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FEATURES OF CONDUCTING LABORATORY WORK ON TECHNICAL DISCIPLINES IN DISTANCE LEARNING FOR TRAINING SPECIALISTS IN HIGHER EDUCATION

Summary

Introduction. Distance learning – this is a form of education using computer and telecommunication technologies that provide interactive interaction between teachers and students at different stages of education and independent work with information network materials. This method of providing educational services allows a person to study at a convenient time and in any place. The person himself chooses what topic or course he wants to study, and if necessary, repeat the material covered. But the process of getting an education or studying a topic requires the involvement of relevant specialists - teachers, trainers, instructors and IT-specialists, who will be able to implement educational plans and ideas in the form of a specific software product – distance course.

Aim of the study. When developing and creating materials for a distance learning, implemented through the distance learning courses, there is a problem in the ability to demonstrate, visualize and provide students with the opportunity to independently repeat in practice certain components of the educational material. This problem may also arise in the development of a distance courses of technical disciplines for the training of specialists in the higher educational institutions.

The goal of the study is to analyze the features of the development and implementation of distance courses in the study of special technical disciplines that involve laboratory work in the higher education institutions.

The subject of the study is the effectiveness of providing laboratory work remotely in the study of special technical disciplines in the higher educational institutions.

Research results. The distance learning still has limitations in its use, in particular in the study of technical disciplines in higher educational institutions, since the available learning technologies do not fully provide students with the perception of the situation, the ability to independently use the equipment and acquire the appropriate skills and abilities. The results of the study prove that distance learning has a positive effect, only in combination - attendance at the lesson + independent study of the material and its consolidation, as an example, with the help of a video recording of the lesson and a virtual simulator.

Discussion. In further research, it is advisable to pay attention to the influence of various forms of training on the effectiveness of studying a particular discipline. It is also necessary to separately investigate the impact of the software used to create and fill distance courses.

Keywords: distance learning, distance course, principles of distance learning didactics, video materials

Introduction

As you know, education should occur throughout a person's life. The current legislation of Ukraine and other countries of the world guarantees equal opportunities for education. But there are various circumstances that impede the process of obtaining education and obtaining relevant knowledge for people with limited mobility, for people who are forced to change their place of permanent residence or epidemiological and sanitary restrictions.

Many educational institutions and services have appeared that provide educational services remotely, using modern information and telecommunication technologies. These organizations conduct distance learning – this is a form of education using computer and telecommunication technologies that provide interactive interaction between teachers and students at different stages of education and independent work with information network materials [1].

This method of providing educational services allows a person to study at a convenient time and in any place. The person himself chooses what topic or course he wants to study, and if necessary, repeat the material covered.

But the process of getting an education or studying a topic requires the involvement of relevant specialists - teachers, trainers, instructors and others. However, in order to implement distance education, these specialists need help from IT-specialists, who will be able to implement educational plans and ideas in the form of a specific software product, as well as be able to provide technical support for it.

Cooperation in the context of distance learning provides for the following areas:

- teacher – student;
- group of teachers – student;
- teacher – a group of students;
- a group of teachers – a group of students;
- student – student;
- general group subject-subject interaction [2].

To ensure for distance learning needs combination of the following tools:

- means of providing educational material to the student;
- means of student progress control;
- means of student consultation by the program-teacher;
- means of interactive cooperation between teacher and student;
- the possibility of quickly supplementing the course with new information,

correcting errors [1].

To ensure for the high efficiency uses of the distance learning, principles based on a humanistic-personal approach. It is providing for the implementation of such pedagogical requirements:

- humanization and democratization of pedagogical relations;
- creation of a multicultural educational environment;
- free choice;
- non-compulsory education;
- not a simple goal;
- advance;
- self-management;
- creation of an intellectual basis;
- responsibility, self-affirmation and self-regulation [2].

An important element of a distance learning is the distance course. Each teacher can decide how the recreation center will look like and what multimedia elements will be used in it. The degree and method of using computer technology in the preparation of the distance course has a significant impact on the effectiveness of its assimilation. The world experience shows that the use of dynamic objects to create visual models of student adaptive modeling in many cases significantly increases the learning effect [1].

However, when developing and creating materials for a distance learning, implemented through the distance learning courses, there is a problem in the ability to demonstrate, visualize

and provide students with the opportunity to independently repeat in practice certain components of the educational material (for example: laboratory work in physics, chemistry, etc.).

This problem may also arise in the development of a distance courses of technical disciplines for the training of specialists in the higher educational institutions.

Purpose, subject and research methods

The goal of the study is to analyze the features of the development and implementation of distance courses in the study of special technical disciplines that involve laboratory work in the higher education institutions.

The subject of the study is the effectiveness of providing laboratory work remotely in the study of special technical disciplines in the higher educational institutions.

Research methods and objectives:

1. analytically explore the environments of distance learning courses to determine their functionality and technical capabilities;
2. analytically explore additional tools and tools for creating educational material for a distance course;
3. to determine and investigate the methods of conducting the educational process in the study of special technical disciplines for distance learning and determine the level of their effectiveness.

Experimental studies were on the example of the discipline "Modern methods and systems for diagnosing vehicles", studied by students of the specialty "Motor transport" at the National Transport University in the period from 01.02.2023 to 31.02.2023.

Research results

Currently, there are many different software and electronic products for distance learning. In general, they can be divided into two groups – commercial (paid access) and non-commercial (free access), which can be further divided into closed and open. Closed products for distance learning are a complete software environment, that is, without updates or adaptations. Open products (usually now created through web services) are constantly being improved, updated and adapted to the current needs of users. The most common of them:

- Atutor (<http://www.atutor.ca>);

- Dokeos (<http://www.dokeos.com>);
- DotLRN (<https://www.ilias.de/en/>);
- Google Classroom (<https://classroom.google.com>);
- LON-CAPA (<http://www.lon-capa.org>);
- Moodle (<http://moodle.org>);
- Sakai (<http://sakaiproject.org>).

All software products for distance learning have the following functional features:

- reference and information electronic teaching tools – electronic texts of lectures, hypertext educational materials, information materials on the Internet, databases with textual, hypertext or multimedia presentation of educational material, electronic encyclopedias, reference books and instructions, information materials of websites, web pages and information portals;
- demonstration and modeling electronic learning tools – simulation multimedia models used instead of dynamic posters, computer learning games;
- controlling electronic learning tools (designed to determine the level of educational achievements of students) – automated control tests, sets of exercises for self-control of knowledge, skills and abilities;
- educational-controlling electronic learning tools designed to control knowledge, skills and abilities in the discipline;
- software for system and applied purposes, which are electronic learning tools, as they help teachers create documents, distance courses.

But, not all software products for distance learning were created or follow the principles of didactics, since they were created under the order of a specific organization that put forward its requirements for the functioning of a distance course [3].

In this regard, it is appropriate to consider distance education through the prism of well-known classical didactic principles. It is in the context of the laws of didactics that computer technologies are transformed into computer pedagogical technologies (Figure 1) [2].

Such it, the role of the distance education has become more important, but new features of creating and conducting classes in distance and online mode have emerged. Teachers were faced with the need to effectively adapt the study of program material in a short time to ensure the high quality of students' knowledge [4].

Additionally, the process has become more complicated by the peculiarity of studying a particular discipline, for example, the study of natural, physiological and technical sciences, where students must visually see or touch a certain subject, independently perform a certain

study or action to gain practical skills, and the like. This problem has become acute in the study of technical disciplines, where, in addition, expensive specialized equipment is used with which students must familiarize themselves and learn how to use it.

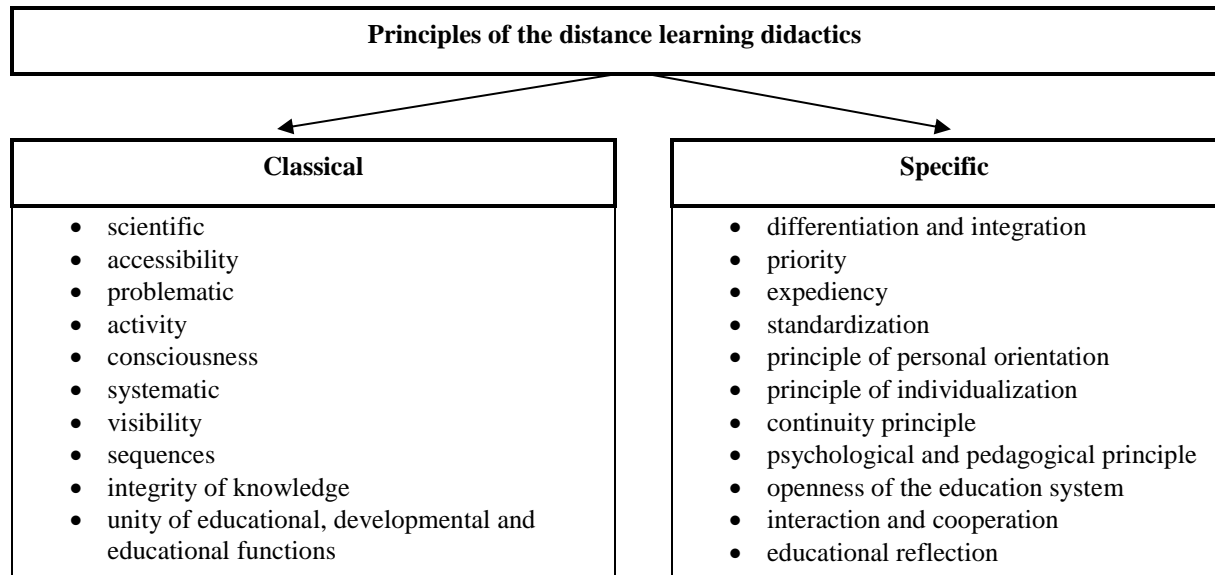


Figure 1. Principles of the distance learning didactics [2].

Source: Own study

The main goal of the teacher during laboratory and practical classes in the conditions of distance learning is the maximum possible introduction of experimental work. Practical implementation outside the laboratory, without the necessary equipment and research materials, requires a reorientation towards self-experimentation [4]. To this end, the teacher should develop remote work, during which the student will be able to see the process itself and repeat it (at least virtually).

All distance courses involving experimental work or research can be conditionally divided into two categories: the first – the student performs an analysis of pre-prepared experimental results; the second – the student independently conducts an experiment to obtain results and analyze them.

To implement the first category of distance courses, full or partial automation of the experimental part of the work is carried out. The main task of automation is a set of experimental data, which are further used to create a work database. To conduct laboratory work in natural disciplines, one can use measuring and control complexes or limit oneself to digital measuring instruments, the data from which is recorded in the memory of a personal computer. The latter makes it possible to significantly simplify the necessary technical base, and to carry out part of the work associated with creating conditions for the experiment and

control manually. In humanitarian works that use large arrays of numbers, it is often possible to confine oneself to scanning and recognizing existing data and then use them for work performed remotely [5].

For the implementation of the second category of distance courses, sets of experimental data were obtained, which are used to create virtual simulators (simulators). They are supplemented by previously obtained data libraries and instructions for carrying out the work. The development of a full-fledged virtual simulator requires the availability or creation of specialized software. In addition to the main technical and educational opportunities, working with a virtual stimulator must necessarily awaken the student's creativity and interest. Methods are used to stimulate motivation, control and self-control of educational activities. The creation of a software product of a level close to the quality of computer games requires creative cooperation between programmers and teachers and financial support [5].

Common models in the education system of European countries are six options for organizing distance learning proposed by UNESCO:

1) the mono-organizational pedagogical model – an educational institution provides training only in a distance form;

2) the bio-organizational pedagogical model – an educational institution implements both full-time and distance learning;

3) the mixed model – full-time students (students) study a part of the courses in person, a part – remotely;

4) the consortium model - association of two or more educational institutions for the implementation of the educational process; at the same time, partners exchange educational materials or redistribute some functions among themselves;

5) the model based on the principle of franchising - partner educational institutions transfer their distance courses to each other;

6) the model of remote classrooms - lectures and seminars directly held in an educational institution are broadcast via telecommunication channels in the form of television programs, video conferences, radio programs for students (listeners) in remote classrooms [2, 6].

The experience gained in 2020-2022 in teaching students in Ukrainian educational institutions using a variety of information educational objects shows that their design should be based on the simultaneous use of didactic-technological and web-technological paradigms. When designing the information environment at the conceptual level, the following should be determined and taken into account:

- the methodology for organizing e-learning resources [7, 8, 9];

- the methodology for managing e-learning resources [7, 8];
- the methodology of learning in the information learning environment [7, 8];
- the educational standards [9];
- the software and hardware tools for creating electronic learning resources [8, 9];
- services and modes for ensuring the formation and application of electronic learning resources and support for the information educational environment [8, 10].

For each the higher education institution, it has become the norm to provide educational services “at a distance”. For this, web technologies are widely used, on the basis of which they are created:

- video and audio lectures, seminars, etc.;
- multimedia lecture materials;
- practical tasks with methodological recommendations for their implementation;
- virtual laboratory work with guidelines for their implementation;
- virtual simulators with guidelines for their use;
- packages of test tasks for conducting control activities, testing with automated verification of results;
- electronic libraries;
- distance courses that combine the above elements of the educational process [10].

Video materials are widely used in the educational process. After analyzing the video content, the following types of training videos have been identified:

- video presentation – a video recording of the introductory speech of the teacher in the academic discipline;
- video review – material that answers the questions “How to register?”, “How to review your own achievements?”, “How to connect to a lesson / course?”, “Where to find and how to use training materials?” etc. (the popular name is Frequently Asked Question(s));
- slide-film (possibly with off-screen accompaniment of the teacher);
- video broadcast (webinar) of a "live" class (mainly lectures);
- video recording of the webinar;
- studio video lesson – a specially filmed short video according to a specially developed scenario and with the participation of professional announcers or actors;
- an interactive video lecture, which containing tasks for independent work and interactive visual elements (hyperlinks, windows with material, etc.);

- multimedia video lecture – filmed in a studio and containing complex special effects;
- educational films;
- video demonstration – a specially filmed video on the performance of actions or technological operations;
- video instructions with explanations for the implementation of practical or laboratory work.

These approaches to distance learning make it possible to reach the audience of students as much as possible, to explain and consolidate theoretical material, and also to ensure access to training for people who, for various reasons, are not able to attend an educational institution.

However, creating an online course and providing them with appropriate content requires appropriate technical support. However, not for any academic discipline it is possible to provide its distance learning, in particular, due to problems with the perception and assimilation of educational material. This problem most often arises in the study of natural and technical disciplines (in particular: surgery and technical diagnostics and repair of machines). These disciplines need an appropriate material and technical base, and students must also acquire practical skills to solve professional problems.

Teachers of the National Transport University (Kyiv, Ukraine) faced this problem, during teaching students in the specialty 274 "Motor transport".

The study presented in the article was carried out on the basis of the laboratory work "Diagnosis of brake systems by methods of road and bench tests" in a remote gun, performed in the study of the discipline "Modern methods and systems for diagnosing vehicles."

The laboratory work involves a set of experiments on a real car in a laboratory (Figure 2) with special equipment and a special section of the road, without other vehicles (Figure 3).



Figure 2. Laboratory conditions for testing vehicle brakes.

Source: Own study



Figure 3. A special closed road for checking the brakes of motor vehicles on the territory of the enterprises "AVIANT".

Source: Own study

All this caused certain problems for the training masters related to:

- lack of a sufficient number of mobile technical means for high-quality transmission of video and audio data from different angles for better visibility of the work;
- low bandwidth of the telecommunications network (Wi-Fi or mobile Internet) when using technical means of transmitting high-resolution video in the case of road tests;
- large volumes of data occupying high-resolution video demonstrations that are difficult to place both on the server and in the cloud storage.

During the period, when the training took place in a mixed mode, four technologies for conducting this laboratory work were worked out:

1. classroom-exit lesson (for students who could attend classes in person);
2. remote class in real time using online conference technologies (for students who are not able to attend classes in person);
3. video recording of the lesson, specially designed for students to independently process this work;
4. a virtual simulator for independent processing of laboratory work and additional acquisition and consolidation of students' skills.

Students had the opportunity to choose the format of the lesson (in the classroom or remotely), as well as free access to the video recording of the lesson and virtual simulators.

Broadcasting of the remote lesson was carried out using mobile devices of educational masters (smartphones) through the Google Meet environment.

The video recording was specially filmed and edited in accordance with the methodology of laboratory work, using explanations in the form of announcers' comments and subtitles.

The virtual simulators were a specially developed simulation program of a roller brake tester written using Visual Basic (Figure 4) and the basic software of the MicroSAT R20 measuring complex (Figure 5), which was used to measure the braking properties of a car on the road. and has a built-in function for playback of measurement results (simulation of a pre-recorded test).

After evaluating the students with the help of the test (the test consisted of 20 questions, 5 points for each correct answer, so that in the end the results corresponded to the 100-point ECTS scale), their academic performance (Table 1) and activity (Table 2) were analyzed.

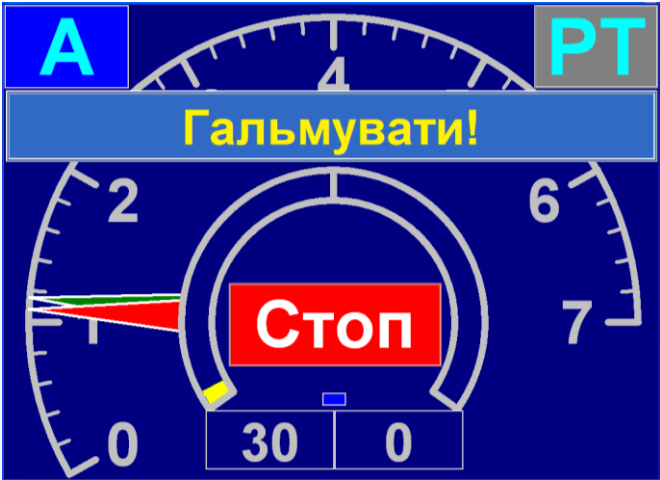


Figure 4. Interface of the virtual simulator of the automated roller brake tester.

Source: Own study

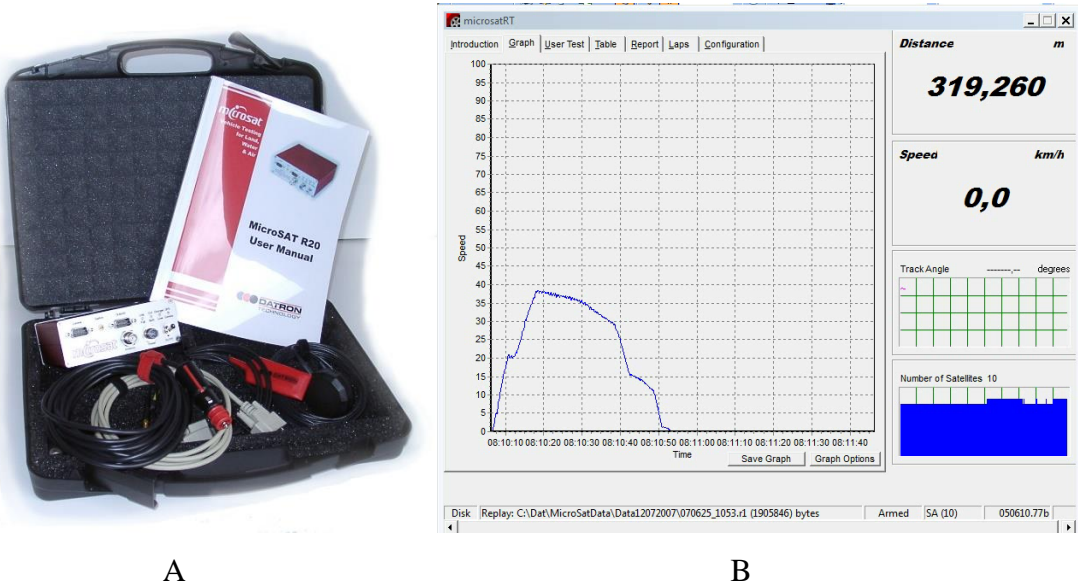


Figure 5. MicroSAT R20 system in a carrying case (A) and its interface (B).

Source: Own study

Table 1. The success of students depending on the form of laboratory classes.

Source: Own study.

№	The form of the laboratory lesson	Distribution of the number of students for their progress, pers.					Total students according to the form of the lesson, pers.
		60-63 points	64-73 points	74-81 points	82-89 points	90-100 points	
1	classroom-exit lesson	–	–	1	2	2	5
2	distance learning	–	1	3	3	1	8
3	video recording of the lesson	1	1	3	1	–	6
4	virtual simulator	1	1	1	–	–	3
Overall success rate, pers.		2	3	8	6	3	22

Table 2. Participation of students in the performance of a laboratory lesson.

Source: Own study.

№ student	The form of the laboratory lesson				Success, points
	classroom-exit lesson	distance learning	video recording of the lesson	virtual simulator *	
1	+		+	+	100
2	+		+	+	95
3		+	+	+	90
4	+		+	+	85
5	+		+	+	85
6		+		+	85
7		+	+		85
8		+	+		85
9			+	+	85
10	+		+		80
11		+	+		80
12		+		+	75
13		+			75
14			+	+	80
15			+		75
16			+		75
17				+	75
18		+			70
19			+		65
20				+	65
21			+		60
22				+	60
Total	5	8	15	12	–

* – a virtual simulator used required additional use of learning guidelines.

Table 2 shows the distribution of students' activity and their progress, expressed by the use of certain forms of laboratory classes and the number of points earned on the control test. Apparently, from those presented in Table 1 and 2 data, 59.1% of students attended the laboratory lesson (in class or online), the remaining 40.9% worked through the material on their own using methodological instructions, video recording of the lesson and virtual simulators (this number of students was determined by activity in the remote course, located on the Moodle platform).

The majority of students (68.2%) used video recording to process the material of the laboratory lesson. Among them were those who were directly present at the lesson (in the classroom or online).

According to Table. 2, it can be established that 54.5% of students who received good grades (75-100 points) had 2 or 3 activities - attended the lesson (in the classroom or online), watched the video of the lesson, completed the task on the virtual simulator. Students who kept a low grade (60-74 points) had 1 or 2 activities, and most of them did not attend the class (in class or online).

Conclusions

The conclusion of the study can be summarized as follows.

1. Distance learning and education in general have all the possibilities for mass application in any educational institution, however, all this requires modern, and sometimes advanced technologies and specialists who can develop and use these technologies.

2. When introducing distance learning into the education system must be developed state standards that will determine the conformity of the means and methods of teaching, and put forward didactic requirements for the use of materials for distance learning.

3. The distance learning still has limitations in its use, in particular in the study of technical disciplines in higher educational institutions, since the available learning technologies do not fully provide students with the perception of the situation, the ability to independently use the equipment and acquire the appropriate skills and abilities.

4. The results of the study prove that distance learning has a positive effect, only in combination - attendance at the lesson + independent study of the material and its consolidation, as an example, with the help of a video recording of the lesson and a virtual simulator. A visual approach to conducting a lesson (in the form of a video recording of the lesson) more stimulates of students to study this material.

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