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Experience in Developing a Distance Learning Platform in The University System of Education

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Abstract

The purpose of this work is to describe the modeling method and the possibility of developing a relatively inexpensive but effective educational platform using the example of an existing distance learning information system. The method of the created system is based on a special approach to the use of modern digital tools that allows one to automate the learning process at a distance. To create an information system for distance learning, a number of requirements and performance criteria were taken into account, which were determined on the basis of an expert analysis of several other similar well-known educational platforms. To develop the software component of the distance learning system, the choice was made on the scripting programming language Hypertext Preprocessor (PHP). The validity of the choice of programming language lies in the fact that, at present, this language is supported by the vast majority of organizations providing professional hosting services. PHP is an easy-to-use language, has a wide range of functionality, is flexible in terms of cross-platforms and is one of the leading languages used to create dynamic websites. The developed system, in full, serves as a good example of demonstrating the main possibilities of using modern information technologies in the field of distance learning. The approach of the received distance learning system at the university has practically proven the effectiveness of this system in the educational process. The users of the information system noted convenient access to the necessary content, ease of analysis of the learning process, and the user-friendly interface of the platform. From a technical standpoint, the introduction of this system into the educational process of a higher educational institution or organization will not incur high economic costs.

Keywords: *Information Technologies, IT Tools, Distance Learning*

INTRODUCTION

Many adults do not always have the opportunity and desire to attend classes at universities. The main reasons for this include, for example, the presence of a family, family responsibilities and permanent work. There is an alternative to solve this problem: the possibility of interactive learning via the global internet.

Currently, traditional teaching methods have lost their effectiveness. Finding new ways and methods to transfer knowledge and skills will allow us to keep up with the ever-changing environment around us. New educational technologies will help not only overcome the limitations of time and space but also assimilate large amounts of information and knowledge qualitatively. Moreover, educational technologies that are based on modern information play an important role in promoting the modernization of education.

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Modern IT is a technology with a "friendly" interface for a user. They allow you to transmit information over great distances in the shortest possible time. This feature is used in the field of distance learning. Information technology makes it possible for teachers and students to communicate directly and share sources of information on the topic of education, teaching aids and materials without leaving home.

The possibility of using distance learning systems attracts not only higher education institutions. A significant number of private and public enterprises in various countries note the benefits of training their employees and customers via information systems.

The relevance of our study is confirmed by the fact that, according to the concept note "Education in the age of COVID-19 and beyond" by the United Nations [20; 17], the COVID-19 pandemic has resulted in the greatest disruption to education systems in history, affecting almost 1.6 billion students in more than 190 countries and on every continent. The way out of this situation was the replacement of traditional education with distance learning.

To determine the level of scientific knowledge on the problem of distance learning, several published sources were analyzed. Reference [18] discussed the general principles of building a distance learning system and its advantages and disadvantages. One of the important shortcomings of distance learning systems, in this study, is the low level of qualification of specialists and, as a result, poorly developed training programs. The author of [7] highlighted the problems of the relatively high cost of programs and subscriptions to specialized sites for teachers and students and the lack or high cost of hiring highly qualified IT specialists for software development.

The authors of articles [5; 6] consider ways to use modern digital tools in distance learning. A comparative description of traditional and distance learning is given. To increase the effectiveness of distance learning, traditional technologies should be supplemented with virtual classroom technology and network communication technology.

To make the subsequent description of the development more clear, it is necessary to clarify the definitions of some terms, names and objects that will be mentioned in the development process.

A distance learning system (DLS) is a set of software products and solutions that integrates and automates all or most of the processes associated with learning.

An analysis of the published literature revealed a wide range of uses for DLS. For example, the authors of works [2; 8] suggest the use of SMART technologies, blended learning technology [12; 3], Moodle [10], Moore transactional distance theory [1], social networks and cloud computing [4], and a Kano-based approach [9].

The administrator of the DLS is a person who is considered a user of the DLS and performs various management functions throughout the educational process.

A teacher is a person who is considered a user of the DLS and performs various functions of developing educational materials for courses; in addition, he or she regulates and controls the educational process of students.

A student is a person who uses DLS and receives education in different courses.

Educational materials are educational information collected or developed by teachers of the distance learning system and are necessary for student learning. All the learning materials are stored on the server. Educational materials include lectures, presentations, tests, and practical tasks.

A course is a set of educational materials collected or compiled on a specific topic. Unlike its content, the course is created by site administration.

A lecture is a set of educational materials in text or presentation formats, in other words, a set of images. Lectures are used by teachers in the development of courses. The teacher can add lectures to the course in a specific tab.

A practical task is an educational resource of a distance learning system, developed and added by a teacher to control knowledge after students have mastered the educational material. Practical tasks form an integral part

of the training course.

The test is an educational resource of the distance learning system and is necessary to control the knowledge gained by students. The test consists of a list of questions, as well as options for answering them. The test is an interactive survey of students on specific topics presented in lectures.

The course instructor is the person responsible for developing a particular course. The teacher is needed to check the progress of students in this course, as well as to develop educational material.

After analyzing modern distance learning systems [19; 1], we can identify the main problems in their development and maintenance:

- choice of platform;
- placement of educational information;
- regulation of the learning process;
- administration of the resource;
- possibility of the development and modernization of DLS.

This work is devoted to the solution of these urgent problems, as well as the direct development of a platform for distance learning.

MATERIALS AND METHODS

The purpose of this study is to develop a distance learning system.

Research objectives:

1. Make an analysis of existing distance learning systems;

2. Identify the advantages and disadvantages of these systems;

3. Establish quality criteria for the future distance learning system;

4. Build a conceptual model of the DLS, define the functions and powers of the platform users, and input and output parameters of the project;

5. Justify the choice of programming language;

6. Create a prototype of a distance learning platform;

7. To test the system under real conditions;

8. Make adjustments in the presence of identified deficiencies;

9. The effectiveness of the received distance learning system is demonstrated.

Immediately before developing a distance learning system, whether it is a platform or an application, it is necessary to determine the basic requirements for the project. It is necessary to determine what tasks are set for the DLS, how exactly to integrate it into the educational process, what resources will be required and what will be the costs for design, development and support. However, first, it is necessary to investigate the state of the educational process, on the basis of which the system will be developed, including paying attention to the initial data needed for development.

The received DLS must meet the following requirements:

principles and methods of distance learning should differ as little as possible from traditional methods;

information technologies in distance learning should provide access to the educational materials of the university, regardless of the location of the user;

The DLS interface should be understandable and convenient for any user;

the distance learning system must be stable during operation and securely protected;

The system should consider the possibility of modernization and scaling.

In the distance learning system, mechanisms for the content and ordering of educational materials must be formed. All the information entered must be accurately organized and presented in the form of an educational course. According to the template, the training course consists of lectures and practical tasks, and it is possible to add presentations and tests.

The information accumulation function should be standardized and have support for adding data from other storages.

Educational information that has been created or added by educators should be accessed through system administrators. Student users should be grouped according to the courses they are enrolled in. The system administrator needs to associate the added courses with the right students. At the same time, he must appoint a teacher responsible for this course. After viewing and studying the lecture material, students must complete a practical task or take a test. Tests consist of a list of questions and some answers to these questions. Test tasks are checked automatically by the system, and the assessment is also set automatically. After completing the practical task, the student must upload his answer as a file so that the teacher can evaluate the work done and assign a grade. Scores for tests or practical assignments are stored in the system database. The teacher responsible for this course has the right to access the results of the group.

Our distance learning system was designed to train students using modern information technologies. It was assumed that the operation of the system would improve the quality of education. As a result, a software product should appear that provides an opportunity to study on the basis of the ready-made educational plan of an educational institution. User interaction with the platform is carried out via the global internet.

For a distance learning system using modern information technologies, the following quality criteria were determined:

accessibility: the platform should provide access to educational materials, regardless of the location of the user;

adaptability: the platform should be able to adapt any educational program in accordance with the individual needs of educational programs;

efficiency: the platform should increase efficiency and productivity, reducing the time required for training;

relevance: the platform should use up-to-date information technologies without costly upgrades;

durability: the platform must meet the above requirements for a long period of time.

Users of the distance learning system were distributed in accordance with their responsibilities, and depending on this, access rights to various elements and functions of the platform were determined. It was proposed to create several types of users: system administrators to manage the platform, teachers and students (Figure 1).

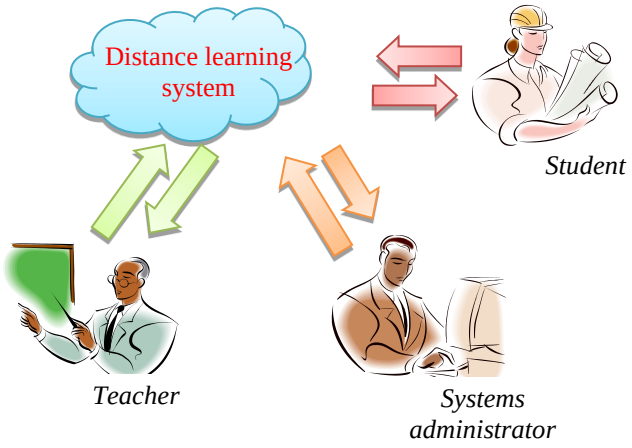

Figure 1. Distance learning system. Source: Compiled by the authors

The system administration has the right to be able to edit all the information added to the DLS; it has access to all the functions of the platform, as well as the database and information storage.

Users with the "teacher" tag have the right to be able to develop educational interactive courses, including the ability to add informational material, such as lectures or presentations, to the system. They can add students to their course by selecting from the list. In addition, they have the right to monitor the progress of students by adding assignments, tests, and assessments.

Users with the "student" tag have rights to access courses, including rights to read and download educational material, as well as rights to take assignments and tests.

Table 1 describes the functions offered for each kind of user.

Table 1. Functions of Distance Learning Platform Users

User type	User functions in the system
Administrator	1. Control over databases; 2. System administration; 3. Creation of courses and information resources of DLS.
Teacher	1. Development and management of courses; 2. Creation and addition of lectures, presentations and other educational materials; 3. Creation of practical and test tasks; 4. Monitoring the progress of students.
Student	1. Studying the educational materials of the course; 2. Passing practical and test tasks of the course; 3. Controlling your own results

Source: Compiled by the authors

Considering the functions of DLS users, it is possible to simulate the educational process in the distance learning system environment. Education in DLS can be divided into several stages. First, a regular structure of the system needs to be developed. This is the responsibility of the system administrator. It is the administrator who controls the users and grants them certain rights.

One of the administrator's functions, as shown in Table 1, is to add new courses. An educational course is not created for a specific group of students. A course instructor can add any registered student user to his course. If the course is available to a wide range of users, then it will not be easy to control the results of all the students. The function of adding or removing students from the course is carried out by the teacher in a special tab on the page of this course. To teach students in the context of a particular course, it is necessary to appoint a teacher who will be responsible for this course and for monitoring the results of the students. In addition, by adding new and improving old educational materials, the course teacher also performs the role of a lecturer.

When developing a complex system, it is divided into several parts, each of which is analyzed separately. There are two different methods of such division into elements: structural (or functional) decomposition and object

(in other words, component) decomposition.

With the structural division of the software system, flowcharts outline its organization. The nodes in the diagram demonstrate "processing centers", that is, functions, and the relationships between these nodes demonstrate the transfer of information. When a platform is created for distance learning, it is possible to emphasize two models: the educational data accumulation model and the learning model. In information technology, the operations that take place in such systems are called "back-end" and "front-end". In detail, "front-end" and "back-end" are concepts that represent the initial and final states of the process [13]. The "front-end" reflects the information entered by the user (input data) in any form and is responsible for converting the received data into a form that the "back-end" can then use. The "front-end" connects the user and the "back-end", acting as an interface. Table 2 describes the front-end and back-end processes and their functions.

Table 2. The functions of the processes "front-end" and "back-end"

Processes	Functions
Front-end	– Adding users; – Adding and managing courses; – Addition of lectures and teaching materials; – Creation of practical and test tasks; – Appointment of courses;
Back-end	– Student education; – Access to educational information;

Source: Compiled by the authors

The combined work of these two processes ensures the high-quality work of the distance learning system. The subsequent division of subsystems can lead to a modular structure, where a special module is responsible for each process. This structure allows the implementation of a simple possibility of upgrading the DLS. To develop a new function or make changes to the system, only one specific module needs to be changed.

It is allowed to apply object decomposition to the system, as well as functional decomposition. In this case, it is necessary to use system users as objects of research. Each specific user has properties that describe him, as well as methods that are necessary to form the functionality. Figure 2 shows the general scheme of a registered user of the distance learning platform.

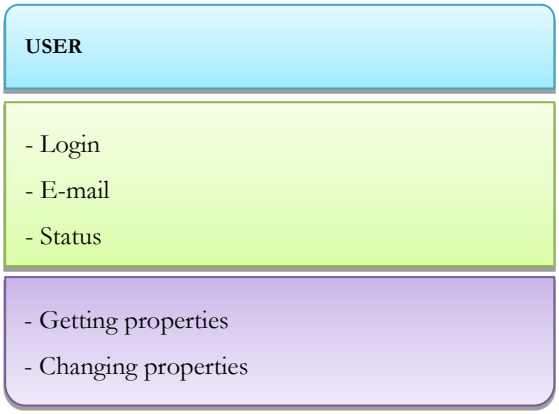

Figure 2. General diagram of the DLS user. Source: Compiled by the authors

As shown in Figure 2, each user of the system has several properties, such as login, email, and status. The "status" parameter shows what type this user belongs to: administrator, teacher or student.

The diagrams for other types of users have new attributes that are required to form the functionality. Figure 3 shows the administrator diagram.

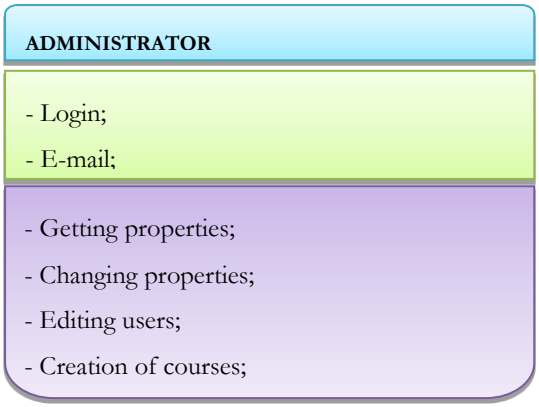

Figure 3. Diagram of the DLS administrator. Source: Compiled by the authors

The figure shows that some other users have been added to the properties of all the users. These properties and rights distinguish the administrator user from other types of distance learning system users. Unlike users-administrators, users-students and users-teachers have their own characteristic properties. The diagram of the teachers can be seen in Figure 4.

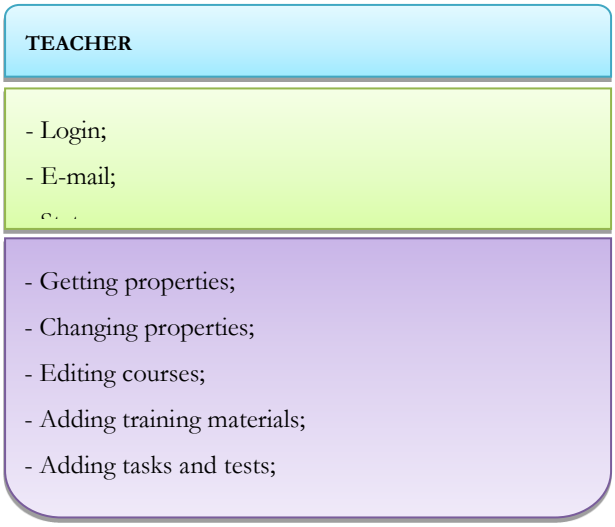

Figure 4. Diagram of the DLS teacher. Source: Compiled by the authors

In addition, teachers have added properties for editing courses and creating and adding lectures and tests.

Student users, in addition to the property that determines their belonging to the course, have the property of performing practical and test tasks. Figure 5 shows a student's diagram.

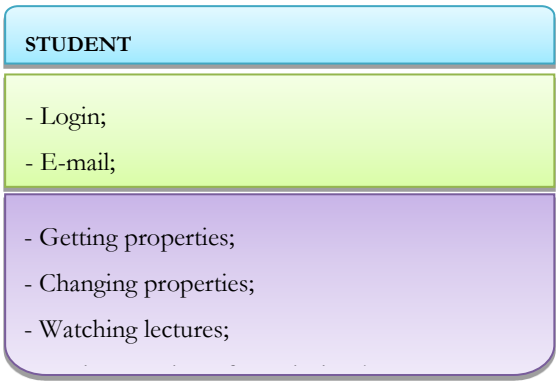

Figure 5. Student DLS diagram. Source: Compiled by the authors

After certain changes, these diagrams can be used in the format of UML diagrams for the development of abstract classes, as well as for the object representation of the DLS. On the basis of the obtained model, developing a platform for distance learning is now possible.

In conclusion, the purpose of this work is to analyze and study the possibility of improving modern information technologies in the field of distance learning.

RESULTS

Initially, the task was to create a cross-platform application that could be opened on any device. This means that good optimization is needed for various devices, such as personal computers, laptops, and mobile phones (both Android and Apple's operating system (IOS)). It would be necessary to solve the problem of software and hardware compatibility of various peripherals and their assemblies. Therefore, the question is now about choosing a programming language in which our project will work.

To develop the software component of the distance learning system, the choice was made on the scripting programming language PHP [17]. This language is widely used for creating web applications and developing interactive sites. Owing to its ease of use, wide functionality, and flexibility in terms of cross-platform and free distribution of source codes, PHP is well suited for creating large internet systems. The most popular sites that are created via PHP are “Facebook”, “Vkontakte”, “Wikipedia”, and “TED”.

The benefits of PHP include the following:

automatic extraction of edit data (POST) and obtain data (GET) parameters, as well as web server environment variables, into predefined arrays;

file functions successfully process both local and remote files;

automated sending of HTTP headers;

work with cookies and sessions;

processing of files uploaded to the server;

work with HTTP headers and HTTP authorization;

work with local and remote files, sockets;

interaction with many different database management systems through additional modules (MySQL, MySQLi, SQLite, Oracle (OCI8), Oracle, Microsoft SQL Server, etc.);

work with XForms.

All scripts of the PHP programming language are performed on the server side and dispense with the installation of unnecessary software by the client, except for the web browser. In response format, a text document, which contains HTML instructions, is sent to the user, and any modern browser interprets it without problems. As a result, the availability of the DLS is ensured for every owner of a personal computer (and not only) with the ability to connect to the global internet [16].

The MySQL database management system is used to store the information necessary for the system. To start the development process, it is necessary to define the structure of the database. During the operation of the distance learning system, tables are added.

The main module of the DL platform is a combination of web applications that support the main functionality of the system:

- graphical interface;

- User registration and authorization;

- Obtaining general information about the user;

- user setting;

- Exit from the session.

To meet the requirements necessary for future updates of the distance learning system, it would be better to turn to the object-oriented programming approach. Most objects in the DLS should be instantiated as class instances. All functions in the DLS are in the form of methods in specific classes.

The html class is responsible for creating a graphical interface in the DLS. It combines the methods necessary to create the html page of the site. The "html" class has two properties: "title" and "page" [15]. When creating an html instance, a title is specified, or in other words, the name of the current page (the "title" property). Owing to the "header" method, a page header is created with a logo and sections of the site (profile, courses, additional sections for the administrator).

The identification block is a distinctive element of the site; most often, it is the logo or the name of the site. The main menu will contain hyperlinks to other pages on the site, such as the user profile or course page. It is available to every user. Additionally, there are links for the authorization of already registered users and the registration of new users. Figure 6 shows the finished graphical interface.

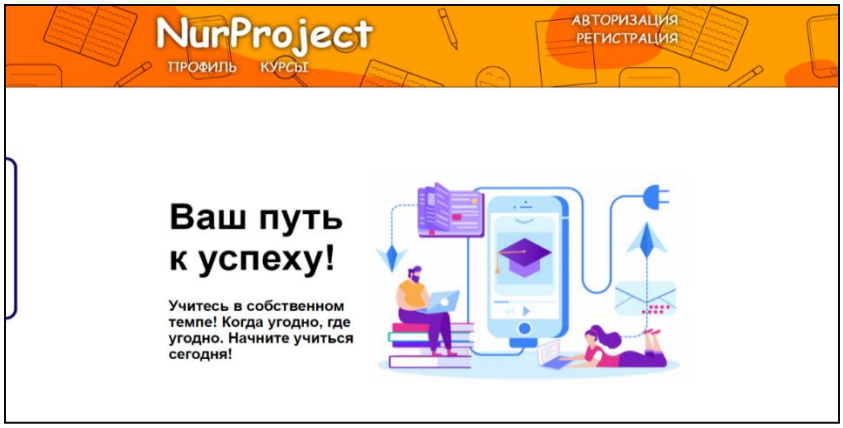

Figure 6. An example of a graphical interface for DLS. Source: Compiled by the authors

To avoid loading the interface with many elements, it was decided to abandon the additional menu in favor minimalism and cleanliness on the screen. Only on the left can you notice an element that pops up when you hover the cursor, with a link to a test to determine the level of knowledge in certain subjects.

Let us examine the part of the code that controls the ability to access limited system resources:

```
<?php if( isset($_SESSION['logged_user']) ) :?>
```

Figure 7. Registered user access. Source: Compiled by the authors

This line in the code indicates that only the registered user can see the subsequent part of the page content (Fig. 7). There is another restriction that allows only users with the required status to see certain content (Fig. 8). Let us consider an example with an administrator:

```
<?php if(($_SESSION['logged_user']->login) == 'admin' ) : ?>
```

Figure 8. Administrator access. Source: Compiled by the authors

The security device of the distance learning system obliges the session to review most of the pages of the site. As soon as the user logs into his site account, his session is created and added to the global array "_SESSION", where all session variables are located. This session device is used in popular social networks such as Facebook, Vkontakte and Twitter, and this mechanism is the most secure way to implement a system of access to specific

pages of the site [21]. After successful authorization of the user, the variable "id" is created and added to the "_SESSION" array, where the unique user identifier from the database is stored. Depending on whether there is such a variable in the array, it is determined whether the user has been authorized. In this case, the system displays a message on the screen asking you to log in.

If the system detects the required "id" variable in the array, then a certain method of the "html" class is implemented, which displays hidden content for unregistered users. Additionally, depending on the type of user, different types of content can be displayed (Figures 9 and 10).

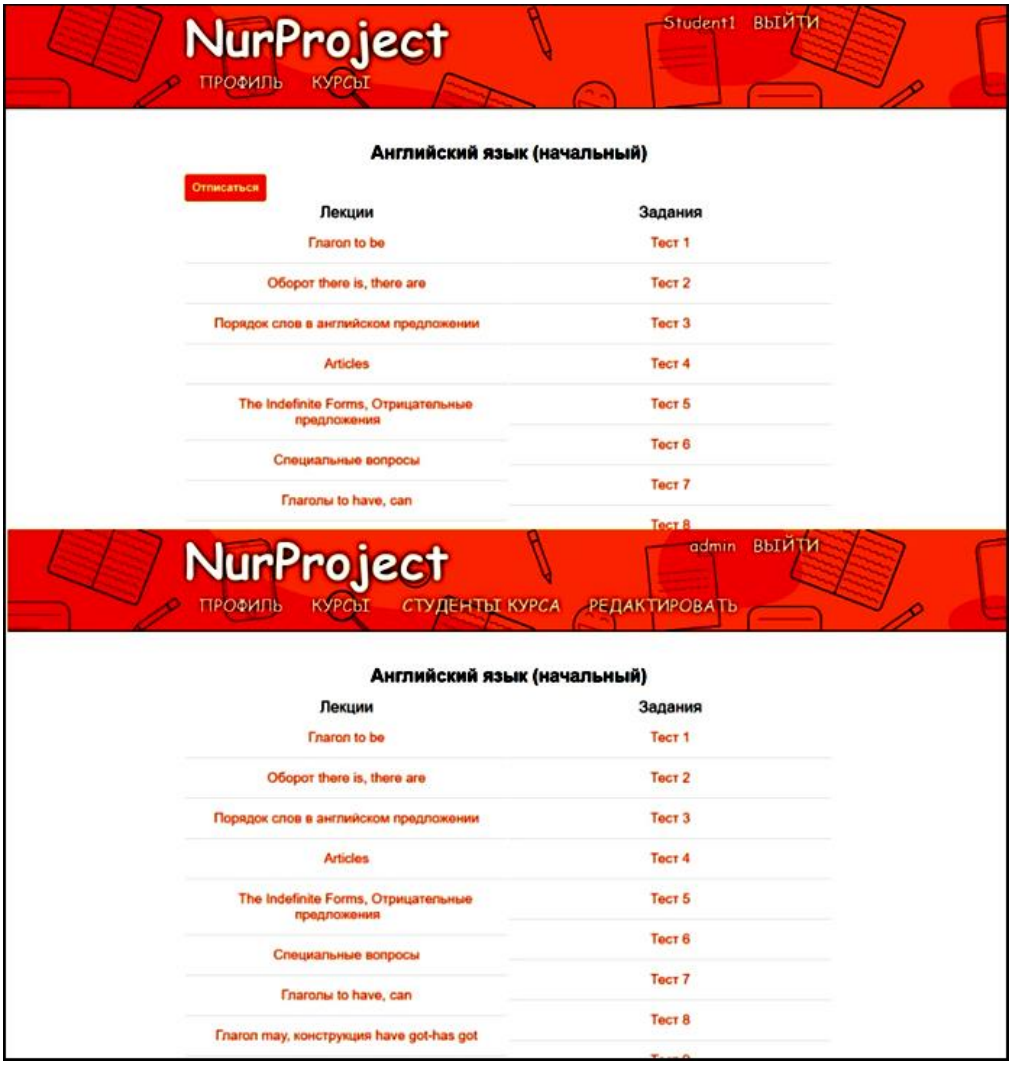

Figure 9. Differences depending on the type of Student1 or admin. Source: Compiled by the authors

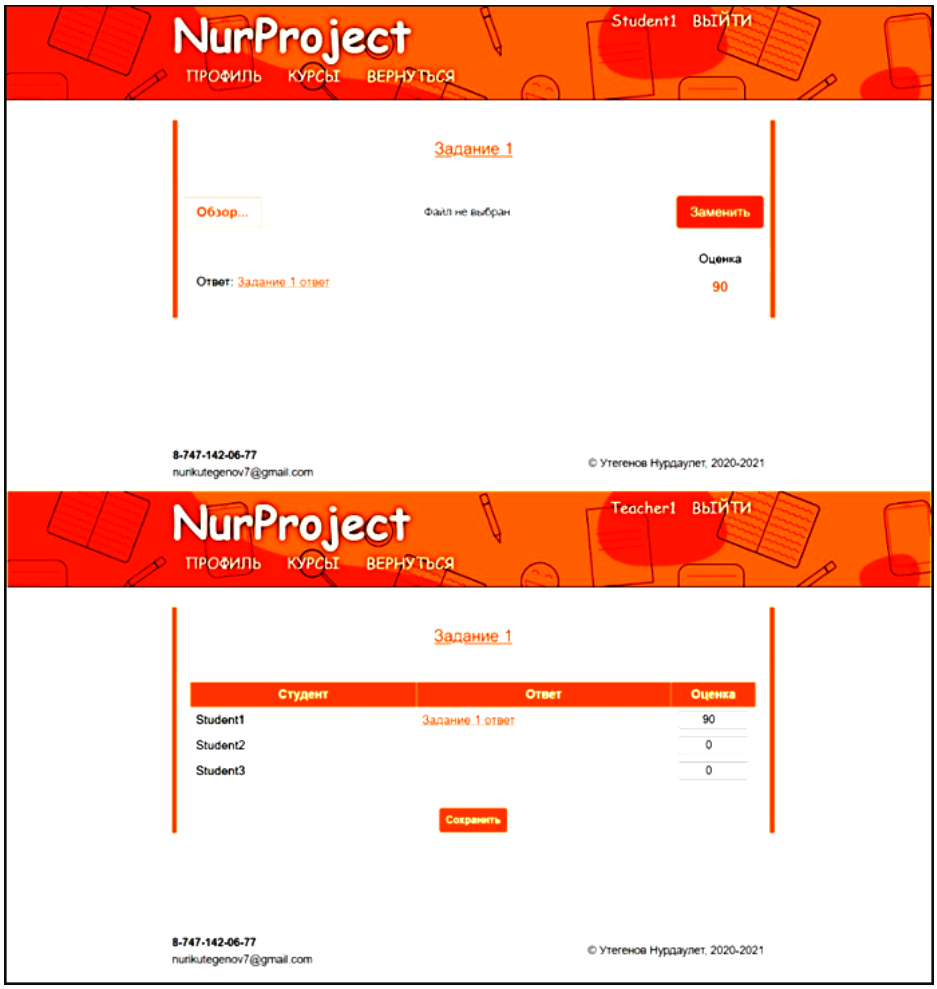

Figure10. Differences depending on the type of Student1 or Teacher1. Source: Compiled by the authors

Thus, we managed to build a unified information learning environment by integrating various systems: personnel management, performance assessment, and the regulation of user knowledge and skills. An additional component of the forum made it possible to build a communication system between the participants of the training.

DISCUSSION

After the creation of our distance learning platform NurProject, a comparative analysis as well as an approbation of DLS with students of Zhangir Khan University (Uralsk, Kazakhstan) with the most popular distance learning systems were carried out. A total of 173 students of the specialty "Information systems and technologies" took part in the pedagogical experiment. The results of the experiment revealed an increase in the level of knowledge of the experimental groups compared with that of the control groups. Furthermore, in the final survey, more than 92% of the respondents, both the students and teachers, stated that they were completely satisfied with the NurProject distance learning system. However, there are some comments that will help improve the system in the future. The results of a comparative analysis of web platforms are shown in Table 3.

Table 3. Comparison of the considered web platforms

Features/Platform	Free of charge	Own hosting or cloud	Browser and mobile version	Technical support	Webinars	Ease of use	Landmark on dist. training	Knowledge Input Filter	Σ
1. WebTutor	-	-	+	+	+	-	-	-	3
2. Moodle	+	-	+	+	-	-	+	-	4
3. iSpringLearn	-	-	+	+	+	-	+	-	4
4. iSpringMarket	-	+	+	+	+	+	-	-	5
5. Google Classroom	+	+	+	+	-	+	-	-	5
6. Teachbase	-	+	+	+	+	+	+	-	6
7. NurProject	+	+	+	+	-	+	+	+	7

Source: Compiled by the authors

An analysis of the literature on the research topic revealed that the most popular distance learning systems are WebTutor, Moodle, iSpring Learn, iSpring Market, Google Classroom, and Teachbase. Therefore, as part of the study, Zhangir Khan University teachers, as well as other third-party experts in the field of distance learning, were offered these platforms for comparative analysis.

A survey of distance learning users made it possible to determine the main criteria by which these systems were evaluated, namely, free of charge, own hosting or cloud, browser and mobile version, technical support, webinars, ease of use, and landmark on dist. training, and the knowledge input filter. As shown in Table 3 Our platform NurProject scored the highest score.

If this criterion or opportunity was present, 1 point was awarded; otherwise, 0 points were awarded. In our opinion, free of charge and ease of use are important criteria in the learning environment of Zhangir Khan University. For further research, we suggest that the expert rank the weight of the criteria using the coefficient k, taking its values in the range $0 < k < 1$.

The results obtained in the present study confirm the results of the iSpring sites and hr-elearning.ru [16; 19], which describe in detail the parameters of such distance learning systems as Moodle, Ilias, iSpring Learn, WebTutor, Teachbase, GetCourse, iSpring Market, Memberlux, "Anti-training", ATutor, Eliademy, Forma LMS, Dokeos, Opigno, OLAT, Skill Cup, Equio, TalentTech, and JetSkills.

Reference [3] similarly evaluated various e-learning tools, such as Wikipedia, Moodle, Web 2.0, Web 3.0 and Blackboard. The authors of this study preferred the Moodle platform.

In addition to the works of [11; 18], we have expanded several criteria for the quality of the distance learning system, with the help of which the level of effectiveness of the most popular platforms was determined.

CONCLUSION

Having studied the various possibilities of using modern information technologies, we can conclude that information technologies and the internet are most suitable for organizing the educational process of students in the field of distance learning. Moreover, the developed platform serves as a good example for demonstrating the main possibilities of using modern IT tools in the field of distance learning.

From a technical point of view, the introduction of this DLS into the educational process of a higher educational institution or organization will not incur high economic costs. The object-oriented approach that was applied as part of the development of the platform contributes to easy and quick system upgrades in the future.

Notably, the developed platform, which is a full-fledged DL website, also represents the basis for the further development of information technology in general and distance learning in particular. In subsequent work, it is possible to use a variety of IT tools, taking into account the specific conditions and requirements of various organizations. For example, there is the possibility of using video communication technologies. The coronavirus disease 2019 (COVID-19) pandemic that began in 2019 also adds to the relevance of this work.

From the point of view of information security, the developed product of domestic production has several advantages over other types of foreign software. The object-oriented approach that was applied as part of the development of the platform contributes to simple and quick system upgrades in the future.

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