning do not contribute to the socialization of the individual, which radically changes the content of education. Education may lose some of its social functions, so e-courses should only serve as a supplement to traditional education. In some areas (medicine, engineering and natural science) purely online education is impossible.

Many problems arise when organizing control over the knowledge acquisition by students, that is, during the ongoing, intermediate and final assessments. Proctoring systems designed to identify a student's personality and ensure that he adheres to the rules for passing the exam are currently most in demand and are used mainly only in organizations developing online education at the federal level (for example, the National Platform for Open Education).

5 Conclusion

Compared to other forms of education, distance teaching is much more laborious, since it requires an extraordinary detailing of the organization of training sessions. What is usually negotiated and explained during the lesson directly in the classroom must be clearly and in detail described in advance on the subject's website. The load on the teacher increases many times, since to conduct an online lesson requires a long and thorough preparation: the development of presentations, videos, etc. A large amount of time is spent on checking individual tasks of various types.

Undoubtedly, for the entire educational system of Russia, the temporary transfer to distance teaching during the Covid-19 pandemic was a kind of test for the ability of educational institutions to use modern innovative technologies to organize and implement the educational process. At the same time, this was an incentive for their active development and identification of the possibilities of such technologies for reforming the education system. It is obvious that the introduction of interactive digital technologies will change the didactics - the science of forms, methods and means of teaching. But it will not eliminate the need to think, that is, to analyze, comprehend and critically evaluate the information received.

The current trend in the development of education in the context of digitalization, which is actually a gradual evolutionary introduction of digital interactive technologies at all levels and all spheres of education, can be considered an objective fact that is beyond doubt. Also, there is no doubt that it is too early to worry about the possibility of completely replacing traditional forms of education with online education. The Covid-19 pandemic has clearly

demonstrated the relevance and, in practice, the indispensability of online education in possible critical situations. Obviously, new educational platforms and resources will appear in the near future, however, many of them, like the existing ones, will not be able to satisfy the real needs of the educational system. This is due to the fact that in the overwhelming majority of cases, developers are only narrow specialists who are well versed in digital content creation, but they are not good in teaching methods and theory. This situation is likely to change to the better over time, and online education software products will improve and function more effectively, complementing and improving traditional education, taking into account the specifics of educational activities and target audiences. The expected “rollback” towards traditional education after the abolition of quarantine and restrictive measures will not change this trend.

However, it should be kept in mind that each university is not only a place for transferring certain knowledge to students, for the formation of the competencies and skills necessary for a future graduate, but also a place for the formation of a student as a social person, for which live communication with peers and teachers is necessary and indispensable.

According to Boris Ilyukhin, Director of the Center for Education Quality Assessment and Management Systems at the FIRO RANEP, “Knowledge and skills of the 21st century are not only information, but also motivation to obtain and understand it. In this regard, no educational technology can replace communication with a teacher, a mentor that is a person who transmits not only formal knowledge (this aspect is really losing weight in the modern world), but also mindset and attitude to life and people. Here the role of the teacher is invaluable”.

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