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Evaluation of the Effectiveness of the Implementation of Moodle for the Study of Pathological Physiology at the Sumy State University

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Abstract: In recent years, education around the world has received certain challenges in the form of the COVID 19 pandemic, and in Ukraine, the educational process continues for the third year against the background of a full-scale war. To prepare for practical classes, students use the Moodle distance learning server. **The purpose** of the study was to assess students' satisfaction



with the distance learning server and determine the impact on students' success. **Materials and methods.** We conducted a detailed Case-study using qualitative and quantitative methods. The survey included questions about user-friendliness of the interface, availability of materials, quality of content, and overall satisfaction with using the system. The selection of research participants was carried out on the basis of a target sample among students of the Sumy State University based on a questionnaire of 2 groups of students of the 2nd year of the Master's degree of the Faculty of Medicine. At the preparatory stage, a questionnaire with a list of questions was developed. At the next stage, a survey of students was conducted. And at the final stage, the results were summed up on a Likert scale and a conclusion was formed. **The obtained results** indicate the existence of a strong correlation in the statement that the educational content meets the educational needs and is 0.76. A strong correlation coefficient exists for the statement that "using the Moodle system increases my motivation to study pathophysiology" and is 0.68, as well as for the statement "I am satisfied with using Moodle to study pathophysiology" and is 0.85. The average degree of correlation was calculated for the statements about the use of test tasks in preparation for practical classes, as well as the occurrence of some technical problems when working with Moodle, which is revealed in the average correlation for the statement about the quick solution of technical problems. **Conclusion.** The implementation of the Moodle system for the study of pathological physiology at the Sumy State University turned out to be effective. Improvement of exam results, high level of student satisfaction and increased motivation to study.

Keywords: e-learning, the Likert scale, distance learning, online resources, learning management system.

Introduction

Digital learning technologies have long been part of education and have become an integral part of the educational process. In recent years, education around the world has received certain challenges in the form of the COVID 19 pandemic, and in Ukraine, the educational process has been going on for the third year against the background of a full-scale war. Digital formats and content (e-learning) have long become an integral part of academic teaching and continuing medical education. It is important to understand that the educational process should be continuous and waiting for the end of the pandemic, which lasted for 2 years, was inappropriate. It was then that the Moodle platform, which was simply a source of additional information and training, became the leading source in the transition to distance learning in the conditions of the Covid pandemic and in the conditions of war (Gamage et al., 2022). Recently, distance learning has moved into the category of everyday life (Wang et al., 2024). Today, we often use the concepts of distance learning and e-learning. Distance education, which developed in the context of the COVID 19 pandemic, and continues in Ukraine in many educational institutions due to the impossibility of physically visiting educational institutions, is used as a form of education. e-learning is a learning tool. Digital formats used by e-learning make it possible to make traditional classes and exams more diverse and understandable thanks to numerous new technical possibilities (Berenyi & Laszlo, 2023). In European countries, the introduction of blended learning using e-learning tools made it possible to solve the problem of increasing the number of students receiving medical education. Thus, the works of Paul Bobbink (2022) describe the methods that were implemented to improve the knowledge of undergraduate medical students. Specialists introduced options for virtual training, as well as elements of mixed training in combination with



the traditional form (Bozkurt & Sharma, 2020). Virtual learning, as a tool, can be more flexible and independent of place and time, therefore it helps to better adapt to the individual needs of students. At the same time, these formats must be carefully planned and integrated into the learning concept, taking into account higher-level competencies and specific learning goals, and the technical implementation must be suitable for the didactic purpose. Also (Leidl et al., 2020) considered possible tools with elements of e-learning with introduction into the initial process of recording e-lectures, virtual web classes. Virtual learning is not intended to replace face-to-face learning in the future, but rather to complement and enrich each other in so-called blended learning formats. The use of e-learning tools increases the formation of practical skills in medical university students (Li et al., 2019). Distance learning platforms that are filled with quality content promote student discipline and improve self-study success (Noh & Kim, 2019). It is important to consider the use of such methods as a living process that should, as far as possible, be accompanied by the didactics of learning and further developed through regular evaluation activities by teachers and students. The use of e-learning technologies enables the student to manage his time (Leidl et al., 2020). E-learning can be used in different formats. Examples can be software in the form of electronic 3D anatomy atlases, or remote platforms: MOODLE, GOOGLE CLASSROOM, PROMETHEUS, ED-ERA, LEARNINGAPPS and others. Modern online technologies have made it possible to introduce the "inverted classroom" model into the learning process. This model involves self-study at home with the help of online resources, and in face-to-face classes there is an analysis of the material or problematic issues. This model has proven itself positively, which has improved the level of students' knowledge (Hege et al., 2020; Kang & Kim, 2021).

Research Problem

Implementation of e-learning in whole or in part is an integral part of studying any discipline. The use of online technologies, on the one hand, facilitated preparation and improved students' access to information sources. But on the other hand, it has created problems that need to be solved.

1. For successful learning using the Moodle remote server, it is necessary to analyse the quality of the content.

2. Online technologies and their use in the educational process require certain work skills from both teachers and students. This can be a problem for older teachers, with a lot of experience and knowledge, they have insufficient computer skills, while young researchers and teachers have good platform skills, but insufficient knowledge.

3. For effective work, it is necessary to analyse the technical capabilities of the Moodle distance learning server.

3. The research conducted by us is aimed at solving the question of the effectiveness of using the Moodle distance learning server in preparing for pathological physiology.

4. With the help of a questionnaire, it is necessary to establish the satisfaction of students and teachers with the work of the Moodle distance learning server.

5. This study will help to establish how the use of Moodle affected the academic performance of students, which will help to draw certain conclusions about the feasibility of using this system?



Research Aim and Research Questions

The purpose of this study is to evaluate the effectiveness of the implementation of the Moodle system for the study of pathological physiology at the Sumy State University.

The research will help us answer the following questions:

1. To what extent students are satisfied with the interface of the Moodle system when studying pathological physiology and how the use of the platform helps them in preparing for classes?
2. How the use of the Moodle platform affects the success of pathological physiology students?
3. What difficulties do students have when working in the system, preparing for classes and listening to lectures on pathological physiology?

Literature Review

The creation of e-learning provides an opportunity to learn throughout life and to choose convenient learning formats and time. For doctors, both students and specialists, lifelong learning is always relevant. Medical fields are very dynamic. Many things change quickly enough in diagnosis and treatment. Therefore, a specialist doctor should always be aware of modern treatment and diagnostic technologies (Büttcher & Ströbel, 2021).

E-learning provides training or obtaining educational content via the Internet or using digital technologies. E-learning provides additional opportunities for face-to-face and distance learning. First of all, the material necessary for preparation can be placed on the distance learning server when using e-learning technology. Even if the student was unable to attend the lecture or class, he will be able to familiarize himself with the video recording of the class or lecture on the distance learning server (Hege et al., 2020).

The mode of joint interaction of the educational group using the Moodle distance learning server provides an opportunity to improve the educational process. Moodle (Modular Object-Oriented Dynamic Learning Environment) is an educational resource for distance learning that can be found in the literature as a learning management system, or LMS, or it can take the form of a CMS course management system, or it can be a virtual learning environment (VLE), or it will be a learning platform with a set of tools for working remotely for the teacher and student (Kang & Kim, 2021).

According to the results of research in 2015-2020, the Moodle program became the most popular for e-learning (Nuryani et al., 2022). The program offers many active courses that are available in many languages. The number of Moodle users has been growing steadily since 2015 and amounted to 294 million users in 2021. The platform has a convenient interface and allows you to add a resource: text file, video material; and also create activities in the form of online workbooks, tests, online tasks, surveys (Murillo et al., 2019).

The Moodle system was developed with the aim of active learning and the possibility of interaction of all participants in the process. The system allows you to divide a complex course



into modules, which is basically implied in the very name of the system. The Moodle platform is available to students 24 hours a day from anywhere in the world (Yoshioka-Maeda et al., 2019).

Moodle is an open system and available under the terms of the GNU General Public License. The main advantages of learning with the help of Moodle are: many formats of educational activities, the use of various types of educational materials in the form of: online lectures, video materials, text files (Rivers, 2021). For the teacher, a wide set of tools is presented, which helps to control the knowledge of students using: questionnaires, test tasks, written tasks, communication in the chat. An important point for successful work in Moodle is the skills of the tutor (teacher) of the course, as the tutor fills in all the necessary information for the course (Aflalo et al., 2020).

Experts indicate that the Moodle platform, as an auxiliary tool for distance learning, improves the success of students, but similar studies conducted among medical and biological students have established a slight difference in the success of online and traditional learning (Sayiner & Ergönül, 2021). Online learning should be student-centered. It is very important to support the student's motivation with the help of high-quality content on the distance learning server. When working on the e-learning server, the teacher should try to use various tools that allow providing the student with accessible and useful information and, on the other hand, create quality tasks for assessing the student's knowledge and skills (Kharchenko et al., 2021).

The concept of "inverted class" is often used in the literature. This is a method of mixed learning, in which students use an online platform to prepare for classes, and in a practical class, the teacher discusses problematic issues and situational problems with students. The learning experience during the pandemic demonstrated a rather successful result of the introduction of e-learning for students of medical universities (Gianoni-Capenakas et al., 2019). But teachers of clinical departments have never considered distance learning as an alternative to face-to-face learning, but only as a measure of immediate response in the conditions of an emergency situation for education. But a number of difficulties have arisen, which must be resolved taking into account the current situation in Ukraine, as well as the forecasts of experts about possible severe pandemics in the near future (Souza et al., 2016).

Online education offers many forms for effective acquisition of both theoretical and practical knowledge by students. For medical students, multimedia materials, virtual patients, simulations, podcasts, webinars, and online courses can be offered (Kim et al., 2021). Online simulations can create virtual patients or quality situational scenarios for the purpose of teaching diagnosis, examination plan, treatment plan. Modern technologies make it possible to widely implement and constantly improve technologies with improved design and new capabilities (Cao et al., 2023).

Simulated central venous catheter training for internal medicine and emergency physicians significantly reduced catheter-related bloodstream infections. A virtual patient collection created through international collaboration during the COVID-19 pandemic was successfully used to teach clinical thinking (Smith et al., 2022; Wu et al., 2020).

When creating learning content, it is necessary to create an attractive and convenient interface. A lot depends on these characteristics. If the interface is accessible and easy to use, the student will be willing to use it when preparing for classes. If the interface is complex and it may



take a lot of time to master the user manual, which may also be quite confusing, that will reduce the number of visits to this resource (Ettl et al., 2022).

An important point when creating content on a distance learning server is taking into account the needs of students, matching the content with educational programs (Ettl et al., 2022). For example, the tests that the student takes in the control mode must be given in the training mode as well. Posted lectures should contain interesting information developed by the teacher, and not be a retelling of a textbook that a student can get in the library (Elgohary et al., 2022).

In modern conditions, the introduction of electronic educational systems becomes an integral part of the educational process. One of the most popular e-learning tools is the Moodle learning management system (Jebb et al., 2021).

In recent years, the introduction of distance learning was necessary to maintain the continuity of education in the conditions of the pandemic, and in Ukraine, online learning made it possible to continue studying for students and pupils who were not physically able to be in educational institutions.

According to the literature of domestic and foreign specialists, the implementation of the remote form has achieved the main goal - preservation of education.

But distance learning using servers has its own characteristics and requires students and teachers to have certain skills for working on online platforms. The issues of the effectiveness of training students on Moodle distance learning servers and the success of students remain unresolved. The issues of student satisfaction with distance learning servers, whether they are filled with the necessary content, and technical issues that arise when working on the platform are still unclear.

Materials and Methods

We conducted a detailed case-study using qualitative and quantitative methods in the following stages:

1. Survey of students: A survey was conducted among students who used the Moodle system to study pathological physiology.
2. Performance analysis: Comparison of the results of the module control in pathological physiology before and after the implementation of the Moodle system.
3. Observation of students' work.

Sample and Participants

The selection of research participants was carried out on the basis of purposive sampling among students of the m on the basis of a survey of 2 groups of students of the 2nd year of the master's degree of the Faculty of Medicine. The group consisted of 15 and 16 people, respectively. So, the number of research participants was 31 (Ettl et al., 2022).



Instruments and Procedures

At the preparatory stage, a questionnaire with a list of questions was developed. At the next stage, a survey of students was conducted. And at the final stage, the results were summarized and a conclusion was formed. The survey included questions about the user-friendliness of the interface, availability of materials, quality of content, and overall satisfaction with using the system (Elgohary et al., 2022). The analysis of success is analysed by studying the average scores of students, determining the number of students who successfully passed the modules and the number of students who received high marks. The students' work in the Moodle system was observed, in particular, how they interact with the content, what difficulties arise and how they are solved (Jebb et al., 2021).

Data Analysis

We used empirical methods of observation, interviewing respondents (conducted using the questionnaire method) and summarizing their results, and also evaluated students on the interface of the Moodle distance learning server using an ordinal rating scale, otherwise known as a Likert scale. The use of this method makes it possible to obtain quantitative estimates of the relationship of respondents, suitable for analyzing the expressiveness of interest in the researched aspect, measured on a rank scale.

Spearman's rank correlation coefficient was also used, which makes it possible to establish a relationship between training in Moodle and students' success based on the results of module evaluations and the average success score (Rimsha et al., 2021).

Results

In the work, using the Likert scale (summary evaluation method), the analysis of opinions and identification of motivation in the study of pathological physiology was carried out. This technique uses a scale that assesses the respondent's attitude to a certain statement. For the analysis, we used a classic scale consisting of five ratings (Elledge et al., 2022):

- completely agree - 5 points;
- agree - 4 points;
- partially agree - 3 points;
- partially disagree - 2 points;
- completely disagree - 1 point.

A positive relationship is coded with 5 points, and a negative relationship with -1 point (See Appendix A).

When asked in the questionnaire how students evaluate the usability of the Moodle system interface when preparing for classes in pathological physiology, the majority (85%) gave a positive assessment. 5% rated the interface as inconvenient and 10% of students indicated that the system interface is of no importance to them.



In the proposed questionnaire, students could give an assessment expressed in points, or put "checkmarks", "pluses" and other signs that allow determining their relationship. It should be noted that from the processing of the results, omissions of answers to some question were found, or the student chose two answers to one question. We excluded such questionnaires from the study, so in the end, the answers of 31 students were taken into account (Pithon et al., 2019).

Processing of research results was carried out in the following sequence.

1st stage - conducting a survey and drawing up a summary table with the survey results. When compiling the summary table, we collected the answers of all students. In the course of processing, omissions of answers were discovered, as well as "spoiled" questionnaires in which students chose several answers. Such questionnaires were excluded, as a result of which the authors processed the questionnaires of 31 students.

In the table 1 presents the survey results.

Table 1

Total Survey Results

Student s	Assertio n 1	Assertio n 2	Assertio n 3	Assertio n 4	Assertio n 5	Assertio n 6	Assertio n 7	Total score
1	5	5	5	2	1	2	4	24
2	3	4	4	2	3	2	4	22
3	5	4	4	2	2	2	4	23
4	5	4	4	4	3	4	4	28
5	5	5	4	5	5	5	4	34
6	5	4	5	4	3	4	4	29
7	4	4	3	4	2	4	3	24
8	5	4	4	4	4	4	4	29
31	4	4	5	4	3	4	4	28

All received points are added up for all statements. At the second stage, statistical processing of the results takes place

At this stage, based on the results of the first stage, it is necessary to build a conjugation table. This stage involves building a conjugation table, where we calculate the correlation coefficient

In the table 2 presents the results of the calculation of 7 statements

At the third stage, the Spearman coefficients of each judgment are calculated and conclusions are drawn.

The calculation is carried out according to the Spearman rank correlation formula:

$$r_s = 1 - \frac{6 \sum d^2}{n(n^2 - 1)}$$



r_s - Spearman's rank correlation coefficient; d - is the difference of pairs of ranks for judgment; n - is the number of pairs of ranks (the number of respondents).

The calculation of the coefficient is presented in Table 3.

Table 2

Correlation

Student	Total score S_0	Judgment score S_1	Total score $S_0 - S_1$	Rank	Rank difference	Rank differenced	The square of the difference in ranks, d^2
1	24	5	19	8	24	16	256
2	22	3	18	12	16	4	16
3	23	5	18	4	8	4	16
4	28	5	23	30	12	-19	361
5	34	5	29	25	24	-1	1
6	29	5	24	7	28	21	441
7	24	4	20	15	20	5	25
8	29	5	24	19	18	-1	1
31	28	4	24	11	12	1	1
	834	134					3358

Table 3

The Results of Calculating the Spearman Coefficient

Assertion	Correlation coefficient, r_s
The interface of the Moodle system is convenient and intuitive	0.68
Learning materials are easily accessible in the Moodle system	0.58
The pathophysiology content on the Moodle server meets my learning needs	0.76
I use tests to prepare for classes and they help me learn the material better	0.45
The distance learning server quickly solves the technical problem when overloaded	0.48
Using the Moodle system increases my motivation to study pathological physiology	0.74
I am satisfied with using Moodle to study the study of pathophysiology	0.85

In order to evaluate the obtained results, it is necessary to establish boundaries that establish a relationship between the characteristics that are evaluated.

A strong relationship with values of the r_s coefficient of 0.7 and more;

- average connection - from 0.4 to 0.699;

- weak connection from 0 to 0.399.



A performance analysis showed that using Moodle increased students' GPA on the final module in Pathological Physiology. The average score on pathological physiology exams increased from 3.5 to 4.2 (on a five-point scale). The number of students who successfully passed the final module also increased by 15% (Figure 1). The number of students who received high grades (4 and 5) also increased by 20% (Figure 2).

Figure 1

The Number of Students Passed the Final Module

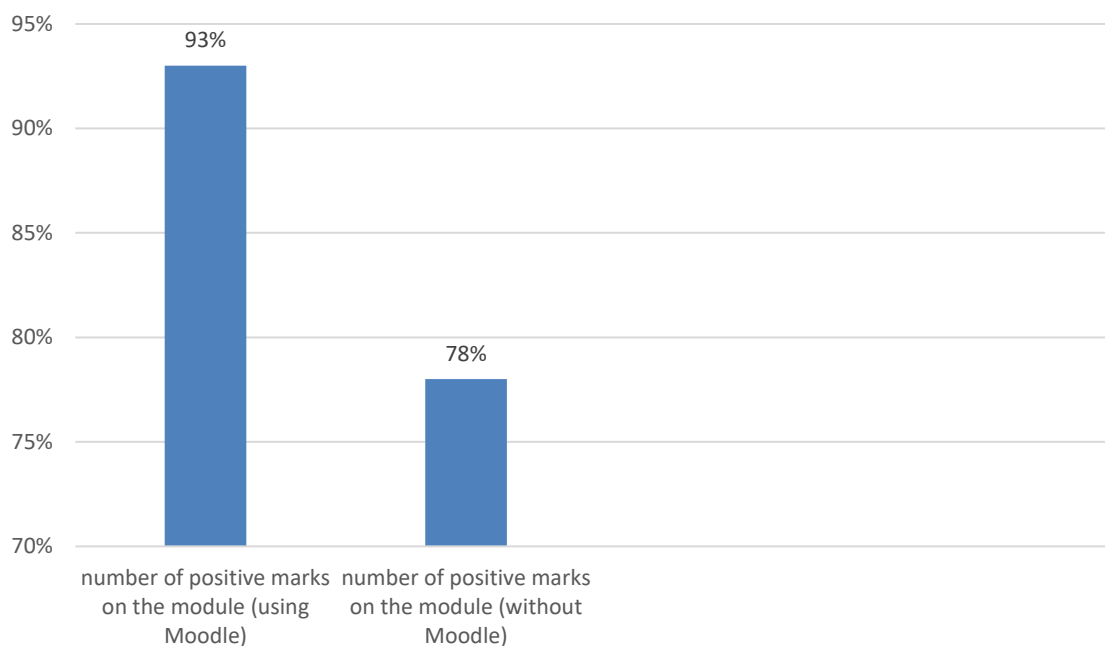
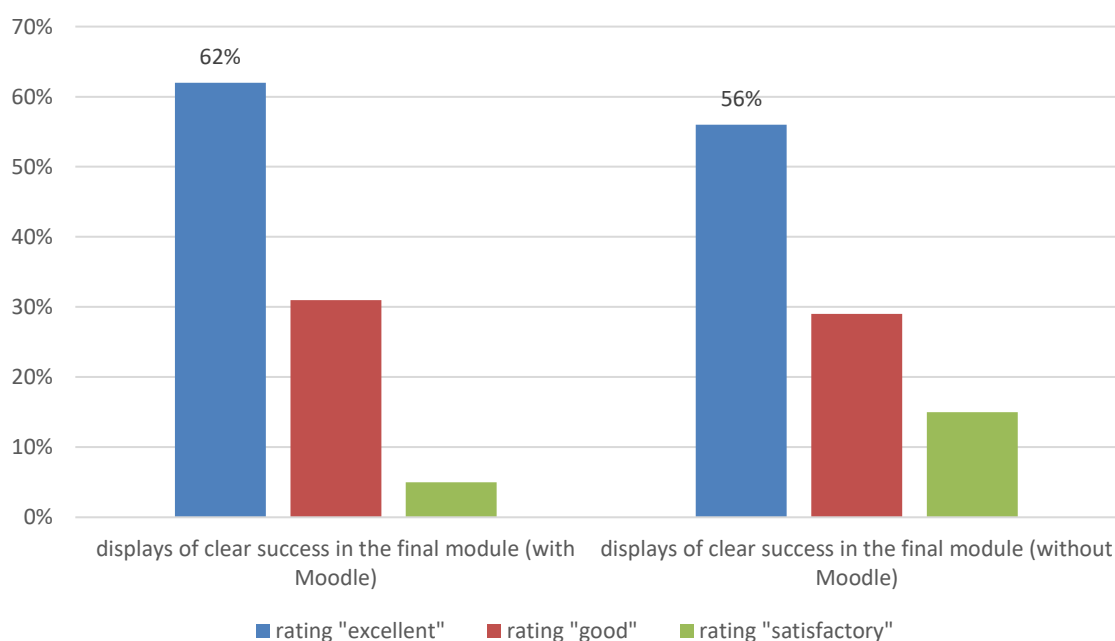


Figure 2

Grades of Students





Discussion

The purpose of this study was to establish the impact of distance learning on students' academic performance, as well as to determine, through a survey, students' satisfaction with distance learning using the Moodle platform.

The obtained results indicate the existence of a strong correlation in the statement that the educational content meets the educational needs and is 0.76. A strong correlation coefficient exists for the statement that "using the Moodle system increases my motivation to study pathophysiology" and is 0.68, as well as for the statement "I am satisfied with using Moodle to study pathophysiology" and is 0.85 (Jebb et al., 2021). The average degree of correlation was calculated for the statements about the use of test tasks in preparation for practical classes, as well as the occurrence of some technical problems when working with mudl, which is revealed in the average correlation for the statement about the quick solution of technical problems (Mudiyanselage & Pan, (2020).

According to the literature, Moodle is widely used in teaching at universities, and according to the results of the analysis, the use of the distance learning system significantly increased the quality of student training, the overall success score (Chaparro-Peláez et al., 2019; Ettl et al., 2022). The use of the platform contributes to solving the issue of academic integrity, and is also a basis for the possible implementation of artificial intelligence in education. Such data are given regarding the use of the Moodle distance learning server for students of nursing, dentistry, and medical practice (De Medio et al., 2020).

According to Moodle users, the risk of quizzes with potentially incorrect answers is quite high. Some tests may be incorrectly formed, and answers may be duplicated, which reduces the quality of the evaluation system. There are also questions about the correctness of the answers (Badia et al., 2019).

A serious problem is the control of Moodle. A team of IT specialists should work to improve the e-learning system. However, not all universities have such resources, which limits the possibilities of improving the system (García-Martín & García-Sánchez, 2020). Teachers are responsible for ensuring optimal student assessment methods. Assessment of knowledge should be comprehensive, taking into account theoretical training and practical skills (Li et al., 2020).

The experience of using Moodle for the training of specialists in general received favorable evaluations, as evidenced by the data presented in the literature. In order to provide students with high-quality material, it is necessary to provide access to electronic versions of textbooks, tests, and lecture materials (Dias et al., 2020; Granić & Marangunić, 2019). The literature sources indicate that survey results show that medical university students have long been using Internet resources to prepare for classes, which saves time for students, provides an opportunity to study at a convenient time, and creates access to information 24/7 (Abdula et al., 2020; Grundgeiger et al., 2023). Specialists of clinical departments noted that the introduction of telemedicine allowed students of medical universities to easily switch to distance education using electronic platforms (Kim et al., 2019; Ullrich et al., 2021). Demonstration of a virtual patient and work in online laboratories significantly expands the student's imagination, and sometimes provides even more opportunities when working in a virtual laboratory than in face-to-face with a limited material and technical base (Morze et al., 2021).



The implementation of distance learning is generally favorably evaluated by the participants of the educational process (Elledge et al., 2022). Students positively evaluate the possibility of self-assessment of knowledge. Participants in the process like access to online webinars, the presence of interactive webinars based on specific cases (De Medio et al., 2020). But there are certain difficulties in implementing distance learning. There are difficulties when interacting at "artificial" meetings, where communication without direct contact can be difficult (Ehrlich et al., 2020). In addition, technical difficulties may arise. Clinical specialties can provide mainly the theoretical part, and practical skills must be practiced face-to-face, the presence of a doctor, a future doctor near the patient is necessary (Garg et al., 2022; Santos et al., 2021). Practicing practical skills in simulation centers is important for students of medical education. On the basis of the centers, you can learn the skills of surgery, obstetrics, dentistry, and therapy.

The assessment of the quality of education showed that the students who took part in the study significantly improved their knowledge of pathological physiology, which was demonstrated in the final modules, and also improved the indicators of the students' qualitative success. In the work of Sithara H P W Gamage, a systematic analysis was carried out, in which the author analyzed 151 sources, regarding the effectiveness and results of the implementation of the distance learning system on the Moodle platform. In the conclusions, the author points out the effectiveness of using the platform for training students of medical institutions and improving the quality of education due to accessibility to information sources.

Our research was presented on a small sample. This may affect the overall results. A certain factor may be the peculiarity of the content of the Moodle platform in the university chosen for the study. A small sample does not allow us to indicate the statistical reliability of the obtained results, the obtained results cannot be generalized for students of all medical universities.

Conclusions and Implications

The use of the Moodle platform in preparing for classes has shown improved exam results, a high level of student satisfaction, and increased motivation to study. According to the results of the study, the success rate of students during the completion of modules and test tasks has significantly increased, which is connected with the possibility for students to pass the test in the training mode until the desired indicators are achieved. According to students, the platform is quite convenient to use, and the content posted on the server should be prepared for uploading. Quick access at a time convenient for the student facilitates the possibility of preparation. Students found the Moodle platform interface easy to use. A significant number of students noted the technical difficulties that occur when working on a server that can be overloaded and unable to cope with such a large number of users. Some students noted that solving technical problems does not happen quickly, which can affect training. To improve the operation of the server, it is necessary to carry out technical prevention and conduct surveys of students and teachers, regarding the ease of working on the platform, as well as the quality of content, which helps to maintain and improve Moodle performance.

Suggestions for Future Research

The use of the Moodle distance learning system in the educational process significantly improved students' knowledge. But there are a number of issues that require further resolution. The database of test tasks needs improvement, as sometimes there are errors in the tests, wrong



answers are coded. Despite the fact that students are satisfied with the server for preparing for practical classes in pathophysiology, the content uploaded to the server, namely videos and images on topics, needs improvement. This determines the topics of our further research.

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Conflict of Interest

None.

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Appendix A

Questionnaire: Experience Using the Moodle System for Studying Pathological Physiology

Question	Totally disagree 1	Partially disagree Disagree 2	Partially agree 3	Agree 4	Completely agree 5
The interface of the Moodle system is convenient and intuitive					
Learning materials are easily accessible in the Moodle system					
The pathophysiology content on the Moodle server meets my learning needs					
I use tests to prepare for classes and they help me learn the material better					
The distance learning server quickly solves the technical problem when overloaded					
Using the Moodle system increases my motivation to study pathological physiology					
I am satisfied with using Moodle to study the study of pathophysiology					