

# Problems of the university teaching transition to e-learning

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**Abstract.** The article discusses the higher educational institutions transition problems to a distance learning operation mode during the pandemic, taking into account the technical universities work specifics. The article describes the problems that have arisen as a result of e-learning mode transition, as well as some solutions to these problems. The article focuses on: the teachers' readiness problems; the e-courses quality for technical specialities students; the teachers' developed materials copyright; virtual learning environments to replace the laboratory stands and equipment for students in distance learning process; distance learning educational process implementation technical support problems. The described problems' proposed solutions' implementation can be carried out in higher educational institutions without hiring additional personnel.

## 1 Introduction

The situation in higher education institutions during the coronavirus COVID-19 pandemic period highlighted various problems concerning the institutions work organization, the relationship between personnel, teachers and students, financing the development of higher educational institutions and their material and technical base equipment [1–3].

But despite the problems and difficulties that have arisen, thanks to the distance learning information technologies introduction, it was possible to ensure the distance learning educational activities implementation, to achieve students' high qualifications and appropriate levels of professional competencies' formation [4].

A general problem solving approach for uncertainty conditions was developed to let the new solutions faster introduction. Acceleration became possible due to an iterative process, which made it possible to start working on solving problems without initially having the complete information and obtaining the necessary data in the course of work.

## 2 Technical problems

First, it is worth mentioning the technical problems that have arisen as a result of a transition to a total remote operation mode that students and teachers have encountered. Among such technical problems the most frequently encountered:

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## **2.1 Individual computer facilities insufficient provision**

Individual computer facilities insufficient provision (including personal computers (PC), mobile devices like laptops and smartphones) has become the reason for the educational activities' mode desynchronization in remote operation mode.

To solve this problem, it is required to equip teachers with PCs or laptops with a camera and a microphone to meet the distance learning management systems (LMS) requirements.

Another difficulty in determining the presence and severity of this problem lies in the fact that even the provision of users with personal computing means does not mean automatic compliance of the available computing facilities with the system requirements for software and hardware of the implemented LMS, communication and collaboration platforms (CCP) and other programs used in the distance learning process. In this regard, one should very carefully choose the software to be introduced so that as many of the available computing devices as possible could be used to work with the introduced software. Today, the global trend is the use of web applications and virtual machines' remote access tools wherever possible. This allows the hardware and software requirements to be minimized to: a stationary or mobile device with a standard web browser. With the widespread adoption of HTML5-capable web browsers, large and complex systems can be built as web applications. During the pandemic, the more intensive use of web applications and remote access server infrastructure by a large number of users has demonstrated some performance and bandwidth problems.

## **2.2 Server infrastructure insufficient performance**

The insufficient server infrastructure performance becomes notable with a sharp increase in the number of LMS users and the transition of technical students' laboratory work from test benches based on real laboratory devices to virtual environments with multi-user access through communication channels. Before the pandemic, the server capacities of many educational institutions were not designed for such a load, and the performance of the server infrastructure had to be rapidly increased.

To scale server infrastructure fast one can use the cloud computing systems for virtual servers and various applications deployment. This solution is the fastest, easiest to use, highly scalable and is often cheaper than building your own infrastructure of similar performance. The other way is to use the third-party data centers for hosting own servers or renting their servers for the server infrastructure scaling. Next goes establishing of own high-performance virtualization servers, which can be quickly incorporated into the existing infrastructure to transfer existing virtual machines to the powerful virtualization servers with minimal reconfiguration. And finally there comes creation of scalable multi-server information systems that can operate on server clusters with different computing performance, ensuring performance scalability. This multi-server approach allows combining external cloud servers, physical servers and virtual machines in one cluster.

The server infrastructure development strategy, containing a reasonable combination of the proposed solutions, will make the server infrastructure of an educational institution more versatile, suitable for solving a changing range of tasks and easily scalable.

The optimal combination of solutions depends on for what tasks, how quickly, for how long, and with what budget, you need to create a server infrastructure.

## **2.3 Communication channels' insufficient bandwidth**

The insufficient communication channels' bandwidth becomes noticeable with an increase in the number of simultaneously connected users to the server infrastructure and an increase in the traffic volume that users exchange with the infrastructure. The bottleneck is usually

the channel through which the server infrastructure is connected to the Internet. Users working remotely from home usually use individual communication channels that are designed for much bigger amount of traffic than is required for work. Problems arise with a server infrastructure channel that was not originally designed for such a load.

To solve this problem one can use the cloud services and content distribution networks designed to serve for many users and high traffic or use third-party data centers to provide reliable user access to own servers or develop own network infrastructure, which gives a new impetus to the development of the organization's information systems, but can be a very expensive undertaking, and therefore requires careful planning.

The network infrastructure development strategy, containing the required combination of the proposed solutions, will make the network infrastructure of an educational institution more versatile, suitable for solving a changing range of tasks and easily scalable.

The optimal combination of solutions depends on what characteristics, how quickly, for how long, and with what budget, you need to create a network infrastructure.

## **2.4 Live communication with the teacher process violation**

Sometimes questions or situations arise that are impossible to discuss or analyse in distance learning without personal communication.

To solve this problem, in addition to web LMS, such as LMS Moodle, the CCPs are used, such as Microsoft Teams, Zoom, Discord, BigBlueButton, etc. This makes it possible to ensure all participants' live presence at the lesson in one virtual classroom "with a whiteboard and a projector". Critics of the CCP use say that some students lose motivation as opposed to being physically present in the classroom. Some of the observations made have shown that those students who are not motivated to study in the CCP usually do not have the motivation to study in the classroom, so there is most likely no any significant difference with physical presence in the classroom for university students. But when studying in the CCP, such students do not demotivate and do not distract others during the lesson. And if someone has problems with the material perception or with the learning motivation, then students can always discuss these problems with the teacher in the same CCP. As for the argument about the teacher positive personal impact with physical presence on those students who, as we said, lack motivation, this impact often boils down to comments about the distracting behavior of these students in class. Some measurements of academic performance do not show a significant positive effect of physical presence alone on the low-motivated students' performance. However, we can conclude that being distracted to increase the low-motivated students' motivation during classes the teacher obviously spends less time on directly explaining the new teaching material for all students. This cannot positively affect their understanding of the material, reduces the amount of material discussed in the class, and may also reduce overall academic performance. To increase motivation and discuss difficult issues, teachers can use the CCP during their office hours to attract more students, who no longer need to come to the teacher's office.

## **2.5 Discrepancy in time depending on the time zone**

Discrepancy in time depending on the time zone does not allow starting distant classes at the same time (if e.g. a student studies in GMT+1 time zone, but lives in GMT+9).

To solve this problem, you should record the lessons in the screencast form, and then upload the media files to the web LMS to let the students in different time zones watch the lessons. The students' questions should be discussed on the web LMS forum to let the discussion be available to all class participants.

If there is a slight discrepancy in time, the schedule can be changed so that classes in the CCP are held for all students at work time (or at least not at night).

## **2.6 Difficulties associated with the knowledge control and certification processes**

Some difficulties arise associated with the students' knowledge control and certification processes [5, 6] on distance learning.

To solve these accounting problems for the students mastering the material, one should use electronic sheets, e.g. provided by the LMS Moodle, which can be configured to account for progress in various assignment types with different grade types. But the distance mode with LMS and written tasks does not guarantee the knowledge quality demonstrated by students.

This problem is successfully solved by using the CCP for live communication with the student's camera and microphone turned on, which allows the needed interaction. The only difficulty may remain is the time zone difference, but you can choose a time that suits everyone, or hold several online meetings for different time zones.

For credits, examinations and final qualifying work defence, the CCP should also be used with the student's webcam and microphone turned on, including when a student is simultaneously connected from a stationary (computer or laptop) and mobile (smartphone or tablet) client device to use multiple microphones and webcams for proctoring.

## **3 Organizational and technical problems**

Among the more serious problems that cannot be solved by technical means alone, the following were noticed:

### **3.1 Copyright protection for digital materials placed in the LMS**

Copyright protection for digital materials developed by the teachers and placed in the LMS to provide distance learning [7] is a concern source for many teachers.

The solution to this problem should include tracking and suppressing the digital materials authored by university employees dissemination by unauthorized persons and should be a comprehensive and long-term activity.

For some dynamically changing training courses (e.g. on the modern technologies), it may turn out that teaching materials regularly change significantly enough that even their possible distribution outside the LMS does not pose a serious threat to this course attractiveness for study at the university, but, on the contrary, could act as an advertisement.

Also, for advertising purposes, short open courses can be created, e.g. for schoolchildren or for a wide range of people without special training.

### **3.2 A decrease in the research activities productivity**

The pandemic caused a certain decrease in the research activities productivity, especially when it comes to a technical or applied profile (sculpture, painting, etc.) university [8]. For all activities requiring access to various equipment that cannot be located at home [9, 10] the transition to remote mode is the reason for the work complete cessation.

To solve this problem, it is required to use telepresence tools (including remotely controlled avatar-robots), as well as laboratory equipment control consoles and sensor data output to web interfaces. This will ensure that experiments are carried out with a minimum personnel physical presence and the experiment participants able to connect through public communication channels using secure virtual private network (VPN) connections.

### **3.3 A Decrease in the students' skills and competencies formation quality**

The pandemic affected a certain decrease in the future professionals' skills and competencies formation quality in the technical field, where classes are often held using special technical training aids, installations, laboratory equipment, etc. The situation is aggravated when it comes to practices that must be carried out in conditions close to production activities [11–13]. The most serious problem of a complete transition to a remote operation mode has affected technical higher educational institutions.

The solution to this problem is partly similar to the solution to the previous one, but it is also possible, taking into account the laboratory educational installations functioning [14, 15], to create their virtual simulators using the virtual desktop infrastructure (VDI) technology or a web interface, available to students at any time via the Internet, which need much less maintenance than physical devices. The students' work results with this equipment can be registered directly in the LMS and sent for verification to the teacher.

## **4 Organizational problems**

Speaking about the technical specialities students' teaching difficulties in a pandemic that have caused a complete change in the technical university educational process and its organization technology, it is necessary to note the students' practical training approaches severe change extreme necessity. This entailed the need to comprehend a number of organizational problems, including:

### **4.1 Fully developed electronic courses lack or absence**

Fully developed electronic courses lack or absence, taking into account the practical and laboratory work implementation, which are performed using special production equipment (e.g. laboratory stands, machine tools, visual aids in mechanics, hydrostatics, kinematics, etc.), as well as the lack of time in the teachers' working schedule to create text and media materials specifically for LMS has become a problem.

To solve this problem, it is necessary to allocate additional working time for teachers [16] to create digital content for LMS, as well as train university teachers in effective practices for creating digital content.

The students can also help the teachers to create the test questions' banks for LMS. First, the questions are formulated by the teacher. At this stage various similar questions should be formulated to make cheating difficult. Then sets of questions are entered into the LMS and offered to students as midterm control. In the first iteration, students should formulate short answers to these questions themselves. After checking, the teacher receives many correct and incorrect answers, which can be combined with the developed questions to create a test questions' bank with variable options for correct and incorrect answers.

### **4.2 Virtual learning environments lack or absence**

Lack or absence of virtual learning environments implemented in a technical university educational process, which allow distance learning students to adequately replace the laboratory equipment use (e.g. device simulators, etc.) has also become a problem.

To solve this problem, it is necessary to allocate resources to create virtual learning environments, as well as to attract teachers in disciplines where it is planned to use such environments to this development with the additional working time allocation for teachers.

### **4.3 A Severe teaching approaches' change**

A severe study regime change during a pandemic caused a severe teaching approaches' change (e.g. when studying complex topics of physics, chemistry and other disciplines and educational modules), which required the new didactic-methodological tools rapid development. E.g. in chemistry complex topics teaching process, teachers had to replace classroom lessons using visual experiences and experiments in which students themselves took part, with video materials in which it is difficult to convey all the experiment nuances, answer all students' questions and analyse the difficulties that arise. This caused certain difficulties in the students' knowledge, abilities, skills and competencies formation, as well as in their verification within the current and intermediate certification framework.

It has now become clear that distance learning using information technology is an educational system new everyday version, so it is necessary to create some new didactic and methodological tools, taking into account their use in distance learning. This will ensure the proper quality of education in the new environment.

### **4.4 Lack of proper technical support for the distance learning implementation**

Lack of proper technical support for the distance learning implementation in the technical universities' educational process in many specialities and areas where the distance learning should be used has made the distance learning transition a slower process. With the massive transition to distance learning, the task was to quickly train university staff in distance learning technologies. This has become a problem in many specialities since approaches to their distance teaching were not developed in advance.

In the future, this problem can be solved by involving the practitioner-specialists in certain disciplines together with those who are already conducting students' training in these disciplines in the distance learning and teaching methods development.

### **4.5 Lack of trained teaching staff for remote teaching**

Switching to distance learning has shown the lack of specially trained qualified personnel, who could effectively carry out students' remote training, especially for those disciplines' teachers where student training takes place using training stands, equipment, apparatus, etc.

A solution to this problem can be achieved within the advanced university teachers' training courses framework, where the university teachers will be trained in the distance work effective organization using various means of LMS, CCP and ways of distance learning digital content creation.

### **4.6 Structuring teaching material complexity in a video lecture**

Structuring teaching material in a video lecture requires a large accompanying material amount, such as graphs, diagrams, formulas, calculations, etc., which the teacher needs to use simultaneously or constantly refer to them during the lesson.

This problem is successfully solved by preliminary opening several application windows demonstrating the necessary materials, expanding these windows to the teacher's PC full screen, and then organizing the teacher's screen display to the students through the CCP with switching between open windows with educational materials. This allows using various materials and software installed on the teacher's PC during the lesson, and quickly switching between them.

#### 4.7 Insufficient distance learning quality in technical/applied disciplines

Whatever the educational material educational potential in the LMS, live contact with the teacher is necessary for technical/applied disciplines university students.

This problem relates primarily to text and graphic materials and is solved by adding media materials to the LMS and using the CCP for live communication.

### 5 Conclusion

At present, the complete replacement of many academic disciplines/educational modules teaching with distance learning does not allow ensuring the proper education quality [17]. However, in those disciplines for which the problems listed in the article have been solved, it is now possible to ensure the education quality similar to face-to-face education and even surpassing it by facilitating the students' independent work with digital educational materials in the LMS and increasing the teachers' contacts availability with the CCP. The distance learning benefit is very high in organizing the individual learning trajectory and the self-study process for the students in a convenient mode. Distance learning allows the teacher to implement group and individual support for the students.

The proposed solutions to the described problems could be implemented in higher educational institutions without hiring additional personnel. That eases the adoption of the e-learning education process [18, 19].

As a result, we can talk about the full-fledged blended learning emergence in which distance e-learning complements the traditional face-to-face education and is already an integral part of a technical university educational activity.

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