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Experience of Using Online Technologies in Transport Education

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ABSTRACT

The objective of this article is to identify pedagogical technologies traditionally used in full-time education, which found their place when educational formats changed in the era of digital transformation. The discussion concerns the project method, the case method, the analysis of the digital footprint, the use of game teaching methods, virtual laboratory work, various types of Internet testing, methods of collective search for a solution to the problem. The application of the considered methods in learning the Physics as a discipline at Moscow Automobile and Road Construction State Technical University (MADI) constituted the empirical basis of the study.

The design method turned to be the most effective and developed one. Its application made it possible to organise participation of students of 1–2 years of study in educational and research work under the guidance of lecturers who are related to physics and the chosen fields of training at MADI. It is shown that as a result, students acquire the skills to search and select the necessary information, learn to complete project work on time, prepare presentations, write scientific texts both for presenting them as oral reports and as texts of scientific articles. Possibilities of using electronic registers are described, in which both attendance at classes and performance of tasks are recorded, and the time factor (indication on whether the work was completed on time or was late) is considered. The article studies the use of a point-rating system to control current assignments, and also provides description of developments by the teaching staff of the department on organisation of an oral exam and test in physics in an online format.

Keywords: transport education, online education, digital educational platform, information technology, physics, experience, project method.

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BACKGROUND

The transition to the use of digital technologies in education is a process that fully reflects the modern trends in economics, particularly in transport. The topic is quite relevant and is of global character for the education. The Russia makes no exception. The adoption of digital technology for education has been discussed and prepared for several years.

Already in 2017, when adopting the Federal Law on Education in the Russian Federation as part of implementation of the National Education Project, the task was set to define such new professions for which knowledge of information technology is required. Obviously, such a task cannot be completed both without the use of information technologies in the course of training, either the knowledge of these technologies on the part of students. This is stipulated in the program on development of digital economy in the Russian Federation that «*...is aimed at creating conditions for development of a knowledge society in the Russian Federation, ... increasing awareness and digital literacy...*»[1].

Implementation of these regulations is impossible without increasing the level of digital knowledge among the population, the younger generation, graduates of secondary schools who after further study in higher schools or colleges become specialists. Accordingly, it became necessary to modernise educational programs at all levels of education and increase motivation of the population to master digital skills. Thus, having a legislative basis, since 2017, preparations have been under way for the transition of some of the educational processes to online forms. However, the thunder struck without warning: the coronavirus pandemic forced everyone to switch to the online educational process overnight, and this concerned each level from a comprehensive school, and colleges, to the universities.

This article was written after a rather long remote operation of the university. During this period, it was especially important not to lose students and their desire to learn, despite the new conditions.

The teachers have realised that distance education is a completely different technology. To master it, the very ideology of education should be changed. When the educational process takes place in a traditional format, the goals, forms, teaching methods are known in advance. In the distance mode, the teacher is faced with an abundance of electronic resources, on the one hand, and a lack of skills and methods of applying digital learning, on the other.

The *objective* of this article is to review the analysis of available pedagogical technologies that have been adapted for the online learning format. The empirical results obtained using these technologies at the Department of Physics of MADI both in full-time and online format prove their relevance and effectiveness.

MATERIALS AND METHODS

As it became clear from the results of the forced transition to distance learning mode, to improve its effectiveness, it is necessary to modernise the existing ones and to move to new pedagogical technologies. Methods of focusing and maintaining the attention of students in face-to-face classes are well known. These methods include a variety of problematic methods, including design method, modular method, case method, flip class methods, gamification, as well as methods of collective search for a solution, such as brainstorming. All these methods are used to one degree or another in the online learning format, and their effectiveness depends on all participants in the educational process. The method of project work and the case method can merge into one, the purpose of which is to awaken in students an interest not only in learning as such, but also in a creative way of studying sciences.

RESULTS

Some characteristics of the online learning format

Even before the COVID-19 attack, the market for annual online education services provided in the Russian Federation was estimated at 38,5 billion roubles. The forecast for the growth of this part of educational services was 12–15 % per year. It is clear that due to the coronavirus pandemic, the demand for online education services has skyrocketed – up to 100 % during self-isolation [1]. Time will show how long this demand will be at this level. However, we can already say that,

[1] Program «Digital Economy of the Russian Federation». Order of the Government of the Russian Federation dated July 28, 2017, No. 1632-r. [Electronic resource]: http://static.government.ru/media/files/9gFM4FHj4PsB79I5v7yLVuPgu4bvR7M0.pdf. Last accessed 24.11.2020.

having experienced difficulties in using online learning, which affected both students and teachers, there are still some positive changes. For example, freeing up time for study or work by reducing the time needed to move from home to work (this is mainly relevant for residents of large cities). For working students (students of correspondence learning departments, mastering new professions without interrupting their work [blended education], corporate training), the online format is already in demand and is widely used.

Of course, the online format does not allow to learn communication, teamwork skills, it cannot socialise students since this is obtained through face-to-face interaction in teacher-to-student and student-to-student format. But at the same time, skills of working with digital technologies that are important for a modern person and to which the future belongs are developing. Modern students and, even more so, schoolchildren represent a generation that was born with gadgets in their hands. The use of a variety of programs is most quickly mastered by young people, despite some «general illiteracy»: they can not speak, write correctly, count in their head or even sum up the figures using a column count, but quickly and decisively accept all online transitions.

Digital inequality

To successfully master the online format, at least four conditions must be met:

- Digital equality.
- Digital literacy.
- Modernisation of the educational process.
- Analysis of the digital footprint of students.

Digital inequality refers to the lack of access to modern information technologies, which may manifest itself depending on remoteness of the considered region of any country from the capitals, as well as due to social inequality of the population due to the difference in income [2]. Social stratification in the Russian Federation is quite high since the income of the rich is 16 times higher than the income of the poor. The speed of connection to the Internet and the cost of 1 GB differs sharply in the metropolitan regions and on the periphery [3].

Digital literacy

Besides access to the Internet, digital literacy is essential for successful use of information technology. A person with digital literacy has the skills and abilities to use various gadgets with all possible applications – social networks, email, Skype, WhatsApp, Telegram and others, owns understanding and adheres to digital ethics and safety on the Internet, has understanding of the digital footprint (shadow), about cyberbullying and combating it. According to the National Agency for Financial Research (NAFI), in the first quarter of 2020, only 27 % of Russians had a high level of digital literacy [4]. The digital literacy index calculated by NAFI considered five components:

- Information literacy.
- Communication literacy.
- Digital content creation.
- Digital security.
- Skills of solving problems in a digital environment.

This index was equal to 58 out of 100 points.

Digital literacy is a concern not only in Russia, but also in the world. In 2018, in the materials of the summit of the heads of developed countries, the stated list of the most important and becoming fundamental competences comprised digital competence, which includes digital literacy, i.e., confident, informed and responsible use and interaction with digital technologies for learning, working and participating in society[2].

Despite the not very high rates of digital literacy among the population of the Russian Federation in general, both students, and university teachers, and schoolteachers, and the schoolchildren themselves, being forced to switch to the online format of the educational process, nevertheless fit into this format of the educational process, which is new for all participants. Most universities in the Russian Federation were able to solve this difficult task in a very short time – to organize universal online education.

Pedagogical technologies

Design method

John Dewey wrote in 1899 about the need to realise the influence of rapid changes in the world to formalise the new requirements of

[2] The leaders of the G-20 adopted the final declaration following the summit in Buenos Aires // Vedomosti. December 2, 2018 [Electronic resource]: https://www.vedomosti.ru/politics/news/2018/12/01/788103-lideri-g20-deklaratsiyu-buenos-airese. Last accessed 24.11.2020.

society to the level of personality development [5]. He also suggested using the project method in teaching. In the 20s of 20th century, this method began to be used in the educational process as applied to school education. This method was actively developed by W. H. Kilpatrick [6] and colleagues. These teachers believed that the united work of students, caused by interest in the topic of the project, becomes not only part of independent work, but also, contributing to the emergence of new knowledge, develops the intellectual abilities of students.

In the wake of the work of D. Dewey and W. Kilpatrick, at the beginning of 20th century, this method was tried in the Soviet school [7]. It was believed that the joint work of students and a teacher with involvement of practical developments allows teachers and students to interact and communicate in a new way, which turns the school into a forge of «future builders of a new life». S. T. Shatskiy wrote that a close connection between the educational process and practical real work will instil the desire and ability to work [7]. They tried to provide this relationship both with study and project work in teams, in which sometimes one was responsible for all participants. However, the hypertrophied enthusiasm for project work with the refusal to study traditional disciplines led to a decrease in students' knowledge. Later, project work as a pedagogical technology was forgotten[3].

Currently, teachers have returned to the search for development of students' abilities through the use of the project method in both secondary and high school. Creative pedagogy has attracted the attention of many domestic teachers and researchers who have developed and continue to develop pedagogical technologies, and the philosophical understanding of this phenomenon, and the psychological aspects of creativity [8].

The design method summarises several important ways to get something new at once. As is well known, all the points of activity required for implementation of a project combine creative, analytical, information and communicative competences. Starting with the choice of a project topic, it is necessary to find, analyse and select the information you need. Then, develop a plan suitable for implementation of the project, considering the time required for each stage, distribute responsibilities between the participants (which gives the right to call the project work a kind of role-playing game), complete the project, take stock and analyse them. This type of educational process for junior university courses is possible only with the participation of a teacher. And we immediately recall the provisions of the pedagogical theory developed by S. T. Shatskiy: «*... the concept of a reasonable school can be as follows: a school is a place where the results of one's personal experience are processed, systematized and brought into connection with the results of someone else's. Thus, the possibility of lively and important mental activity is created, natural forces are developed and exercised*» [7, pp. 20–21].

Case method

This method involves the search for options for solving a problem situation, preferably a real one. Cases can be different in terms of problems and purpose. Among them, one can single out those that are important for the educational process: these are training and research cases. Both of them allow you to get and use the skills of searching and analysing information, options for solving a problem, evaluating the solution. Working through a case allows you to learn not only to hear a teammate, but also to listen to him, allows you to learn how to work in a team. With these characteristics, the case method is somewhat close to the design method [9]. The difference is that the design method is closer to doing real work, often ready for implementation, while the case method may contain educational problems, the solution of which is important for understanding a specific section of the discipline being studied.

The case method is implemented not only in written work, but also includes discussion of the proposed solutions by team members, which allows them to learn to formulate, express and defend their point of view. A correctly executed case allows you to feel responsibility for the decision made, for its implementation. All this, in general, increases motivation to study. The problems solved by

[3] By the decree of the Central Committee of the All-Union Communist Party of Bolsheviks on primary and secondary schools (Appendix No. 5 to clause 31 of pr. PB No. 58 of August 25, 1931), the project method was prohibited. [Electronic resource]: https://istmat.info/node/53561. Last accessed 24.11.2020.

the case method, ideally, should be a kind of puzzle, a situation with internal intrigue, and the solution should provide an opportunity for setting new tasks in the future.

Gamification

To create a learning game, you can use someone else's experience and repeat some techniques [10]. Most games include a tiered order with a bonus or some other benefit for the player who participates in the game and completes the task of the level. If the task is not completed, then the participant is again at the beginning of the unfulfilled level. And this happens at every level. During the game, skills are formed imperceptibly for the participant, and training takes place in the format chosen by the creator of the game. As a bonus, the participant can receive additional points, for example, during the game against the clock, if he met the scheduled time or completed the task ahead of schedule.

A participant in the game block, while completing tasks, simultaneously competes with other participants. The published results can reveal the rating of a given participant, which is an additional incentive to complete all tasks quickly and successfully. The Moodle platform allows you to identify such a rating within any assignment and contains various options for assessing knowledge: you can create any tests, conduct any polls, set the writing of an essay or review. For each task, you can set a time frame: days of the week or months for the task, as well as determine the time for completing each part of the task – in minutes or in some other way. The account of the execution time and the number of attempts can also be presented in the rating [11].

Analysis of the digital footprint of students

A digital footprint or shadow is the information that remains when using the Internet in any form: viewing materials, completing educational assignments, participating in social networks, both passive (viewing only) and active (posts and comments), as well as participation in interest groups and a choice of friends. As already discussed above, the Moodle platform allows you to use game methods, as well as to identify the digital footprint of students when completing assignments [11]. Completing assignments on the Microsoft Teams platform also allows you to analyse a student's digital footprint.

The digital footprint is the data of the rating system obtained from the results of the student's performance of tasks, as well as those additional actions of the student during training, which are reports and presentations at conferences or during implementation of course and diploma projects. Thus, a well-established system for recording and analysing a student's digital footprint can tell about his development, about his capabilities and actions during the educational process (and not only in his extra-curricular life). This system can help to find an individual trajectory for training of each given student, as well as prompt the teacher about the necessary changes in this curriculum and tasks to check its mastery.

Virtual laboratory

For more than a year, virtual laboratory work has been used in secondary schools, for example, «Virtual laboratory work in physics» by Project-Service and by Fascinating Reality. However, in connection with the transition to the online format of education, the question arose about virtual laboratory work in higher education. Teachers from different universities are involved in development of a virtual workshop [12; 13], but, unfortunately, the market economy dictates its own terms, and it is possible to use the developments of other universities only by concluding agreements with a certain payment. Therefore, many universities have to manage on their own. Perhaps this is a very good experience, but the training process does not always go quickly and without additional obstacles.

Experience of using online pedagogical technologies

Projects and cases

With the beginning of the distance learning format, the lecturers of the department of physics began to create online courses in physics, test assignments using digital platforms Microsoft Teams and Moodle, and create a virtual physics workshop. But it should be noted that many of the pedagogical technologies mentioned above were used in full-time education. The project method has been in demand when working with learners for many years. In the last five years alone, the department has completed more than 70 projects in physics, mainly by sophomore students, and 68 projects in the discipline «Physical foundations of microelectronics». Some of these projects can

today be equated to cases, moreover, to training cases, since they turned out to be complete in terms of presentation of the topic.

For example, projects related to real life in MADI: a study of illumination of corridors and classrooms, a study of the dependence of the amount of carbon dioxide in classrooms on the time of the lesson. The materials of the project for the study of errors of video cameras, speedometers and a navigator allow drivers to quickly orient themselves on the road, where, as you know, it is necessary to choose the right speed mode. The study of the effect of wheel balancing on vehicle handling is directly related to road safety. Traffic safety is also associated with projects to study recuperation of vehicle braking energy, to find physical methods of dealing with noise and vibration in a car, to experimentally compare the noise characteristics of a vehicle on studded and non-studded rubber, to practically study the formation of a profile of a «comb» type road surface, according to considering the effect of studded tires on road wear.

Research projects, which can be considered as cases too, represent the results of scientific work of students carried out under the guidance of teachers of the department, for example, «Study of microwave radiation and high-voltage electric arc in different ignition conditions», «Experimental determination of the physical and mechanical characteristics of a car» or «Study of the properties of dilatant fluids and their application in the development of artificial irregularities».

Projects in the discipline «Physical foundations of microelectronics» contained information on the methods of growing and subsequent processing of silicon monocrystals – the main material of microelectronics, on new developments of international corporations producing microelectronic products, on information storage devices, on photoelectric converters as a local power plant.

At the department of physics of MADI, the results of the project work of first- and second-year students are presented in the form of reports at the annual student scientific and methodological conference and in articles written jointly by teachers and students.

Students participate in international competitions of student projects:

• International competition of university groups Best University Group (Stage: specialty. Nomination: scientific work. Direction: physical and mathematical sciences. Form: report on research work).

• International competition of students and teachers of professional educational institutions Professional Stars (Stage: specialty. Nomination: scientific work. Direction: physical and mathematical sciences. Form of the competition project: report).

• International championship «Quality of education» (Stage: specialty. Nomination: scientific work. Direction: physical and mathematical sciences. Form of the competition project: report).

In all these competitions, MADI students won prizes with the presentation of certificates.

Based on the results of project activities for 2018–2020, teachers, together with university students, published more than 15 articles in

Automobile. Road. Infrastructure, the electronic journal of MADI and in other editions.

Game methods

The use of game techniques has found application in creation of an educational information system («IS-MADI physics»), due to which the student learns and at the same time performs tasks, participating in the rating system for assessing his knowledge. The information system is built like a multilevel game. Performing a low complexity level allows you to move to the next more difficult level, and so on, until the result is achieved – a solution to a problem of increased complexity. If during the passage of any level mistakes are made, then the program throws the student to a lower level, and he must pass this level again. A student can find all the necessary methodological materials for performing tasks in «IS-MADI Physics» in electronic form within this system itself – lectures, presentations of materials, reference tables [14].

Digital footprint analysis

During their work in the online format, teachers began to use the Internet more actively to analyse the effectiveness of students' academic work. On the Microsoft Teams platform, all the achievements of students are recorded in electronic journals, which are built considering the experience of long-term use of the point-rating system in full-time education [15].

The digital footprint of students' activity on the Microsoft Teams platform represents all students' answers to control questions in lectures, solving problems on the current material, tests, as well as the results of using IS-MADI Physics information system [16]. Undergraduate students, studying physics, undergo various types of Internet testing (from input to residual knowledge) using software created at MADI [17]. The digital footprint of students' activity on the Moodle platform presents test results in all areas of physics studied at MADI, as well as the results of assignments [18].

Laboratory workshop

One of the important parts of studying physics at a technical university is a laboratory workshop. During the transition to the online format, it was necessary to transfer the existing laboratory practice to the virtual execution mode. Currently, in the current sections of physics, the department is fully equipped with virtual laboratory works, which include methodological and video materials, as well as measurement results generated individually for each student. Work on creation of new laboratory work continues.

Exam online

The practice of conducting intermediate attestation of students in the form of a written exam in the context of online learning, which was used in full-time training, has become impossible. The need to control the student's behavior during the exam and the objectivity of assessing the competencies formed as a result of mastering the discipline led to the use of the oral form of examinations and tests. The oral format of the exam turned out to be truly oral: individual tickets were created, which contained questions and tasks that allowed assessing the level of development by various indicators – to know, to be able to, to own. The student received the exam ticket under the webcam, no more than five minutes were given to study the questions, and then the student began to answer. The results of distance exams have yet to be comprehended and the best methods for their implementation have to be developed. A simple comparison of the results of exams in full-time and distance forms showed that the number of unsatisfactory marks received by students is significantly less in the online format.

CONCLUSIONS

Despite the urgency and unexpectedness of introduction of the online format for students of all forms of education, the experience of teaching the physics discipline at the transport university has shown the possibilities of using well-known and regularly used methods in full-time format, as well as involving new methods and techniques in the educational process. Modern digital technologies make it possible to interest the remote student, to keep his attention, to motivate him to master the educational material. This is witnessed by very first research publications dedicated to the analysis of the results of the forced and accelerated transition to online learning (e.g., [19–22]. Online learning is a different process than traditional learning, but it can be rewarding and fun.

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