Methodology for identifying the effective proportion of educational activities for the purpose of conducting distance learning without losing the quality of the educational process

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Abstract. The pandemic of the new coronavirus infection has significantly affected all areas of society in all countries of the world, the education sector is no exception. In view of the rapid spread of the growth of morbidity, many universities were forced to abandon the traditional educational model and switch to a remote mode of operation. However, such a transition raises a serious question about the quality of training of students. This paper analyzes the effectiveness of distance learning in one of the technical specialties of the Moscow Aviation Institute (National Research University). This analysis contains various statistical data. This study shows that although distance learning forms have a number of positive aspects, they also have a number of negative factors, in view of which a complete transition from the classical educational model to the distance form is impossible.

At the end of 2019, society faced a serious challenge that faced all spheres of life caused by COVID-19. In view of the intensive spread of the disease among various groups of the population, the main goals of the ministries of health in different countries of the world were to stop the increase in the incidence by limiting physical contact between people. So, many areas of business are faced with the need to carry out their activities online, education is no exception [1]. COVID-19 has brought significant changes to the way higher education institutions operate [2]. Also, when implementing distance learning forms, it is required to maintain the unchanged quality of the educational process, namely, to ensure the implementation of all the basic competencies that must be acquired by the student.

In the Russian system of higher education (Bachelor's, Specialist, Master's, Postgraduate, Doctorate) in various areas of training, a special set of competencies has been developed and monitored at the state level, which the student should acquire during the development of the educational program. These competencies, along with their development results, are spelled out in the Federal State Educational Standard [3], and the following groups of competencies are distinguished for the direction of training in the 24th group "Aviation":

- universal;
- general professional;
- professional;
- additional professional competencies.

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In turn, for each of the given groups of competencies, as well as for each competence, the results of their development are specifically presented, which can be divided into the following groups:

- to know;
- to be able;
- to have skills.

Schematically, these learning outcomes can be shown in figure 1.

The system of monitoring the activities of higher educational institutions adopted in the Russian Federation, as well as a number of standards developed for the implementation of educational activities, make it possible to make a fairly clear division of educational activities that pursue the achievement of various results of development. In the system of Russian higher education, the following forms of educational activity can be distinguished:

- lectures;
- practical classes;
- laboratory classes;
- student personnel scientific work;
- practice;
- state final certification.

Schematically, the above types of load can be represented on the diagram as follows (figure 2).

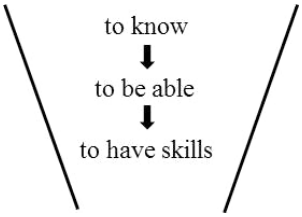

Figure 1. Learning outcomes

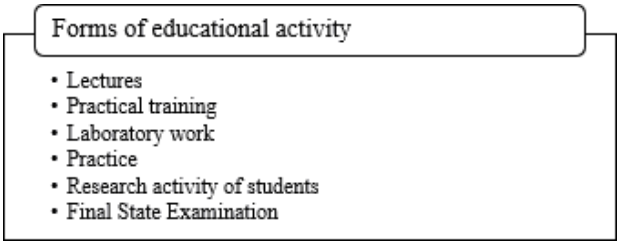

Figure 2. Forms of educational activity

Analysis of the effectiveness of the introduction of distance learning should not be attributed to the entire educational program as a whole; it is more correct to consider distance learning in the ability to achieve the required results of mastering each of the competencies presented.

This paper will consider the positive experience of introducing distance learning at the Moscow Aviation Institute.

Further consideration of the educational process will be based on the classification of competencies and the results of development, which were given earlier.

According to the legislation of the Russian Federation, the duration of the bachelor's educational program is 240 credits.

Structure of the Credit can be represented in formula (1)

$$\text{Credit} = T_{\text{classrom}} + T_{\text{student self}} = 36 \text{ hours}. \quad (1)$$

The structure of each credit unit within the framework of each specific course is a floating value, but with a sufficiently high accuracy it can be assumed that the number of credit points is divided equally between classroom and independent student work for 18 hours.

To assess the importance of taking certain measures, it is necessary to analyze in more detail the structure of the basic curriculum in the direction of "Aviation". So, according to this plan, 47.55% of the load is implemented in the format of lectures. The total number of classroom sessions is approximately 9000 hours. The remaining load can be divided as follows:

- 35% classroom load falls on practical classes;
- −7.45% of the classroom load falls on laboratory work.

Other types of load that are not taken into account in the classroom include:

- practices;
- final state certification.

Today, using modern digital platforms, it becomes possible to conduct lectures without losing quality. In order to improve the quality of the educational process, the lecture material can be recorded in advance, in which case the student will have the opportunity to view the material in good quality. The introduction of such activities can significantly reduce labor costs for the implementation of the educational process. The freed-up time of the teaching staff can be used to provide consulting support to students, as well as to modernize existing educational programs [4].

Modern educational platforms have a fairly wide functionality for conducting practical exercises of varying complexity and focus [5].

In the technical specialties of Russian higher education, the most popular types of practical training are:

- Project activities of students. Students are divided into groups of 3–7 people, assign roles in the team and solve a case. This form of the educational process has a beneficial effect on inter-student communication, which is especially urgently needed during physical restrictions on the interaction of students. Also, such type of educational activity allows to implement competitive model in the educational process [6].
- Another, no less popular format of practical training is the analysis of typical tasks, the purpose of which is to consolidate the theoretical material.

Both of these formats can be implemented online without loss of quality. However, despite all the advantages of distance learning, they have a number of undeniable disadvantages. It is impossible to carry out laboratory work with the help of only remote forms, since this format of conducting classes requires the availability and access to it of special equipment, which is located on the territory of the university.

Thus, based on the structure of a typical curriculum, approximately 83% of the classroom load can be carried out in a distance format.

It is necessary to analyze in more detail the structure of the remaining 17%, which are implemented in the form of laboratory work.

Laboratory work, depending on the nature of the subject and the competence acquired, can be one of the following types, shown in figure 3:

- Computational—graphic laboratory work. As part of the implementation of this type of laboratory work, the student, using modern software, learns to solve typical problems of programming and engineering. The difficulties of organizing this type of classes include the fact that, depending on the specific software manufacturer, it is not always possible to install software on a student's personal computer. However, most software vendors have student licenses. Another equally significant drawback is the fact that even with student software licenses, this imposes additional requirements on the technical capabilities of a student's personal computer.

- Technological laboratory work. This type of laboratory work is most common in disciplines that have the goal of studying technological processes and/or studying industrial equipment that is used in various enterprises.
- Laboratory work for the study of fundamental sciences. In the direction of training "Aviation", a fairly significant share of competencies is devoted to the study of general engineering subjects. These subjects include: physics, chemistry, resistance of materials, etc. These laboratory work should also take place in specialized classes, using the required equipment in compliance with all safety measures.

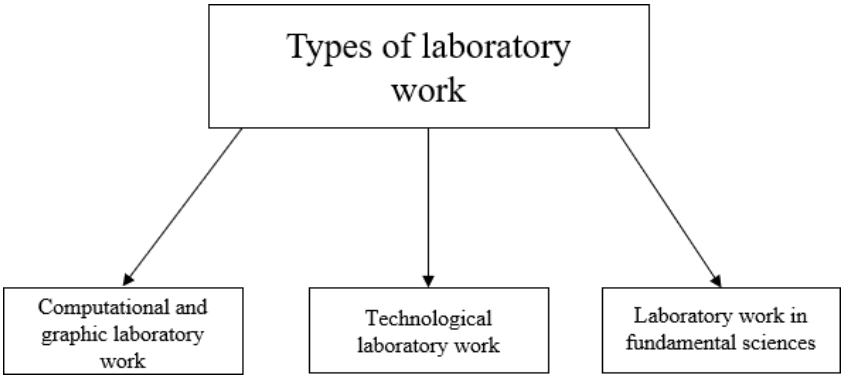

Figure 3. Types of laboratory work

As part of the implementation of the study under consideration, the percentage of laboratory work of the first type to all possible laboratory work is approximately 64%. Thus, 64% of 17% of implemented laboratory work can be carried out remotely

$$N_{\text{lab work dist}} = 0.64 \cdot 0.17 \cdot 100\% = 10\%. \tag{2}$$

Consequently,

$$N_{\text{dist}} = 83\% + 10\% = 93\%. \tag{3}$$

Thus, approximately 93% of educational events held at the Moscow Aviation Institute (National Research University) can be implemented remotely without losing the quality of the educational process. However, within the framework of this study, other factors that may affect the assimilation of certain competencies were not taken into account. One of the most significant factors is the ability of students to organize themselves. It turns out that 93% of educational activities do not entail a loss of quality for students who are conscientious about the educational process [7, 8].

Based on the structure of the basic curriculum and taking into account the total number of classroom sessions, it is not difficult to calculate the weighted average face-to-face load for students and faculty for laboratory work.

Thus, assuming that laboratory work is distributed evenly over the years of study, and also evenly distributed within each academic year, we get:

$$T_{\text{offline lab per week}} = \frac{9000 \cdot (1 - 0.93)}{4 \cdot 35} = 1.16 \text{ groups work/week}. \tag{4}$$

Where 35 is the average number of academic weeks per year, and 4 is the duration in years of the "Bachelor's" education program.

At the moment, the number of undergraduate students of the Moscow Aviation Institute is just over 10,000 students, and the average size of the study group is 12 people. Thus,

$$N_{\text{groups}} = \frac{10000}{12} = 833. \tag{5}$$

And the total load of the university for laboratory work is

$$T_{\text{offline lab}} = 833 \cdot 1.16 = 997 \text{ lab hours/week}. \tag{6}$$

With an average number of faculty members of the Moscow Aviation Institute $N_{\text{prof}} = 3000$ we will get the average load on the teacher for conducting face-to-face laboratory work per week

$$T_{\text{prof lab}} = \frac{997}{3000} = 0.33 \text{ prof hour/week}. \tag{7}$$

Laboratory work, depending on the specifics of the course and its duration, has a duration of 2 or 4 academic hours, respectively, respectively, each teacher can conduct laboratory work for a group once every 6 weeks and 12 weeks, respectively, which in turn fully meets the sanitary and epidemiological standards and exceeds the quarantine period of 14 days, which, to a fairly high degree, can reduce the growth of morbidity among students.

Conclusion

This paper provides a detailed analysis of one of the main curricula implemented at the Moscow Aviation Institute. It was shown that most of the educational load in the amount of 93% of the entire classroom load can be implemented remotely without losing the quality of the educational process and without distorting the requirements for the results of mastering each specific competence.

As noted in this study, the achievement of such high values of the possible number of educational activities implemented with the use of digital technologies is possible only with a sufficiently high level of self-organization of students and requires quite significant efforts from the administrative staff to adapt the educational process to rapidly changing realities.

One of the most significant conclusions of this work is the fact that in view of the relatively low percentage of the classroom load, which can be implemented exclusively in full-time work, it was shown that such laboratory work can be carried out in compliance with all measures to prevent an increase in morbidity among students.

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