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COMPUTER TRAINING PROGRAMS AND TESTING AS TOOLS FOR DISTANCE MATHEMATICAL DISCIPLINES DELIVERY

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Abstract

Mathematical disciplines play an important role in training quality specialists in all areas of economics and finance. Programs in mathematical disciplines at the Financial University under the Government of the Russian Federation provide a basis for the mastery of a wide range of competencies by students, which will make future specialists competitive in the labor market. A full-fledged study of mathematical disciplines and mathematical competencies development require a large number of academic hours, and in case of extramural students, most of the educational material is mastered independently. In this regard, an important role is played by interactive forms of organizing the educational process and independent work of students using computer learning technologies, such as computer testing, electronic textbooks, computer programs performing the functions of both teaching and the acquired knowledge verification. In connection with the 2020 pandemic, all higher education partially or completely adopted distance learning. Therefore, it is relevant to use and develop those methods and technologies that have been successfully used in extramural education being video lectures, computer training programs, computer final testing and testing for self-preparation, online seminars (webinars). All these modern methods do not exclude, but only complement the teacher's work with students and taken in totality create an effective learning environment contributing to quick adaptation to external constraints while maintaining and developing the main learning outcomes. It is stipulated by the fact that computer testing benefits self-training and verification of final knowledge as well as serves as an objective assessment in using a grade-rating system.

Keywords: Computer training programs, distance learning, testing

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1. Introduction

Currently, higher education faces the need to urgently transfer to distance learning in connection with the coronavirus pandemic. This led to the earliest possible introduction of new methods and technologies of distance education (Borisova & Fridman, 2020). The Financial University under the Government of the Russian Federation has adequately coped with this challenge, having qualified teachers a sufficient technological base and extensive experience in working with distance computer technologies, which have been used for many years in extramural and online forms of education, are constantly developing and improving. Among the wide variety of forms and technologies of distance education, computer-based learning programs and computer testing hold a special place due to the variety of functions and the versatility of use.

At the end of the 90s, the All-Russian State Distance-Learning Institute of Finance and Economics began to develop a system of computer-based learning programs, which became one of the most effective tools for organizing independent work of students at the first stages of distance learning in mathematical disciplines at the correspondence department. Extramural education always suffers from a lack of classroom studies and assumes that students masters most of the material on their own. Therefore, it is so important to develop and augment teaching practice with the tools that help organize independent work effectively (Konopleva & Znienko, 2017). Moreover, it appears that in the near future, extramural education in economics will be provided distantly. The coronavirus pandemic has only accelerated the adoption of distance learning in higher education (Petronzi & Dominic, 2020).

The system of computer-based learning programs enabled to implement distance learning in an asynchronous format, involving the use of pre-prepared materials by students (Romanov et al., 2000). At the same time, the teachers of the Department of Higher Mathematics began to develop and introduce computer testing methods used both to check the final knowledge and to provide students' self-training (self-training tests on certain topics and in general for the course of the discipline).

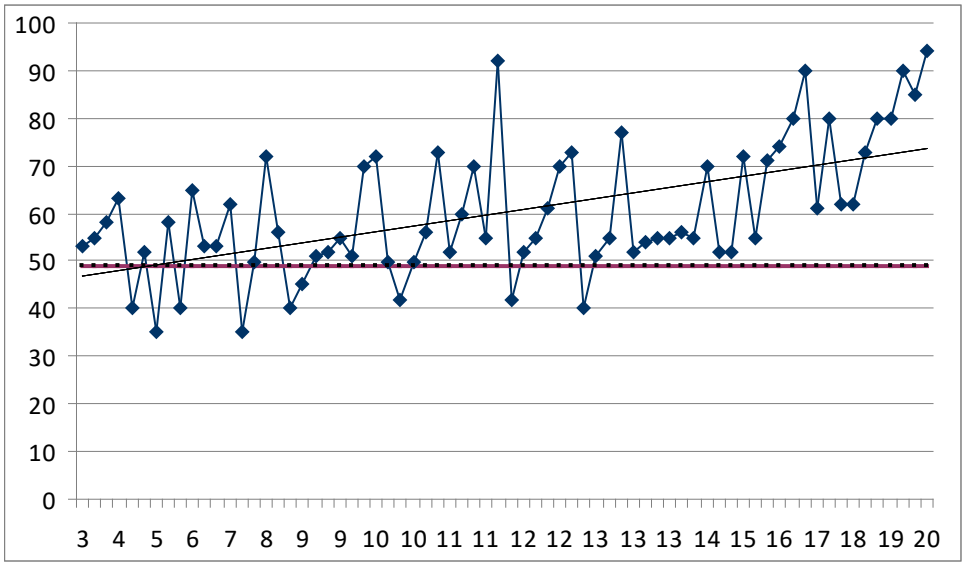

Figure 1. Statistical data processing results

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2. Problem Statement

The study of mathematical disciplines in extramural and online education has always experienced the problem of teaching hours shortage. In this regard, the question of effective students' independent work organization is acute.

3. Research Questions

We study the features of the development and application of computer-based learning programs in mathematical disciplines for the effective organization of independent work of extramural and distance education students at the Financial University under the Government of the Russian Federation.

The experience of using computer testing at the Financial University and the possibility of updating it on modern training platforms are analyzed.

4. Purpose of the Study

The purpose of the study is to summarize the experience in the development and application of computer-based learning programs and computer testing in teaching mathematical disciplines at the Financial University under the Government of the Russian Federation for extramural students and to explore the possibility of updating the mentioned programs on modern educational platforms with their further application for all forms of education as one of the effective elements of distance learning.

5. Research Methods

Synthesis, analysis, systematization, literature review, comparison and observation.

6. Findings

Computer-based learning programs as an element of learning and self-control

Computer-based learning programs are not just a set of formulas, definitions, tasks and tests. This is not the text of a book or a set of test assignments.

This is a qualitatively new product giving new opportunities for students' independent work and for teaching and control functions (Konopleva & Znienko, 2017)

Computer-based learning program consists of two systems: informational, which represents the content part, and software, containing software implementation (Romanov et al., 2000) Initially, when developing computer-based learning programs, there were two extreme viewpoints. The first one implied that it was important to create educational content having a solid scientific and methodological basis and converting it into a computer form was not problematic.

Another view implicated that a skilled programmer could take any printed textbook and make it an effective teaching tool without the author's help.

Both viewpoints seemed to be partially correct. The creation of computer-based learning programs in the distance learning system is an iterative process of interaction between the authors of educational

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content and the developers of computer technologies, the connection between which (especially at the first stages) could be carried out by a methodologist.

The specific schemes for the implementation of training materials presented by authors become clearer as the corresponding fragments of the computer training program appear. On the other hand, the developer of computer programs, knowing their capabilities, can put forward new ideas of educational content presentation.

The interaction of the author of educational materials and the developer of computer programs is necessary in the development of scenarios for the software modules operation caused by the emergence of new regulatory documents or curricula, in the approbation and updating of the computer-based learning programs.

With the growth of computer literacy, it is possible to develop computer-based learning programs by the teachers. However, in terms of their functionality, such developments, as a rule, have a lower quality in comparison with the professional ones.

Separate stages can be distinguished in the technology of creating computer-based learning programs: source materials development; software development; computer preparation of the content; layout development; approbation with the follow-up revision based on its results; preparation and recording of the distribution kit: development of documentation for the user and the tutor.

The most important component of the development of computer-based learning programs is source materials development due to the specific requirements to the educational materials specified by the distance learning technology.

The computer-based learning programs in mathematical disciplines should be linked to basic textbooks, for example, Kremer textbooks (2019), and included in the case study of teaching and methodological materials for students of distance education.

A team of authors led by an editor worked on the creation of educational materials. The duties of the editor include ensuring strict compliance of educational materials with the discipline program, uniformity of their presentation and designations, compliance with the relationships between the individual topics of the discipline, avoidance of material repetition or discrepancies of the same provisions.

Computer-based learning programs have a modular structure aimed to obtain clear educational materials organization. It should be even stricter than in a traditional textbook, since, on the one hand, it facilitates the student's individual work, and, on the other hand, it enables to implement hypertext transitions.

Students' active work with the computer-based learning programs rather than passive contemplation of information on the screen is a very important aspect of the educational process. Therefore, a well-constructed teaching script benefits the students' engagement in a dialogue with the teacher, who has foreseen the possible questions, typical errors in the analysis of problems, the necessary tips, links to the corresponding fragments of the computer-based learning programs.

For example, in the Computer-based learning programs-1 scenario for the discipline "Mathematics" for the first-year students, all the material was divided into blocks, each of which had its own designation, and the whole variety of blocks was combined in four groups:

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R – a fragment of reference (theoretical) material;

E – examples on the theoretical issues analysis;

C – comments on examples (explanations, hints, indications of errors, etc.);

S – exercises for self-control and control (formulation of tasks with correct solutions and answers).

For example, block E4.1 denotes example 1 to topic 4, and C4.1 (4) – comment 4 to this example.

Computer-based learning programs for the disciplines “Mathematics”, “Probability Theory and Mathematical Statistics” were used as a supplement to the basic textbooks, so it was important to keep the link between them within the curriculum of the discipline.

After studying separate topics of the computer-based learning programs, students were subject to self-testing with various types of tasks: multiple choice, matching, open-cloze answers, a numerical answer.

At a certain stage, computer-based training programs were a fairly effective means of distance learning. There is the need to update the computer-based training programs, which should be done not only by the authors of educational content, who are initiators, as a rule, but also by computer programs developers.

In a long run the possibility of developing computer-based training programs on the MOODLE platform, which is now used for online students and partially for students of extramural and intramural forms of study seems interesting (Lyubanets, 2017) After updating computer-based training programs in accordance with new work programs and educational plans on the new platform, they can again become one of the most important components of distance learning both in terms of training and students’ self-preparation for formative assessment. Extramural students can also use interactive programs to help them master difficult topics as well as self-control. Computer-based training programs can be useful in preparing for case tournaments in mathematical disciplines, which are quite widely used at different levels of education including secondary school when mastering the basics of mathematical modeling (Tan & Ang, 2013; Zbiek & Conner, 2006).

Such an educational element as computer testing has been used when teaching the disciplines of the mathematical cycle from the late 90s to the present time, for students of extramural and online education.

First of all, it should be noted that computer testing is only one of the elements of the general training system and disclaim dominance in it (Potemkin & Fridman, 2015). However, computer testing facilitates the solution of many problems afflicting the teacher in the learning process. Computer testing can be used to implement a variety of functions, such as being a tool for the initial knowledge assessment (important for determining the level of the first-semester students’ mathematical knowledge), and for the residual knowledge assessment, as an element of a course exam, self-study, formative assessment. The most important advantage of computer testing is its independence from subjectivity, which is of particular importance in a point-rating system.

In a situation where the number of academic hours for mastering a discipline is small in comparison with the volume of the material being mastered and the requirements for acquiring the relevant competencies, the issue of adequate, independent and fair assessment of the student’s work is especially acute.

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For example, in the case of extramural and distance learning, when the number of hours of direct communication between the teacher and students is extremely small, as well as in the case when intramural students have long breaks in studying, for example, once every two weeks, as well as when studying elective disciplines, the teacher does not have a sufficient stock of standard methods of independent formative assessment. In this case, the role of computer testing as an independent tool for students' knowledge assessment is very significant.

Testing can be carried out in a computer class, which favors the control of students' work independence. The student being alone with the computer and having no opportunity to get a clue or use someone's help, receives an independent adequate assessment of their knowledge. This assessment can be used both by the student to realize the existing gaps and get an impulse to eliminate them, and a teacher for an objective ranking of students in a study group in order to distribute points fairly.

For many years, the Institute of Distance Education of the Financial University has been implementing computer testing in the Stellus system. A huge test base for each discipline created by the teachers of the corresponding disciplines, being regularly updated in accordance with changes in the discipline programs, was accumulated. The system structure was dynamic, which enabled to customize tests both for the specifics of teaching disciplines for different areas, and for a specific group, for example, during formative assessment. At the same time, it was possible to change the number and content of topics in the test, assessment criteria, and the number of possible repetitions of testing for a particular student. This system was used both for extramural system in mathematical disciplines and intramural one (in the discipline "Probability theory and mathematical statistics" and the optional discipline "Elements of combinatorial analysis and mathematical logic") as an independent tool for assessing students' knowledge and was taken into account when distributing points for academic progress during a semester.

At a certain stage, compulsory computer testing was introduced as a necessary condition for admitting students to the final semester exams. Over the years of this computer testing system application, a large statistical material, which enables to assert the presence of a direct correlation between the results of computer testing and the final grade of a student on the exam, has been accumulated. Thus, for example, in 2014 bachelors of economics were tested in the discipline "Probability theory and mathematical statistics". Among them, 70 students were randomly selected. Their test results and examination session results were compared (the final points scored by the students for the work in the semester and the examination scores). It is easy to see that there is a positive correlation. The correlation coefficient is 0.55.

It should be noted that the testing, which was carried out several days before the exam, helped to stimulate students to prepare for the exam more thoroughly. Indeed, despite the fact that many students received rather low scores on testing, they were able to successfully pass the exam.

The test base was transmitted to the Information and Education Portal of the Financial University, and then to the educational platform MOODLE and was regularly updated by teachers. The testing system was transformed in two directions being final testing for distance learning students and testing for self-preparation and formative assessment.

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Testing for students' self-preparation is implemented without a teacher's supervision and is both a tool for self-control and learning.

Without limiting the number of attempts and providing students with both a set of tests on various topics of the program, and the final test for the entire course, we enable the learner to identify not only knowledge gaps, but also the ways to address them. The practice of testing unsuccessful students before mandatory repetition of the exam has also proved to be successful (Borisova & Fridman, 2020). Thus, computer testing plays both a controlling and a teaching role in the learning process.

7. Conclusion

The authors' many years' experience shows that computer-based training programs are a very promising tool for organizing students' independent work amidst a shortage of extramural hours, as well as in the case of a transition to a distance learning format. Computer-based training programs, combining elements of a textbook, an interactive problem book and a training device, carry out both training and control functions.

An important role is also played by computer testing, which enables to objectively build a point-rating system of assessment, and performs both control and training functions. Thus, both of these tools need to be further developed, updated and widely used in distance, offline and hybrid forms of education, improving the educational process and increasing the efficiency of students' independent work.

The introduction of computer technologies has not only enriched the educational process, it also has played an invaluable role in perceiving the computer by students not as a game, but a tool that assists learning, thinking and creating. Studying computer technologies outside the classroom allows students to develop algorithmic and logical thinking, imagination, a desire to boost self-esteem, and get the final result. Psychological readiness for life in the information society, initial computer literacy and using a personal computer as a means of solving problems are now becoming necessary for every person regardless of their profession. All this makes qualitatively new requirements for general education, whose purpose is to lay the potential for beneficial personality development. In this regard, a personality-oriented approach to education attaching great importance to the student's independent cognitive activity is of great significance (Strakhov et al., 2012). At the same time, the role of the teacher remains the main one both in training and creating effective tools for organizing the students' independent work.

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