The object of this study is the process of implementation of control measures with the help of distance learning technologies for students of technical specialties. The problem of the application of information and communication technologies for the effective implementation of final control during distance learning has been studied. An authentic algorithm for creating a test on the Moodle platform has been developed. The proposed algorithm is based on the use of the classical structure of the ticket, which allows implementing an approach to final control that is closest to the traditional one. This is important for assessing the acquired practical students competences of engineering specialties since for them the control measure may include a combination of textual, graphic, and computational tasks. The application of the algorithm in practice allows one to improve the quality of the final assessment by ensuring equal conditions for students, attracting the optimal set of tools for this, as well as identifying the student and thus ensuring the transparency of the control measure.

Verification of the developed algorithm during the quarantine period sessions at the Faculty of Transport Construction of the National Transport University demonstrated a better adaptability of students to conduct control measures in remote form. This is confirmed by an increase in quality (from 1.16 % to 6.8 %) and success (to 7.4 %) rates among students, as well as a high level of student satisfaction in 2022 with the effectiveness of online learning, which was determined through an anonymous questionnaire. Promising steps regarding the use of the algorithm in the final evaluation are the development of measures for the implementation of automated recognition of the emotional status of students

Keywords: distance learning, control measures, systems LMS, Moodle, algorithm for creating an exam

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DEVISING AN APPROACH TO THE USE OF DISTANCE EDUCATION TECHNOLOGIES IN PERFORMING CONTROL MEASURES FOR TECHNICAL STUDENTS

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1. Introduction

The introduction of quarantine measures, caused by the global pandemic of COVID-19, regarding the organization of the educational process at institutions of higher education determined the need to transition from a traditional form of education to a mixed and distance form. Such a rapid transition caused a number of problems of an organizational, technical, and legal nature, in particular, regarding the organization and implementation of control measures. The procedure for conducting an exam or assessment has become fundamentally new. It included the use of information and communication technologies, synchronous and asynchronous methods of conducting the control event and methods of identifying the person of the applicant, the type of examination task. Reorganization of examination materials for engineering specialties caused special difficulties. This is due to the fact that, traditionally, the examination ticket included a wide range of theoretical tasks and an engineering task or a calculation-graphic task. In addition, the set of information and communication technologies that allow the implementation of the traditional structure of the examination ticket is significantly limited. Automated multifunctional information systems of the LMS class, in particular, for example, Moodle, are considered more successful in solving such a task. However, there is a need to develop algorithms for the use of such tools for the implementation of a control measure in the traditional form, which renders relevance to the chosen research area.

2. Literature review and problem statement

Many researchers have paid attention to the task of organizing and conducting control measures using automated

information systems such as LMS (Learning Management System). For example, among the fundamental works in Ukraine in this field, a collective monograph [1] should be noted. It considers the analysis of the Ukrainian experience of organizing distance education. In turn, work [1] noted problems in the implementation of control measures and their objectivity among students of engineering specialties. These problems were related to the emergency (rapid) transition to distance learning during the quarantine due to COVID-19. However, in the cited scientific work, the issue of conducting control measures for students of engineering specialties is not fully resolved.

A critical analysis of the problems and prospects of using information and communication technologies in education is given in [2, 3]. In particular, these studies report the results of a student survey on the quality of distance learning and the feasibility of using information and communication technologies. Paper [4] presents a model of the transition from traditional to distance learning. The review of these studies shows that when switching to distance learning, an important aspect is the preliminary preparation of the educational institution and lecturers. It is necessary to take into account the learning objectives, teaching style, and adapt the courses to the needs of students. However, apart from stating the problems of distance learning and determining the necessary steps, research data [2–4] do not provide practical recommendations for achieving the quality of education.

In [5], it was determined that assessment and control measures in the online environment are one of the key elements of the teaching and learning process. However, the proposed approach is quite generalized and mostly does not take into account the specifics of individual educational programs. Studies [6, 7] were aimed at proving the objectivity of using distance learning technologies to implement control measures during the quarantine period during COVID-19. In particular, work [6] reports the results of the analysis of the quality of online education of students, which was performed using the descriptive-phenomenological method. The result of the study was the classification of the received data according to advantages, problems and recommendations. However, a relatively small sample of students was studied, in which representatives of technical specialties were not present. Study [7] describes the advantages of using LMS class systems. But the author did not fully develop recommendations for evaluating the results of online education.

The main efforts of researchers [8, 9] were aimed at ensuring the academic integrity of students when taking exams or practical tasks. In [8], it was proposed to use online testing with various interactive tasks as one of the methods of combating dishonesty. In work [9], lecturers are suggested to devise authentic means of online diagnostics of students' learning results. However, this does not solve the problem of complex tasks for the exams of engineering students.

Study [10] reports a study of students' attitudes towards computer testing as a type of control measure. The authors note that conducting the exam with the help of computer tools led to an increase in the success of students. However, a number of technical problems with online testing were identified, related to lack of skills, data loss during test processing, and the risk of student dishonesty. In [11], the advantages, disadvantages, and problems of developing test tasks for distance courses and their use during control measures are defined. However, the studies are of a generalized nature and do not take into account the problems of examining engineering students.

Study [12] determined the role of information and communication technologies as a tool for assessing the level of students' knowledge. As a result, the positive impact of periodic computer testing in the subject «mathematics» on the final results of education was established. However, the effectiveness of using online tools during the final control was not fully substantiated.

Thus, in work [13], the authors proved the effectiveness of using different types of Moodle tasks for online English language testing at higher education institutions. At the same time, a sample was analyzed from the number of first-year undergraduate students (857 students) at the National University «Kyiv-Mohyla Academy» (Ukraine) and from the number of lecturers of the English language department (20 lecturers). In particular, in a similar study [14], the authors recorded a 13.41 % improvement in the quality of performance of control measures using the Moodle platform compared to the same period when such tests were not used. Thus, it can be argued that LMS platforms have a better potential in ensuring the quality of student assessment.

Study [15] reports the results of the analysis of the attitude to testing of graduate students under the conditions of online learning based on the Moodle information system. In particular, graduate students noted that online testing creates psychological comfort for the applicant and is a more convenient form of control than a paper or oral form.

In work [16], it was established that the Moodle platform makes it possible to conduct a qualitative check of the level of knowledge through intermediate and control testing. In particular, the authors of paper [17] proposed and tested a complex model of distance learning for engineers based on a combination of Moodle (Australia), CADMATIC (Ukraine), and TeamViewer (Germany) technologies. These scientific works [16, 17] are as close as possible to the goal of this study but they do not contain the results we are looking for. Namely, the cited works do not ensure the implementation of a complex engineering task online.

The review of the above studies [1–17] reveals insufficient attention in the scientific environment to the implementation of control measures for engineering specialties. This especially applies to the synchronous mode with the entrants completing essay-type test tasks.

3. The aim and objectives of the study

The purpose of our research is to devise an approach to the use of information and communication technologies in the implementation of control measures for students of technical specialties. This will make it possible to improve the quality of the final evaluation of students of engineering specialties by using an optimal set of distance learning tools.

To achieve the goal of the study, the following tasks were set and implemented:

– to develop an algorithm for the implementation of control measures with the help of distance learning technologies of students;

– to propose a methodology for evaluating the effectiveness of the developed control measures implementation algorithm;

– to perform an assessment of the effectiveness of the use of information and communication technologies in the implementation of control measures using the proposed methodology.

4. The study materials and methods

The object of the research is the process of implementation of control measures with the help of distance learning technologies of students of technical specialties.

The basis for devising the methodical approach is the algorithm for the implementation of control measures with the help of distance learning technologies for students of technical specialties. This algorithm is based on the use of scientific analysis methods in the field of student evaluation in mixed and distance learning. The main hypothesis of the study assumes that when using distance learning technologies for students of technical specialties, it is necessary to apply combined solutions regarding control measures. The main assumption of the study is the need to combine text, graphic, and computational tasks when assessing the acquired practical competencies of engineering students during control events. This makes it possible to improve the quality of the final assessment by using an optimal set of distance learning tools. The effectiveness of the proposed algorithm was evaluated using the KPI (Key Performance Indicators) method. Data for evaluating the effectiveness of the algorithm were obtained from the results of the session of engineering students at the Faculty of Transport Construction of the National Transport University (Ukraine, Kyiv) over the past three years. In the analyzed years, sessions of students of engineering specialties were included when taking exams traditionally, mixed, and online (according to the developed algorithm). The general personal information of the applicants in this study has been removed. Only KPIs achieved by the student during the session were used.

The final analysis file included, in general, the cohorts of bachelor's programs from the first to the fourth year and master's programs from the first year. In total, for the 2019–2020 academic year, the cohort was 420 students, for the 2020–2021 academic year – 392 students, for the 2021–2022 academic year – 385 students. The results of the student session for the bachelor's educational programs «Environmental protection technologies», «Construction and civil engineering», «Geodesy and land management» and the master's educational programs «Construction and civil engineering», «Geodesy and land management» were analyzed. In addition, an anonymous survey of students was conducted regarding the challenges and issues they faced during the transition to distance learning. 233 students took part in the survey.

5. Results of devising an approach to the implementation of control measures using distance learning technologies

5. 1. Development of an algorithm for implementation of control measures using distance learning technologies

The main forms of obtaining education at institutions of higher education are institutional (full-time (daytime, evening), part-time, distance, online) and dual. Until 2019, the most common forms of higher education in Ukraine were full-time and part-time. With the introduction of quarantine, which is associated with the global pandemic of COVID-19, the situation has changed in favor of distance and mixed forms of education. The transition to mostly new forms of education for most universities forced a methodological restructuring of the organization of the educational process with the use of information and communication technologies.

Modern information and communication technologies contribute to the mutual integration of higher education, innovative and scientific activities as components of the «triangle of knowledge». The three-dimensional concept of combining education, research, and innovation allows universities to ensure their competitiveness and contribute to the development of the state's economy by producing the specialists it needs. The basis of this is the generation and transfer of knowledge. The common area of intersection of the three components is the most effective area of development of each component in the «triangle of knowledge».

In this regard, most universities have devised their procedures for transition to new forms of learning and teaching. For example, in the 2019–2020 academic year, the Faculty of Transport Construction at the National Transport University (Ukraine, Kyiv) developed its own Procedure for conducting the credit and examination session [18]. According to the developed procedure during the implementation of control measures in remote form (Fig. 1):

1) the lecturer provides equal conditions for passing the exam or credit for all students;

2) the lecturer is obliged to identify the student when issuing the assignment. Identification must take place by means of a video conference with a student who presents a record book or other document certifying his/her identity in the absence of a record book;

3) the lecturer ensures the transparency of the exam (the video conference must be open to all visitors, the lecturer is the administrator of the conference);

4) the student is obliged to perform the tasks independently during the control event and not to use any auxiliary means;

5) the task is performed in two stages: written and defense of the written answer using a video conference.

Distance and mixed learning at the Faculty of Transport Construction of the National Transport University takes place mainly through the university Moodle platform, which was built at the Local Distance Learning Center. The administration of the National Transport University constantly promotes the implementation of various distance learning services and devises appropriate methodological recommendations for the organization of the educational process, which allow lecturers to use a variety of services and educational platforms [19, 20].

However, the main problem faced by lecturers of engineering disciplines was the creation of conditions for the objectivity and impartiality of evaluation of control measures in a remote or mixed form.

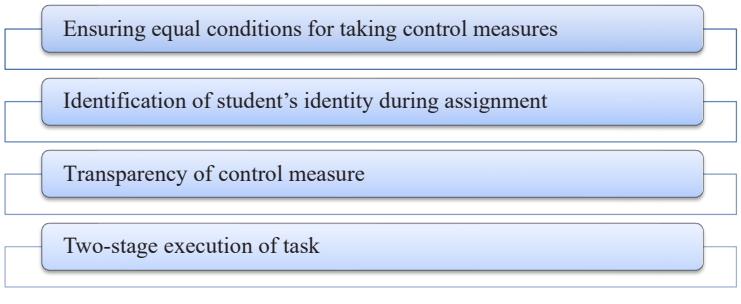

Fig. 1. The basic principles of conducting control measures under remote mode

Acquiring an engineering profession requires assessment of acquired practical competencies, which for the majority of disciplines can be assessed in the event of conducting a control event using a classical or combined approach. It can be at the same time – writing an essay, solving a problem, calculating-graphic work, drawing, etc. Thus, to solve this problem, an authentic algorithm for organizing a classic test in Moodle was developed (Fig. 2).

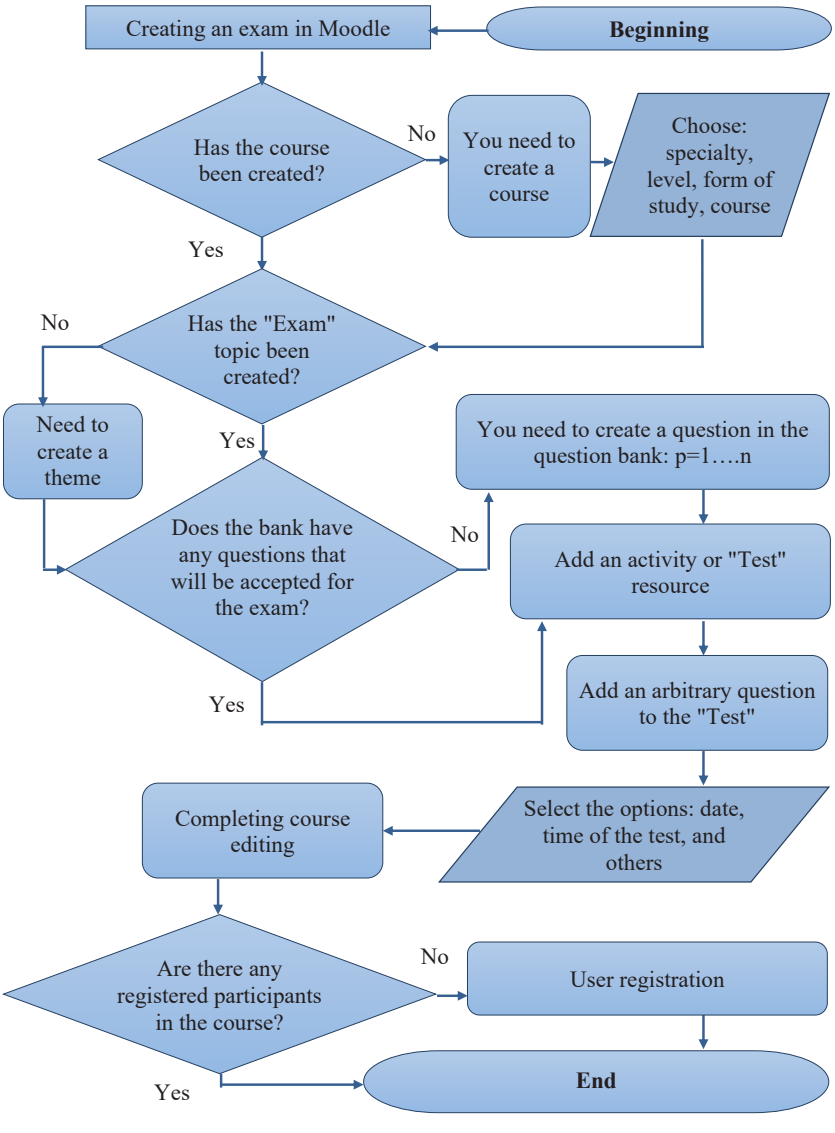

Fig. 2. Algorithm for organizing a test in Moodle (on the example of an exam)

The algorithm is implemented step by step as follows:

Step 1. Creating a course in the environment.

To perform this step, the lecturer needs to log in on the Moodle platform page (in particular, for example, at the National Transport University – via the link https://do.ntu.edu.ua (Fig. 3)). If the lecturer is not registered in Moodle, then registration in the system for lecturers takes place in advance on the main page.

Let's move on to the course of our discipline. If the lecturer does not have a created course, s/he selects «specialty» → «educational program» → «form of education», for example, full-time → «level of higher education» (bachelor, master) → «course» (for example, 1, 2, 3, 4), clicks the «Add a new course» button, and fills in the corresponding windows with information about the course (Fig. 4).

The lecturer checks the presence of all students connected to his/her discipline by going to the «This course» → «Participants» tab. In the absence of connected students, their enrollment in the course must be completed. To do this, select the «Enroll users» option, enter the abbreviated name of the group and the year of admission in the «Select users» window, or search for students by last name. After selecting a certain cohort of applicants, the lecturer clicks «Enroll selected users and groups». In the window that appeared after enrolling participants in the course, one can check the presence of all students and their online presence in the system at the moment, the field «Last login to the course» (Fig. 5).

Next, the lecturer returns to the page of his/her course («my courses» → «subject name»).

Step 2. Creating an exam.

The lecturer needs to go to his/her course and select the «Actions menu ⚙» → → «edit» option. On the course page, one needs to select the option «+add section» → name the created «Topic _», for example, «Final control» (by clicking on the icon ✎) (Fig. 6).

Next, in the «Actions menu ⚙» option, the lecturer selects «Question bank» → → «categories» → in the «add category» window, fills in «Name» → Exam and clicks the «Add category» button. In the added category, the lecturer selects the «Questions» tab → in the «Select a category» window, selects «Exam» → clicks «Create a new question» and selects the «Essay» type. On the page, one needs to enter the name of the question «Ticket No. 1». And in the «Question text» window – enter the questions and tasks of the examination ticket itself «1....2....3...», choosing the answer format «without direct text» and allowing attached files «unlimited» (Fig. 7).

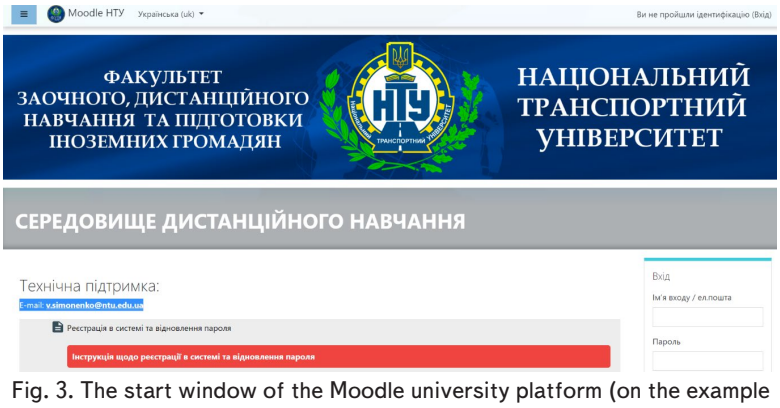

Fig. 3. The start window of the Moodle university platform (on the example of the National Transport University, Kyiv, Ukraine)

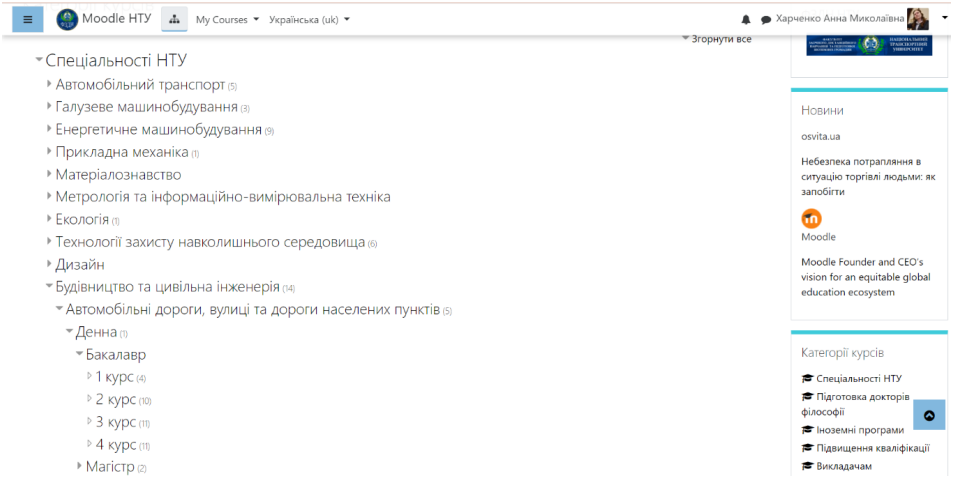

Fig. 4. Structure of the Moodle university platform (on the example of the National Transport University, Kyiv, Ukraine)

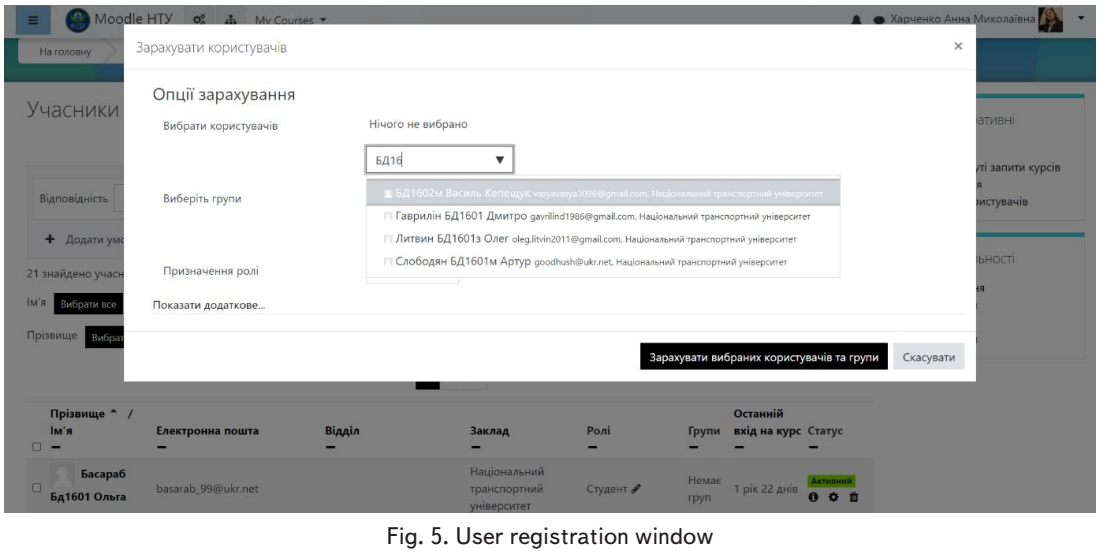

Fig. 5. User registration window

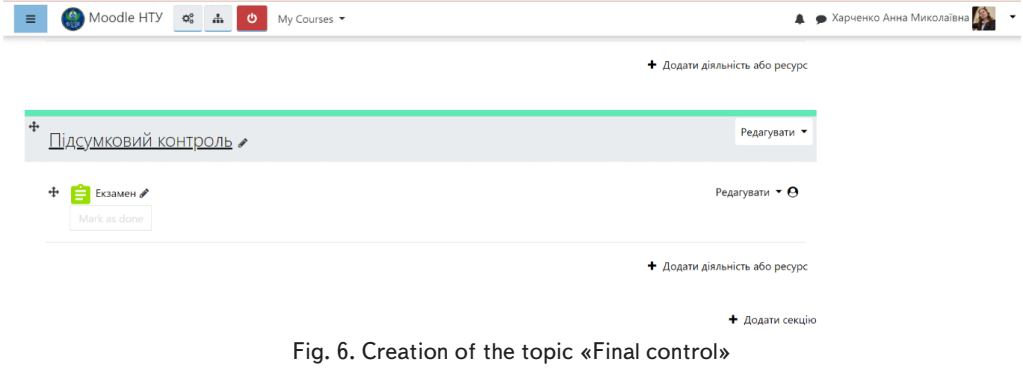

Fig. 6. Creation of the topic «Final control»

Each ticket must contain a combined approach for engineers (abstract writing, problem solving, calculation and graphic work, drawings, etc.). The classic ticket can be added as a photo (Fig. 7) or in the «Question text» field. The lecturer can also use a test task in combination with an engineering task.

The ticket creation procedure must be repeated as many times as it is necessary to create tickets (Fig. 8).

Next, we move on to the course. In the «Final control» section, select «+Add an activity or resource» → «Test» → → «Add» → name «Exam» → tab «Time selection» (select a day, time and time limit) → Save and return.

In the «Final control» category, click on the test «Exam» → → «Edit test» → in the «Add» tab, select «+ random question». Next, select the «Exam» category and the number of random questions «1», click «Add random question» (Fig. 9).

When enrolling in the course, the student chooses the «Exam» test. By clicking on it, s/he receives a ticket randomly selected by the system. Without closing the window with the ticket and without writing down the answer, the student takes a photo of the answer and uploads it to the window under the ticket, clicks «Done». When logging into the Moodle system, the lecturer receives information in the form of attached files placed opposite the students' last names.

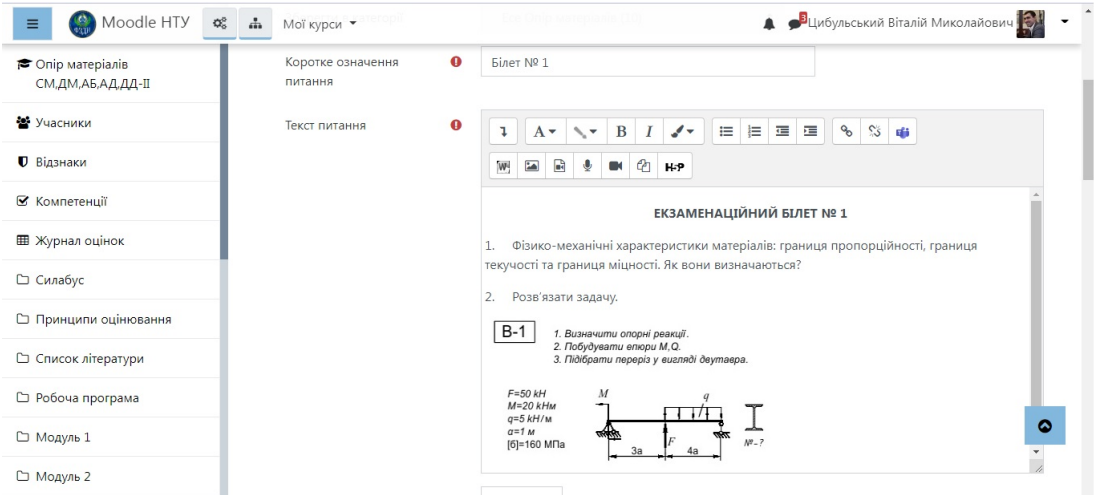

Fig. 7. Creating a classic ticket in the Moodle environment

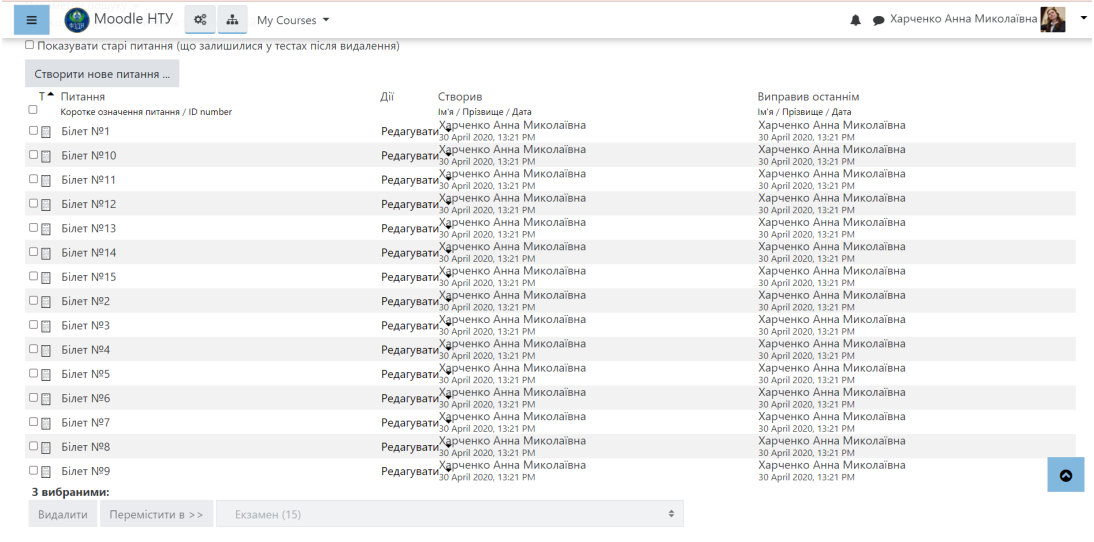

Fig. 8. General view of the «Exam» category in the «Question Bank»

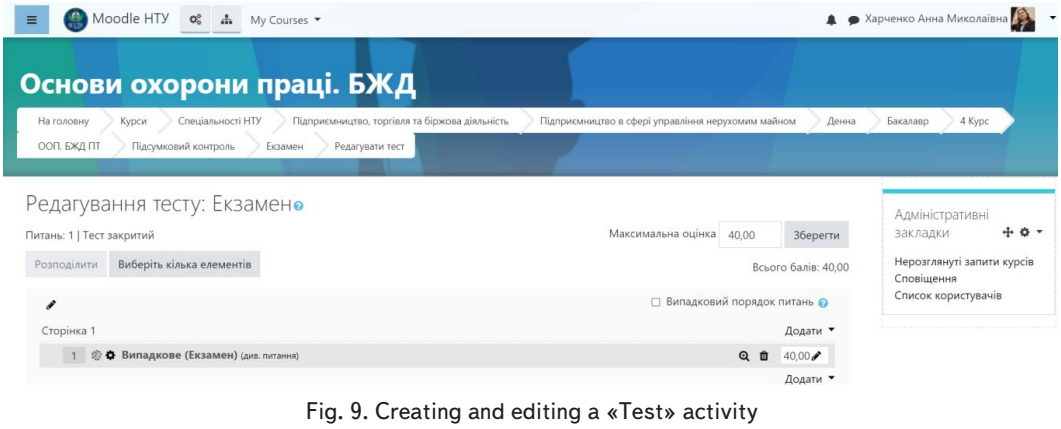

Fig. 9. Creating and editing a «Test» activity

Up to 2 hours are allotted for Step 2 (of which 1 hour 20 minutes is for writing, 40 minutes for technical procedures: photographing the answer, attaching, sending).

Step 3. Synchronous ticket protection.

The next step is to protect the student's written response to the ticket in synchronous mode using information and communication technologies (for example, Skype, Zoom, Google Meet, etc.).

5. 2. Methodology for evaluating the effectiveness of the developed algorithm

It is advisable to evaluate the proposed algorithm in practice using the so-called KPI method (Key Performance Indicators method). Peter Drucker's KPI methodology is aimed at evaluating achievements and helps understand how effectively the proposed solution works at an individual university. To analyze the effectiveness of the developed

algorithm for final control for engineering specialties, the following KPIs are proposed:

– learning result (achieved);

– students' performance during the session;

– achieved quality – the ratio of the obtained positive result (grades «A», «B», «C») to satisfactory (grades «D», «E»).

Thus, the function of applying the KPI method will have a formalized form:

$$f(KPI)=\{R,P,Q\}\to\max, \quad (1)$$

where R is the learning outcomes, or the percentage of those students who started the session; P is the success rate of students during the session, or the percentage of students who passed the session (success rate); Q – achieved quality – the ratio of the obtained positive result (grades «A», «B», «C») to satisfactory (grades «D», «E»).

The limitations of mathematical model (1) are as follows:

$$\begin{cases} R,P,Q>0; \\ Q\to\max,\ Q_h\in[0.75\div1.0]; \\ P,R\to\max. \end{cases} \quad (2)$$

At the same time, a high quality indicator is considered when the positive result within the session is at least 75 %.

In addition to the analysis of KPI indicators, it is possible to apply a frontal survey of students, which will make it possible to determine the quality of distance learning from the point of view of their judgments. However, it is necessary to ensure the representativeness of the sample for the student survey. Representativeness can be determined by assessing the response rate, as well as by using a double survey. To check the results of a double survey, it is advisable to define two indicators: representativeness and non-response bias [17]:

$$\bar{Y}=W_r Y_r+W_m Y_m, \quad (3)$$

where Y_r and Y_m are the average values of the results for the groups of respondents and non-respondents (indices r for respondents and m for non-respondents); W_r and W_m are the shares of groups in the combined sample.

There are conditions for these groups:

$$\begin{cases} W_r+W_m=1; \\ Y_r\approx Y_m. \end{cases} \quad (4)$$

In particular, in a subsequent study based on KPI indicators, an analysis of the quality and success of students of the Faculty of Transport Construction at the National Transport University was conducted over three academic years.

ing platform at NTU. More than 5,600 users, including more than 300 university lecturers, are registered in the Moodle environment (do.ntu.edu.ua).

The Moodle distance learning system introduced at the National Transport University makes it possible to organize a full-fledged distance learning process, to apply a system for monitoring and evaluating students' learning activities and other necessary components of the virtual learning system.

In order to evaluate the effectiveness of the use of information and communication technologies in the implementation of control measures, an analysis of quality and success was carried out according to KPI criteria during three academic years. The assessment was carried out on the example of the achievements of students of the Faculty of Transport Construction at the National Transport University (Fig. 10, 11, Table 1).

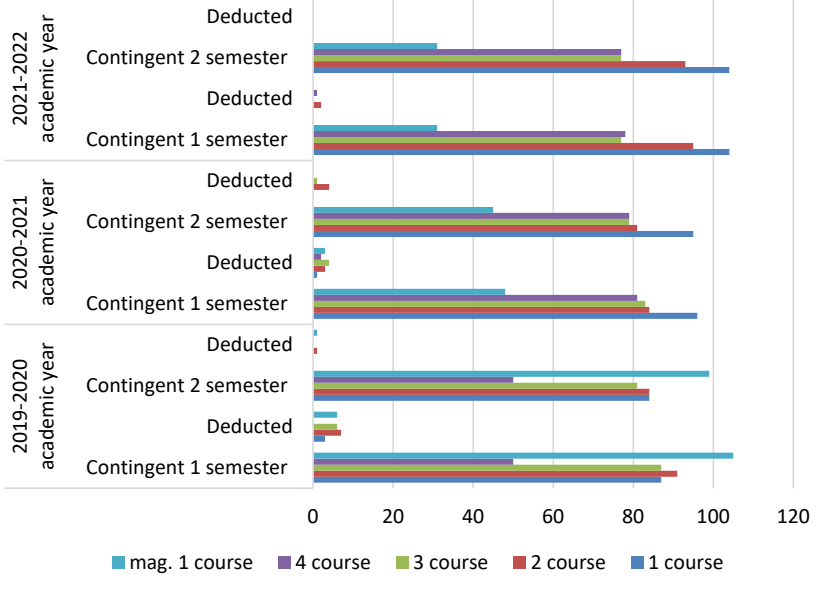

Fig. 10. Dynamics of cohort at the Faculty of Transport Construction

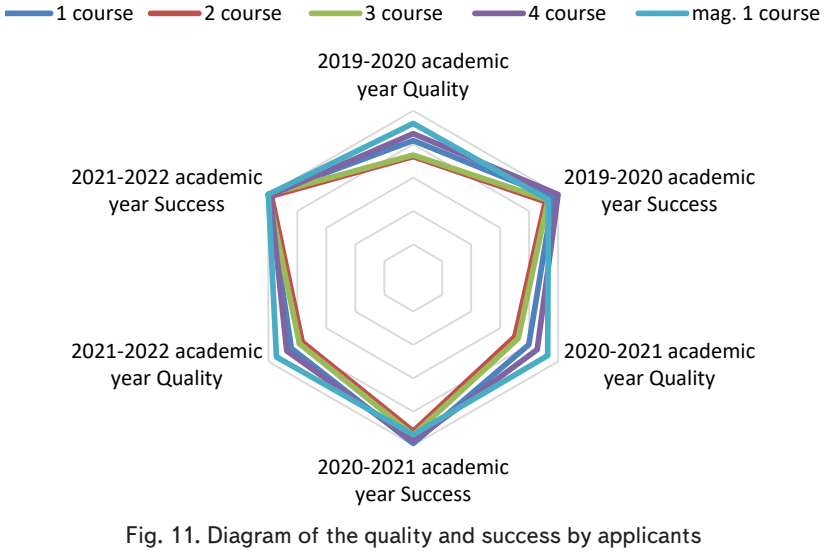

Fig. 11. Diagram of the quality and success by applicants

5. 3. Evaluation of the effectiveness of using information and communication technologies in the implementation of control measures

In recent years, there has been a positive trend in the growth of the number of users of the Moodle distance learn-

According to the data obtained from the analysis of cohort during the quarantine, the largest number of expelled students was in the first years. This is related to the problems of students' adaptation to the educational process under new conditions for them. In turn, for students studying in senior

courses, there were no significant problems with the transition to distance or mixed education. This is confirmed by the analysis of plot of the quality and success by applicants, according to which for 2021–2022 these indicators have actually leveled off for all courses. Accordingly, the optimization problem in the form of (1) with restrictions (2), indicators (3), according to the actual data in Table 1 and conditions (4), a trend analysis was performed (Table 2).

A trend analysis of the indicators of the quality and success by students over three academic years revealed that these indicators have a tendency to improve. In particular, for the 2021–2022 academic year, the quality increased the most in the third year of the bachelor's degree by 6.8 %, the success rate in this course – by 7.4 %. The smallest increase in the quality of education took place in the fourth year of bachelors – by 1.16 %. This is due to a natural decline in interest in learning, students' concentration on writing a qualification paper and future employment. Such results confirm the effectiveness of the applied algorithm during the performance of control measures as they ensure the compliance of the optimization problem (1) with constraints (2).

A survey of students in 2022 regarding the effectiveness of online learning confirmed their high satisfaction with the quality of teaching of educational components. In particular, 27 % of respondents assessed the quality of online classes as «excellent», about 36 % – as «good», and 26 % recognized the level of online teaching as «sufficient». About 11 % still consider the level of distance learning «unsatisfactory», which is mostly related to problems of mastering information and communication technologies, lack of communication and necessary computer tools, problems of adaptation and self-organization.

Thus, it is possible to assert the gradual adaptation of students to distance education and the effectiveness of using the Moodle university platform for conducting control activities in engineering disciplines.

The introduced methodical approach to the final control led to an increase in the quality and success of students, which is confirmed by the analysis of analytical data for the study periods, including the pre-quarantine traditional approach to control measures.

Our analysis allows further development of measures to solve the specified problems regarding the introduction of mixed or distance learning at the university.

6. Discussion of results of verifying the developed algorithm for the implementation of control measures

The developed algorithm for conducting control measures (Fig. 2) is based on the use of the structure of a classic ticket, which allows implementing an approach to the final control that is closest to the traditional one. In contrast to the proposals [4, 17], this algorithm allows more effective assessment of the acquired practical competencies of engineering students. Thanks to the application of the developed algorithm, the control measure can include a set of different types of tasks (Fig. 8), in contrast to similar solutions [10, 11]. In particular, it is important for students of engineering majors to perform graphic and calculation-graphic tasks and drawings (Fig. 7), which was not taken into account in study [13]. This methodical approach to evaluating the results of control measures in practice makes it possible to more realistically evaluate the knowledge acquired by students during training. In turn, the use of the proposed combination of information and communication technologies ensures the identification of the student's personality and the transparency of the control measure (Step 2, Step 3). This minimizes the risks of academic dishonesty in contrast to [8, 9].

Table 1

Information on the achieved indicators of quality and success by students, %

Academic course	2019–2020 academic year		2020–2021 academic year		2021–2022 academic year	
	Quality	Success	Quality	Success	Quality	Success
Bachelor's Level						
1 year	82.2	96.55	79.8	98.96	84.2	100.00
2 year	72.6	91.21	70.2	91.67	76.6	97.89
3 year	73.5	93.10	72.4	93.98	78.5	100.00
4 year	86.3	100.00	85.6	97.53	87.3	98.72
Master's Level						
1 year	92.4	93.33	92.8	93.75	94.4	100.00

Table 2

Trend analysis of indicators of quality and success by students, %

Academic course	Absolute quality deviation		Relative quality deviation 2021/2022 to 2019/2020	Absolute success deviation		Relative deviation in academic performance 2021/2022 to 2019/2020
	2020/2021 and 2019/2020	2021/2022 and 2019/2020		2020/2021 and 2019/2020	2021/2022 and 2019/2020	
Bachelor's level						
1 year	–2.4	2	2433	2.41	3.45	3.571
2 year	–2.4	4	5.510	0.46	6.69	7330
3 year	–1.1	5	6.803	0.87	6.90	7.407
4 year	–0.7	1	1.159	–2.47	–1.28	–1 282
Bachelor's level						
1 year	0.4	2	2.165	0.42	6.67	7.143

A methodology for evaluating the effectiveness of the developed algorithm is proposed, which is based on the practical use of the KPI approach (1), (2), or Peter Drucker's KPI methodology. Three main KPIs were applied (1): academic performance (achieved); students' performance during the session; achieved quality.

This algorithm and the procedure for evaluating its effectiveness were applied to engineering students. The results of the assessment of KPI indicators (Table 1, Fig. 11, Table 2) showed that the quality increased the most in the third year of the bachelor's degree (by 6.8 %), while the success rate in this course increased by 7.4 % (Table 2). The smallest increase in the quality of education was recorded in the fourth year of bachelors – by 1.16 %. However, since there is a tendency to increase KPI indicators during the analyzed three academic years, it is possible to draw a conclusion about the effectiveness of using the proposed algorithm for the implementation of control measures.

The limitations of using the algorithm for the implementation of control measures using information and communication technologies are the insufficient level of provision of students with technical means. Also, as practice has shown, lecturers need more time to prepare digitized calculation and graphic tasks for tickets. The further development of this study is to expand the possibilities of evaluating the acquired competencies by using automated recognition of students' emotional state.

A promising direction of this research is the implementation of the developed algorithm for the implementation of control measures at other faculties and technical universities in Ukraine or other countries. This could make it possible to adapt the student to the online form of final control, similar to the traditional one, which will ensure the achievement of programmatic learning outcomes of engineering educational components.

According to the results of our research, there was a need to rebuild and further improve training courses in Moodle, taking into account the developed authentic algorithm.

In the future, it is necessary to expand the possibilities of the Moodle university platform to ensure the work of a large number of users, as well as to implement the interaction of the Moodle distance learning platform with electronic systems for supporting the educational process, automated recognition of the emotional state of students.

Also, promising research areas are the development of measures to implement this algorithm taking into account the characteristics of various technical specialties.

7. Conclusions

1. We have proposed an authentic three-stage algorithm to solve the task of conducting control measures online for engineering students. This algorithm is based on the use of the structure of a classic examination ticket, which includes theoretical questions and practical tasks and is implemented using the Moodle distance learning platform. To implement the developed algorithm in Moodle, a test task template of the «essay» type is used in combination with synchronous protection of the answer using a video conference.

2. To evaluate the effectiveness of the algorithm, a method based on the use of the KPI procedure is suggested. Three KPI indicators are taken as a basis: academic result, success of students during the session, achieved quality. In parallel with the evaluation of the effectiveness of the algorithm according to KPI indicators, a frontal survey of students was conducted. That made it possible to additionally analyze the results of the implementation of the algorithm from the point of view of students' judgments regarding the quality of education.

3. The possibilities of using our algorithm were tested on the example of the Faculty of Transport Construction at the National Transport University. It has been proven that in practice the algorithm is an effective tool for the implementation of control measures. This makes it possible to improve the quality of the final assessment, providing equal conditions for students and involving the optimal set of tools to this end. The analyzed indicators of the quality and success of students confirmed the adequacy of the proposed algorithm since when it is applied, their gradual adaptation to conducting control measures in a remote form is observed.

Conflicts of interest

The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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Data availability

The data will be provided upon reasonable request.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the presented work.

References

1. Kukharenko, V. M., Bondarenko, V. V. (2020). Ekstrene dystantsiyne navchannia v Ukraini. Kharkiv: Vyd-vo KP «Miska drukarnia», 409.
2. Torres Martín, C., Acal, C., El Homrani, M., Mingorance Estrada, Á. (2021). Impact on the Virtual Learning Environment Due to COVID-19. Sustainability, 13 (2), 582. doi: https://doi.org/10.3390/su13020582
3. Means, B., Neisler, J. (2021). Teaching and Learning in the Time of COVID: The Student Perspective. Online Learning, 25 (1). doi: https://doi.org/10.24059/olj.v25i1.2496
4. Bojović, Ž., Bojović, P. D., Vujošević, D., Šuh, J. (2020). Education in times of crisis: Rapid transition to distance learning. Computer Applications in Engineering Education, 28 (6), 1467–1489. doi: https://doi.org/10.1002/cae.22318

5. Byrnes, R., Ellis, A. (2006). The prevalence and characteristics of online assessment in Australian universities. Australasian Journal of Educational Technology, 22 (1). doi: https://doi.org/10.14742/ajet.1309
6. Bdair, I. A. (2021). Nursing students' and faculty members' perspectives about online learning during COVID-19 pandemic: A qualitative study. Teaching and Learning in Nursing, 16 (3), 220–226. doi: https://doi.org/10.1016/j.teln.2021.02.008
7. Bradley, V. M. (2020). Learning Management System (LMS) Use with Online Instruction. International Journal of Technology in Education, 4 (1), 68. doi: https://doi.org/10.46328/ijte.36
8. Chirumamilla, A., Sindre, G., Nguyen-Duc, A. (2020). Cheating in e-exams and paper exams: the perceptions of engineering students and teachers in Norway. Assessment & Evaluation in Higher Education, 45 (7), 940–957. doi: https://doi.org/10.1080/02602938.2020.1719975
9. Yazici, S., Yildiz Durak, H., Aksu Dünya, B., Şentürk, B. (2022). Online versus face-to-face cheating: The prevalence of cheating behaviours during the pandemic compared to the pre-pandemic among Turkish University students. Journal of Computer Assisted Learning, 39 (1), 231–254. doi: https://doi.org/10.1111/jcal.12743
10. Tella, A., Bashorun, M. T. (2012). Attitude of Undergraduate Students Towards Computer-Based Test (CBT). International Journal of Information and Communication Technology Education, 8 (2), 33–45. doi: https://doi.org/10.4018/jicte.2012040103
11. Ebrahimi, M. R., Hashemi Toroujeni, S. M., Shahbazi, V. (2019). Score Equivalence, Gender Difference, and Testing Mode Preference in a Comparative Study between Computer- Based Testing and Paper-Based Testing. International Journal of Emerging Technologies in Learning (IJET), 14 (07), 128. doi: https://doi.org/10.3991/ijet.v14i07.10175
12. Nurhikmah, H., Farida, F., Ervianti, E. (2021). The Impact of Computer-based Test and Students' Ability in Computer Self - Efficacy on Mathematics Learning Outcomes. Journal of Education Technology, 5 (4), 603. doi: https://doi.org/10.23887/jet.v5i4.34942
13. Kucherova, O. O., Ushakova, I. O. (2022). Effectiveness of online testing in general english university course from teacher and student perspectives. Information Technologies and Learning Tools, 87 (1), 185–198. doi: https://doi.org/10.33407/itlt.v87i1.4812
14. Khalymon I. Yo., Shevchenko S. I. (2019). Role of training tests lms moodle in teaching students of linguistic profile. Information Technologies and Learning Tools, 72 (4), 246–257. doi: https://doi.org/10.33407/itlt.v72i4.2455
15. Starosta B. I. (2021). Postgraduate students' attitude towards computer-based testing of learning results. Information Technologies and Learning Tools, 82 (2), 215–230. doi: https://doi.org/10.33407/itlt.v82i2.3304
16. De Medio, C., Limongelli, C., Sciarrone, F., Temperini, M. (2020). MoodleREC: A recommendation system for creating courses using the moodle e-learning platform. Computers in Human Behavior, 104, 106168. doi: https://doi.org/10.1016/j.chb.2019.106168
17. Zhukov, Y. D., Haidai, H. Y., Kudin, O. O. (2022). The current state and prospects of the use of distance learning instruments during study ship engineering. Information Technologies and Learning Tools, 87 (1), 151–165. doi: https://doi.org/10.33407/itlt.v87i1.4505
18. Pro zatverdzhennia Polozhennia pro dystantsiyne navchannia. Zareiestrovano v Ministerstvi yustytsiyi Ukrainy 30 kvitnia 2013 r. za No. 703/23235. Available at: https://zakon.rada.gov.ua/laws/show/z0703-13#Text
19. Rekomendatsiyi Naukovo-metodychnoi rady Natsionalnoho transportnoho universytetu z orhanizatsiyi ta zdiysnennia osvitnoho protsesu v umovakh karantynu. (Zatverdzheno na zasidanni NMR 09.04.2020r., protokol No. 30). Available at: http://www.ntu.edu.ua/wp-content/uploads/2020/04/recom_met_rada.pdf
20. Lasater, K. B., Jarrín, O. F., Aiken, L. H., McHugh, M. D., Sloane, D. M., Smith, H. L. (2019). A Methodology For Studying Organizational Performance. Medical Care, 57 (9), 742–749. doi: https://doi.org/10.1097/mlr.0000000000001167