

# Problems of assessing students' knowledge in mathematics using LMS Moodle

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**Abstract.** The widespread introduction of the LMS Moodle educational environment into the educational process in the framework of distance learning and recommendations to use the abovementioned resource for full-time education served as the prerequisites for this study. The authors believe that the knowledge assessment system for distance learning cannot be automatically applied to assess students of other forms of education, but should be adapted to them. The purpose of the research was to study the issues of assessment in the Moodle environment, to develop a methodology for using it to assess the knowledge of students of economic bachelor's degree in Mathematics. To achieve the goal, scientific literature on this topic was studied, pedagogical design, experiment and student survey were used as research methods. As a result, the authors of the article designed a control and measuring system for assessing knowledge in mathematics in LMS Moodle and the procedure for intermediate certification using this system. The experience of introducing a knowledge assessment system in the first year of the Financial University under the Government of the Russian Federation and a questionnaire survey showed the specificity of approaches to assessing students' knowledge in an electronic environment in Mathematics. To control the academic achievements of students, the authors consider it necessary to check additionally the performance of the teacher with the subsequent correction of points. The novelty of the research lies in the development of a methodology for using LMS Moodle for assessing students' knowledge in mathematics in the course of full-time education.

**Keywords:** LMS Moodle, testing, measurement control system, teaching mathematics

## 1 Introduction

Digital transformation is actively involved in the educational processes of higher education institutions. One of the indicators of the introduction of digital technologies into the educational process is the use of electronic learning systems, LMS Moodle in particular. The platform developed for virtual communication between a student and a teacher in the

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course of distance learning becomes increasingly popular when working with full-time students.

In the 2020-2021 academic year, the authors have developed electronic training courses (ETC) in the Moodle environment for communication with first-year undergraduate economics students at the Financial University. The practical evaluation made it possible to single out a number of problems related to the assessment of students' knowledge, which in turn led to the research hypothesis: the knowledge assessment system used in LMS Moodle for distance learning cannot be automatically applied to assess the knowledge of full-time students and those, who study in blended learning mode.

The purpose of the study was to develop a methodology for using the LMS Moodle platform for assessing students' knowledge in mathematics in a blended learning mode. To achieve the goal, the following tasks were set:

- to explore the experience of LMS Moodle electronic testing in teaching mathematical disciplines;
- to create a base of test items in mathematics for assessing first-year undergraduate economics students at the Financial University;
- to test the created base for monitoring the academic achievements of students;
- to study the opinion of students on the effectiveness of the introduction of electronic assessment tools.

## **2 Materials and methods**

LMS Moodle has long established itself as an environment for creation and implementation of the ETCs with a pedagogical support system. Consider the recent works associated with this research.

A recent review of e-learning in mathematical content was carried out by the Spanish [1]. A comparative analysis of blended, distance, e-learning and virtual learning using the example of students from the Philippines is given in [2], while the scientific papers [3] of the authors from Portugal describe the possibilities of LMS Moodle as an online assessment tool for a number of educational programs in mathematics.

The experience of designing the ETCs in mathematics for blended learning of future teachers is reflected in the work [4], the article [5] is devoted to the problem of testing. The works [6, 7] related to the process of creating adaptive e-learning courses in mathematics require special attention. The authors also would like to note the article [8], which characterizes the capabilities of the Moodle platform for automatically checking the course assignments with computer support.

The problem of assessment of the learning outcomes within the framework of the ETCs is relevant for the research being conducted. In a recent expert study [9], the instrumental capabilities of assessment of the course elements are revealed, the authors of the article [10] define the technology for test items development. Note the useful experience of developing an assessment system in the humanities [11, 12] and technical [13] disciplines. In a survey work on the assessment capabilities of the LMS Moodle [14], the organization of the main forms of assessment was presented: cumulative (Summative assessment) and formative (Formative assessment).

As a summary, the authors emphasize that the existing publications mainly describe the use of cumulative assessment of students' knowledge in LMS Moodle, while inadequate attention is paid to the formative assessment aspect. This prompts us to focus specifically on the formative assessment associated with the face-to-face learning regime.

In addition to the review of publications on assessment tools in the Moodle environment, the authors note the following methods of the proposed research:

- pedagogical design of a system of assessment tools for current and intermediate control;
- practical evaluation of the base of test problems in mathematics as part of the creation of the individual ETCs;
- questioning – a survey of students who have completed test tasks in the Moodle environment during the year to get feedback.

### **3 Results**

#### **3.1 Pedagogical design of the assessment tool system**

According to the “Mathematics” work program the course is divided into two main sections “Mathematical Analysis” and “Linear Algebra”, each of which has its own technical features when creating tests.

In the first semester of the academic year, a bank of test questions of 10 categories in the mathematical analysis was created: a total of about 1200 questions, about 60% of which are associated with the generation of parameters. In the second semester, 9 categories in mathematical analysis, 11 categories in linear algebra and 2 categories in linear programming were created: several thousand test questions were obtained, 95% of which are generated.

When developing test questions in mathematical disciplines, the following problems arise:

- complex problem statement;
- dependence on many parameters;
- analytical solution;
- a large number of options;
- approximate or numerical solutions to problems;
- ambiguity in the presentation of answers;
- complex structure of the answer;
- receipt of an answer in a convenient form (whole numbers, ordinary fractions);
- control of solution steps.

Let us focus on one of the many types of test questions: Formulas – a plug-in for Moodle [15], which is an optional component. This type of question can use random parameters and complex answer structures. Answer fields, placed anywhere in the question, make it possible to create assignments with different types of answers (coordinates, polynomial, matrix, etc.) Thus, the Formulas type is a powerful and functional tool for generating mathematical problems taking into account their peculiarities and for forming a more flexible variable assessment.

The formation of a bank of tasks for the subject includes a very important aspect – the assessment system. The solution of tasks in mathematics consists of many logical and computational operations therefore it would be incorrect to evaluate such tasks by the final answer.

The authors believe that a partial solution to this problem involves the development of test questions with step-by-step assessment. In this case, the student receives points from LMS Moodle for each correct step of the solution, depending on the significance and complexity of the actions. However, this approach does not allow to entrust the assessment

of students' knowledge completely to the electronic platform. The authors concluded that in addition to electronic verification of the answer, the solution of the task should be verified by the teacher.

### 3.2 Experience in using the control and measuring system for assessing knowledge on the Moodle platform

To evaluate the experimental test work performed by students on the Moodle platform, it was decided to take into account the results of the teacher's verification of the written decision and, after adjusting, set the final score. The verification experience showed a significant discrepancy between the electronic assessment and the assessment of the written decision. See Table 1 for examples of such discrepancies. 1. The presence of a sufficiently large percentage of discrepancies (on average 30-35%) confirmed the hypothesis of the need for a final revised assessment.

**Table 1.** Fragment of the table of checking the test work in mathematics.

Moodle	Assessment by the teacher	Revised assessment	Reason for revision
0	1	0.9	the solution is correct
0	1	0.8	the answer was entered in a format violation
0	0.7	0.7	the solution is correct, no answer entered
0	0.4-0.7	0.4-0.7	arithmetic error
1	0.5	0.5	with the right solution
1	0	0	resolved partially
			insufficient justification
			no solution

Based on the analysis of the test results on the Moodle platform, the Regulations for the examination in Mathematics were developed. The document reflects the mandatory verification by the teacher of the written solutions given by the students and subsequent correction of scores from Moodle.

According to the Regulations, the assessment of examination papers is carried out according to the criteria:

1. Each correct answer to a question is entered in electronic form, if there is a correct solution in the examination paper, it is estimated at 10 points.
2. For a correctly entered answer 0 points are given if:
  - the decision of the corresponding item of the assignment has not been submitted;
  - the entered solution is incorrect.
3. For the absence of an answer in electronic form to the question of the examination paper, if there is a correct substantiated written solution, a penalty of 5 points out of 10 is removed.

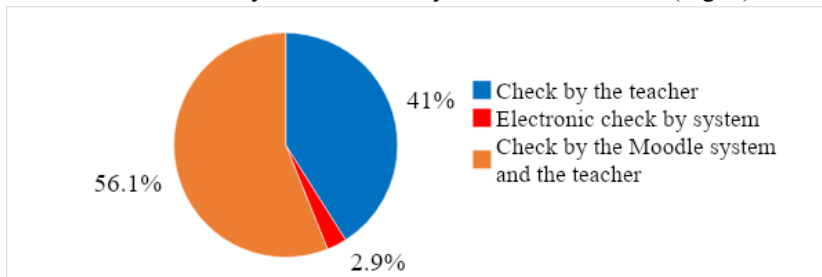
To organize control over students' academic achievements in the Moodle environment, it is necessary, first, to acquaint them with the specifics of testing and assessment. In this regard, it is recommended to conduct short tests and trainings, some recommendations for the types of assessment are presented in Table 2.

**Table 2.** Distribution of assignment types by assessment type.

Assessment type	Types of recommended assignments
Moodle	theoretical express survey, training
Moodle + check by the teacher	independent and control work,

	test, exam
check by the teacher	homework, case, project

According to the results of the survey of 205 first-year students who had the experience of testing on the Moodle platform for two semesters, it can be stated that students also prefer combined verification by the electronic system and the teacher (Fig. 1).



**Fig. 1.** What assessment of works do you consider the most objective? *Source:* compiled by the authors.

## 4 Discussion

The specificity of the mathematics makes it necessary to fix the sources and consequences of various mathematical errors, to check the consistency and validity of the methods used to obtain the correct result. Effective tracking of these aspects is possible only by checking the written solution to the problem and, as a result, summarizing the result in a cumulative assessment. This creates a balance between cumulative and formative assessment. We also agree with the authors of the review [14], who assign the leading role to tracking the student’s individual progress by means of formative assessment.

We share the opinion of the authors [16], who consider the combination of automated assessment with other species to be the most effective. Interestingly, in addition to the teacher’s assessment, the importance of self-assessment and mutual assessment is noted.

Working with electronic tests is one of the important communicative digital competence skills related to digital communication [17]. In their future professional activities, students will face the need to communicate in the format of strict digital regulations, and during their studies, it is necessary to prepare them for this.

## 5 Conclusion

The experience of testing in the Moodle environment and the research conducted allow us to conclude that LMS Moodle has a positive impact on the educational process of full-time students.

The important benefits of using Moodle when teaching math are:

- the ability to generate a large number of tasks;
- the variety of types of test items;
- the development of students’ digital communication skills.

The formulated hypothesis of ineffectiveness of the automatic application of Moodle work algorithms in terms of evaluating work for full-time students was confirmed. The same conclusion follows from a survey of students with experience working on the platform. For the widespread introduction of LMS Moodle into the knowledge assessment process, specially developed regulations and guidelines are required, and they should not

duplicate similar regulations for distance learning. For the subject “Mathematics”, the authors generally recommend using a combined check: Moodle electronic assessment for effective student feedback and teacher check. The different types of verification are justified by the content and structure of the proposed assignments.

To create the most objective system for assessing the knowledge of students of any form of education, a megabase of test items is needed, focused on increasing the variety of types of tasks. The development of such a megabase is a laborious and time-consuming process that requires serious testing and adjustment. This is a prospect for the further work of the group of authors.

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