Motivation of technical university students to study physics and methods of teaching it in the context of a pandemic

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Abstract. The article deals with the current problems facing modern higher education related to the teaching of natural science disciplines in technical universities. The article analyzes the influence of students’ motivation, their interest in the educational process, and the reasons that affect the assimilation of the material. Ways to solve this issue in the context of a new coronavirus infection pandemic are proposed. The use of distance learning technologies allows you to solve some of the difficulties that have arisen.

1. Introduction
Currently, higher education is a continuous search for new forms of organization of educational process, which could provide a high level of learning, efficiency of learning, and the development of creative abilities of students, allowing to engage in research and project work. A number of articles offer flip training [1, 2], the essence of which is that the student studies theoretical material in advance before the laboratory session, looks at meek videos and presentations. And directly in the classroom, the material being studied is discussed, the student clarifies something for a more detailed study of the issue. And this method gives good results. Due to the fact that students are offered a fairly wide range of different teaching methods, the question arises with the assessment of the competencies acquired by the student, as well as the knowledge of students [3, 4]. students Often overestimate their capabilities. The authors of the articles [5, 6] suggest using neural networks for a fair assessment of knowledge.

In addition, the motivation of students and the goals they set for themselves while studying at the University play an important role. The teacher is only a conductor of knowledge, and the ability to perceive the material and the desire to learn depends on the student. The teaching staff of universities is constantly searching for methods of teaching natural science subjects [7]. Today, information and communication technologies that need to be used in the educational process compete with traditional methods of conducting classes and simply transmitting information. This became especially relevant at the time of the emergence of a new coronavirus infection COVID-19. University teachers faced the problem of conducting classes in a remote format. At the same time, teaching should remain at a decent level. Therefore, the article deals with very topical issues of higher education-motivation of students in the study of physics at a technical University and suggests one of the ways to solve this problem - the use of distance educational information technologies.


2. Motivating students to learn

All over the world, higher engineering education is being developed, which is aimed not only at teaching students knowledge in General and special disciplines, but also at forming their directed educational motivation. This paper examines the orientation and level of students’ academic motivation in the study of physics, which at the technical University is a universal language for modeling, describing and studying the subject world, phenomena and processes and forms the features of critical and abstract thinking of future engineers. Under the motivation to study a physics course for students of a technical University, we will understand internal motivation, in which the motive is the cognitive interest associated with this subject. Only in this case does the student's own activity take place as directly satisfying the cognitive need — the need for knowledge and understanding [8]. Due to the urgency of this problem, the purpose of our work was to identify the features of the manifestation of motivation of technical University students to acquire knowledge in the field of physics.

The study was attended by 2nd-year students of the faculty of industrial process automation of the Ufa state petroleum technological University of the Republic of Bashkortostan (a total of 168 respondents), who described their attitude to physics. In the course of the study, the following methods were tested: a questionnaire aimed at identifying the direction and level of development of internal motivation for educational activities in the study of physics (the method of T.D. Dubovitskaya); testing the level of knowledge in the discipline of physics; the t-student criterion; calculation of rank correlation [9]. The results obtained at the ascertaining stage of the study allowed us to conclude that there were no significant differences between the attitude to physics among students of different groups. The majority of students were characterized by a positive motivational attitude to study the discipline of physics both in the first and second years. According to students, the main motivators for studying physics are competent University teachers who present program material in an accessible form, use multimedia presentations, computer modeling and modern educational technologies. According to students, cognitive interest increases during laboratory classes in physics, where they can not only demonstrate the acquired knowledge, but also practically study virtual (simulated) pictures of the real process, physical phenomena and laws. Students highly appreciated the fact that when they use modeling of physical phenomena in practice, their interest in programming languages such as Pascal ABC, Basic and C++ increases.

To establish a link between students’ internal motivation to acquire knowledge in physics and their academic performance in this discipline, we used Spearman's rank correlation calculation. The correlation coefficient was 0.488164, which indicates an average relationship (from 0.32 to 0.68). The reliability of the obtained relationships is confirmed by the student's t-test, whose indicator was slightly less than 24 units, which suggests a high reliability of the results of our study (p<0.01). It was found that 62% of students with an average level and 19% with a high level of academic performance scored a large number of points that characterize the manifestation of positive motivation (7-8 points) to learn physics. Conversely, students who scored a number of points corresponding to a low level of motivation (4-6 points) had poor academic performance. This may be due to the fact that for these students, physics is of interest only in so far as it will be useful to them when studying other disciplines for which their internal motivation will be higher.

Research on the orientation of motivation allows us to state that most students’ internal motivation dominates the external one. This suggests that most students in the study of physics satisfy their cognitive needs, get an intellectual charge from the process of learning and realize their personal potential. The results of the study also showed that students of the faculty of industrial process automation have an average and high level of external motivation, which indicates that students are interested in getting a high amount of points for the semester, a good mark, passing a test or exam, and receiving an increased scholarship. Note that needs, including cognitive ones, arise in certain situations where the learning process and its organization play an important role.
3. Distance learning technologies in physics teaching
I think no one will argue that physics is the basis of all natural science disciplines, and is also the Foundation of modern scientific and technological progress. In this regard, students studying physics should clearly understand its role in science, technology, and production. The rapid development of computer technology and the continuous growth of its functionality provides ample opportunities for the use of computers and related software in all forms of the educational process. They can be used during lectures, laboratory and practical classes, when studying topics and completing tasks submitted for independent review, as well as for self-testing at home. The use of computer technologies has significantly expanded the possibilities of demonstrating a lecture experiment, allowing you to model various processes and phenomena that are technically very difficult or impossible to show during a lecture. Physics is an experimental science, so it is always taught, accompanied by a demonstration experiment. When giving lectures, you can use computer equipment with a multimedia projector and a demonstration screen, or an interactive whiteboard, which provides very wide opportunities for demonstrating the material being studied. Using a variety of illustrative materials, multimedia and interactive models allows you to raise the learning process to a new level. It should be noted that it is more interesting for modern students to perceive information at a new level, in this form, than in the form of outdated models or posters. Interactive elements of training programs allow you to move from passive learning to active independent modeling of phenomena and processes. Let's now consider some information and telecommunication technologies used in the process of teaching physics to University students.

3.1. Demonstration of virtual physics experiment
To implement this task, you must have one computer, a projector, and a screen, or an interactive whiteboard. The main advantage of this technology is that it allows you to virtually demonstrate any physical process or phenomenon visually and colorfully. In addition, students can perform a physical experiment themselves or watch it while sitting at home in front of a computer. For example, using the Open physics computer program created by Fizikon, you can demonstrate 25 models only in the sections "Mechanics" and "Molecular physics and thermodynamics".

Let's look at some examples. The model allows us to study Newton's second law by the example of the motion of two bodies connected by a weightless inextensible thread thrown over a light block. You can change the mass of bodies and the mass of the additional load $\Delta m$ and observe the accelerated movement of the system (figure 1).

![Figure 1. The model "Movement of bodies on a light block".](image-url)
The model is intended to illustrate the law of conservation of momentum on the example of jet motion. The movement of the rocket in free space is demonstrated. A graph of changes in the speed of the rocket over time is given. The relative velocity $u$ of gas outflow from the rocket is assumed to be set. By changing the mass of the $M_f$ fuel loaded into the rocket, you can observe the accelerated movement of the rocket until the fuel is completely burned out and its subsequent uniform movement. Try to determine in a computer experiment at what the minimum ratio of the initial and final mass of $M_0/M$ is for a single-stage rocket, it can reach the first space speed (at a given gas flow rate). You need to check the result using the Tsiolkovsky formula (figure 2).

The model illustrates Newton's third law by the example of the motion of connected bars under the gravity of one of them. The blocks are connected by a weightless, inextensible thread that is thrown over a light block. By changing the mass of the bars, you can observe the movement of the system with different accelerations. Pay attention to the forces applied to the bars. Make sure that the elastic forces acting on the bars from the thread side are the same in modulus and are directed in opposite directions: $F_{12} = -F_{21}$ (figure 3).

3.2. Virtual laboratory workshop
To conduct a virtual laboratory workshop, you must have a computer class and a computer program for conducting virtual classes (for example, the computer program "Open physics"). This type of activity is
extremely effective for the creative development of students, as the student performs tasks independently. The teacher only gives guidance and monitors the performance of the job.

The model allows us to study the law of interaction of point charges (Coulomb's law). The model clearly demonstrates the change in the forces of interacting charges depending on changes in their sign and magnitude. The magnitude and direction of the force vectors, the resulting force, and the distance between charges are shown. Based on the results of the experiment, the parameters of the electric field are calculated (figure 4).

The model is intended for studying the Carnot theorem (Carnot cycle). By changing the temperature or volume of the gas, we get the efficiency of the cycle, a graph of the dependence of gas pressure on its volume, and a diagram of changes in heat, work, and internal energy depending on changing parameters. Using the Clapeyron-Mendeleev equation, the number of moles of gas under the piston is calculated (figure 5).

For example, the physics section "Optics" studies the effect of diffraction on the resolution limit of a telescope lens. The model is a computer analog of the experiment of observing two close point sources using a small telescope. You can change the wavelength $\lambda$, the diameter $D$ of the open part of the lens (aperture), and the angular distance $\psi$ between two light sources. The computer reproduces on the screen the observed diffraction images of sources and the distribution of light intensity in the diffraction images (figure 6).

![Figure 5. The "Carnot Cycle" model.](image1)

Figure 5. The "Carnot Cycle" model.

![Figure 6. The model "Diffraction limit of resolution".](image2)

Figure 6. The model "Diffraction limit of resolution".

3.3. Computer testing

It should be noted that computer testing in the educational process in one form or another has been used for a long time. The use of computers makes the testing process so technologically advanced that it may become the main control element in the near future. Currently, the Ufa state petroleum technological University at the Department of" Physics "is actively used together with the traditional and this form of control of students' knowledge. The Department has developed a database consisting of tasks of different levels of complexity for all sections of the General physics course. Testing can be carried out as an admission to laboratory work, as a defense of work already done, for a test or exam. Tasks are made up either as a test or as a task where you need to enter the result of calculations. The number of tasks and their level of complexity is determined by the teacher who leads the discipline, depending on the goal. The advantage of using such a testing system is that students can take the test at any time and in any place during a certain day, get the result immediately, and evaluate their level of knowledge. Especially
the above-mentioned method of monitoring students' knowledge became relevant during the period of self-isolation, when teachers and students were deprived of direct communication.

Of course, a computer, tablet, interactive whiteboard will not solve all the problems of the educational process, they are only multifunctional technical tools that complement learning, and will not replace books. However, the use of remote information technologies in teaching physics at the University allows us to solve the following tasks more successfully: to develop students' imaginative thinking through the use of wide opportunities for presenting visual information; to motivate cognitive interest based on students' natural craving for computer technology.

4. Conclusion

Our study confirmed the effectiveness of the proposed methodology for diagnosing students' learning motivation, and the results obtained can be used to analyze the causes of failure in the discipline of physics, the direction of their cognitive interests, and when implementing a personal approach to individual planning of practical tasks and laboratory classes. In addition, along with a variety of technologies, forms and methods, as well as teaching methods, information and communication technologies in training allow you to achieve a positive result in teaching physics to students of technical universities. The use of remote educational technologies for conducting lectures, practical and laboratory classes during the pandemic allows you to maintain a decent level of teaching, and even increase it, attracting students to develop their creative potential, to engage in scientific and project activities, as well as to monitor the knowledge gained remotely.

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