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**USING TEST TECHNOLOGIES IN THE CONDITIONS OF  
INFORMATIZATION OF HIGHER EDUCATION**

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***Abstract***

This paper studies development and introduction of testing technologies to encourage individual learning and cognitive activities of students in the conditions of computerization of education. The authors described a possibility to develop new ways of using information and communication technologies provided by different packages of application software. The paper presents a possibility and ways of applying the acrotex package to develop interactive training materials. The authors describe how to use testing materials for efficient individual work of students. The authors have developed a set of original electronic learning and teaching materials, containing forming tests. Developed materials allow university teachers to apply an individual approach to training, and monitor a progress of learning quickly and impartially.

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**Keywords:** Interactive learning, test technologies, training tests, progress tests, e-learning tools, computerization of education.



## 1. Introduction

Study and introduction of new forms and techniques of training and education, creation of new educational technologies are one of important trends in development of a current higher education system. In recent decades we have seen a rapid development of online learning, distance learning, information and communication network and multimedia technologies. Creating required technologies, information environment of a university, and studying those, who use online learning services, and relevant emerging markets are issues under examination by many researchers in Russia and abroad (Chuprova, 2016 Kelly, Coates, & Naylor, 2016; Kerimbayev, Kultan, Abdykarimova, & Akramova, 2017; Kivinen, Piironen, & Saikkonen, 2016; Leontyeva, 2017; Songkram, 2015; Tomczyk et al., 2017).

Environment of electronic learning, when cooperation between teachers and students is separated by time and distance, creates prerequisites for implementing new educational practices, which should address a dynamically changing labor market demand and information behavior of “digital” generations. As stated by Noskova, Pavlova, and Yakovleva (2016), electronic educational practices should be subject-oriented, with a high share of cooperation and team work. It means opening a field for research and experimental activities of university teachers.

## 2. Problem Statement

Current computerization of education requires improving competence of teachers in the field of ICT tools (Abdurazakov, Aziyev, Romanov, & Sadykova, 2017; Noskova et al., 2016), their integration in a teaching/learning process (Lawrence & Tar, 2018; Semenova, 2017).

When a quantity of class hours decreases, a university teacher should build its own and students' activities in such a way as to encourage students to study subjects well and independently and acquire professional competences. A task of a search for efficient didactic possibilities of modern information technologies remains crucial and interesting for researchers.

## 3. Research Questions

Some papers dedicated to online learning present a relation between teachers' use of the Internet and multimedia technologies and a positive attitude of students to achievement of learning goals and efficient cooperation with teachers and fellow students (Maloshonok, 2016; Noskova et al., 2016).

Disadvantages of e-learning include a rigid character of taught materials, a problem with students' self-organization, limitations on acquiring skills, disregard of individual features of students, dependence on hardware, and a low quality of taught materials and control over a level of acquired knowledge (Klimenskikh et al., 2018).

Some researchers do not support an excessively general, content-free, one-size-fits-all promotion of information and communication technologies in teaching. Thus, Borovik (2010) believes that higher mathematics, applying information technologies, is poor compatible with e-learning.

Many teachers point out that currently didactic properties of electronic learning resources undergo significant changes (Abdurazakov et al., 2017; Belova, 2015; Kerimbayev et al., 2017; Leontyeva, 2017). At an early stage of development, electronic didactic tools performed the same functions as paper ones,

but at a higher level of availability and visualization. At a current stage, it is possible to add properties of interactivity, greatly expanding their didactic possibilities.

To increase academic performance of students, we should shift a focus in a teaching/learning process to a higher level of independent learning, efficient technologies of teaching students about rational techniques of independent activities (Chuprova, 2016). The authors think that an efficient didactic tool of independent work of university students may be relevant training tests with interactive elements.

Assessment of knowledge is also one of critical elements of students' independent work. In electronic learning environment issues of an efficient use of testing to assess knowledge are of current concern (Akmatbekova, 2017); issues of preparation of progress tests and their reliability are under study by many researchers.

Modern didactics deems a test to be a convenient and reliable tool to diagnose and monitor a learning process. Testing as a type of assessment of students' learning and cognitive activities is under consideration in many didactic papers (Karolčík, Čípková, Veselský, & Hrubíšková, 2013). Some authors, for example, Chuprova (2016), states that practical and technological materials on application of education testing are not thoroughly developed. Thus, issues of testing technologies related to their content and methodology remain topical.

The authors believe that development of interactive testing materials solves such important tasks as:

- expansion of ICT competence of university teachers,
- increase in a level of developed electronic teaching materials,
- encouragement of students' independent cognitive activity, while providing their mobility,
- regular control of students' independent work,
- saving time for university teachers, which is critical in their intensive work.

#### **4. Purpose of the Study**

The research aims at increasing efficiency of teaching students to disciplines of mathematics, included in training programs at the technical university, by applying electronic training and progress tests with interactive elements.

#### **5. Research Methods**

Key methods of the research are: 1) analysis of scientific papers related to development of testing technologies in education, organization of students' independent work and possibilities of modern information and communication technologies in education; 2) analysis and summary of regulatory documents on a teaching/learning process at a university; 3) analysis of practice and experience in teaching mathematics at a technical university; 4) experimental methods with diagnostics tools and expert evaluation.

## 6. Findings

Thanks to convenient assessment functions testing technologies have been long ago and steadily introduced into teaching practice. Advantages of tests as an assessment tool usually include: 1) impartial assessment as there is no influence by relations between a teacher and a student; 2) fast speed and non-ambiguity of results; 3) large scope of materials included into tests; 4) assessment of many students at the same time; 5) applicability of results for a comparative analysis.

In the course of teaching at the university diagnostic and progress tests may be used together with forming tests, whose main purpose is to form an integral system of mathematical knowledge and competences. The authors study efficient organization of students' independent work. One of efficient ways to organize such work is forming testing materials.

This paper presents one of possible options to create interactive training tests as didactic tools contributing to better learning and remembering of training materials. Prepared tests have a property of variability due to included tasks of various levels of difficulty, ensuring differentiated learning and building an individual learning road map for every student.

A general structure of testing materials includes:

- theory presented as an interactive electronic lecture
- examples of key problems with full reasonable solutions,
- comprehension questions,
- training interactive tests,
- training and progress tests to be taken by students independently.

Now there is a description of preparing testing materials by the example of the subject "Ordinary differential equations". As part of the subject, the following issues are under study: order of a differential equation; existence and uniqueness of the solution to the differential equation; particular types of first-order differential equations; differential equations of higher order; differential equations allowing reduction of order; linear differential equations of higher order; systems of differential equations.

The materials have been tested by the authors, when teaching students of both modes of study at the Nosov Magnitogorsk State Technical University.

Studying a subject matter starts from studying theory presented as lectures. Lectures contain definitions, key theoretical provisions, proofs of main facts. Then students are provided with examples of similar solutions to typical problems and comprehension questions. Having studied the subject matter and answered questions, students start doing a test.

Tests prepared and used by the authors in teaching are divided for convenience into training and progress ones. Training tests aim at drilling key concepts, primary skills, and algorithms of solving key problems on the subject matter under study. Problems included in the training test are various in terms of their difficulty. The test contains problems of a theoretical nature, problems aimed at remembering formulae or key features of definitions, key problems on the subject matter, tasks where it is required to complete missing operations or state a true sequence of operations. Doing training tests aims at revealing gaps in learning training materials. Having solved the problem and input the answer in a required form, students immediately see their results in points. If an answer is incorrect, tests provide for a possibility to review mistakes and read a detailed correct solution. One more goal of training tests is to provide students

with a process and system of assessment. Training tests are presented in three options with different levels of difficulty.

The next stage of studying the subject matter is doing a progress test. Such test also performs a training function; therefore, it may be called as a training and progress test. Progress tests do not provide for reviewing mistakes or correct solutions. Having done the progress test, students immediately see their results in points, but they cannot see where exactly they have made mistakes. The authors consider two options of using progress testing in a teaching/learning process. The first one is progress testing as a tool and way to arrange individual work at home; the second one is as testing directly in the classroom.

Progress tests are prepared in several options on every subject matter, each with three levels of difficulty.

Types of tasks used when preparing tests and examples of such tasks are given below.

1. A closed form of testing as multiple choice tests. Such tests do not provide for any input of answers. A student under test should choose one or several correct answers from suggested ones. This type of tests also includes tasks to match items or set a correct consequence of actions.

When developing tests, the authors use the following tasks:

- to choose one correct (or incorrect) answer from suggested ones,
- with an alternative response,
- to choose several correct (or incorrect) answers,
- to match items,
- to choose the one best answer,
- requiring to restore a correct sequence of actions (an answer in such tasks is a correct set of figures or letters defining the next answer or action) or tasks requiring to restore missing elements, while solving them.

An example of such task is given in Figure 01.

**Start** (Click « Start », answer the question, then click « Stop ».)

4. (13<sup>pts</sup>) Solve the Cauchy problem  $y' + y \operatorname{tg} x = \sin 2x$ ,  $y(0) = -2$ . In empty cells, place the missed expressions. Use symbols  $(du/dx)$  instead of  $u'$  and  $(dv/dx)$  instead of  $v'$ .

Will make a replacement  $y = \text{[ ]}$ , then  $\frac{dy}{dx} = \text{[ ]}$ .

Substitute the resulting equation into the original:  $\text{[ ]} = 0$ .

Equal to zero the second and third terms and reduce by  $u$ :  $\text{[ ]} = 0$ .

Multiply by  $dx$  and divide the variables  $\text{[ ]} = 0$ .

Calculate the integrals  $\text{[ ]} = 0$ , then express  $v$   $v = \text{[ ]}$ .

Insert the resulting value for  $v$  into the original equation  $\text{[ ]} = 0$ .

Express  $u$  from the resulting equation as an integral  $u = \int \text{[ ]} dx + C = \text{[ ]} + C$ .

We write down the General solution of the differential equation

$$y = \text{[ ]}$$

Using the initial condition, find the constant  $C = \text{[ ]}$ , and write down the solution

$$y = \text{[ ]}$$

**Stop** **Correct**

Answer:  Check out the solution.

**Figure 01.** An example of a practice test with a possibility to input symbols and check out the solution

To enable the task, you should click the “Start” button; to review the result – click the “Stop” button; to view the solution – click the relevant button “Check out the solution”.

2. An open form of testing as giving short answers. This type of tasks provides for an input of answers in characters.

We have used tasks requiring:

- to give a numerical answer,
- to give an answer in a symbolic expression,
- to complete an answer in a free form with limitations to the answer (in numbers, in characters).

To create problems with multiple options and various levels, we have applied a facet task technique.

Testing materials and tests themselves are prepared as a PDF file. Interactivity is implemented by applying in a LaTeX system (Lamport, 1994) an acrotex package designed by Story, Professor of Mathematics, from the University of Akron (Story, 2017).

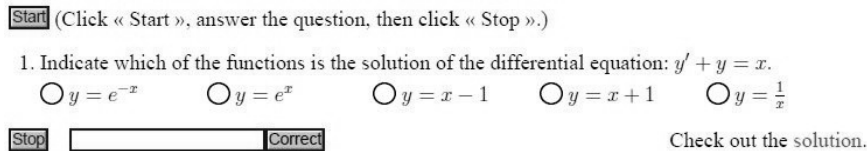
The acrotex package is enabled by the command:

```
\usepackage[xetex,unicode=true]{exerquiz}
```

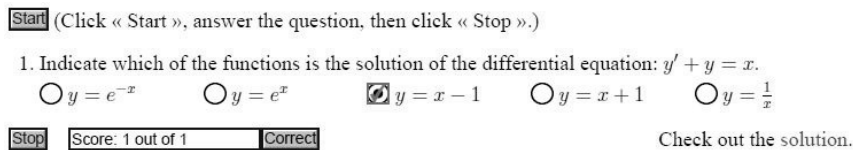
At the next step we enable the dljslib package to use JavaScript.

```
\usepackage[setSupport,ImplMulti,limitArith]{dljslib}
```

Figures 02 and 03 give an example of interactive elements included into the test. Below we describe their creation (Figure 04).



**Figure 02.** An example of a test to choose one answer before inputting the solution.



**Figure 03.** An example of a test to choose one answer after clicking the “Correct” button.

```
\begin{EmptyBlock}\label{test:firorddiffequ01}
\end{EmptyBlock}
\begin{quiz}{FirOrdDiffequ01}
(Click << Start >>, answer the question, then click << Stop >>.)
\begin{questions}

\item[1,]PTs{1} Indicate which of the functions is the solution of the differential equation: $y'+y=x$.
\begin{answers}*{5}
\Ans0 $y=e^{-x}$ &\Ans0 $y=e^x$ &\Ans1 $y=x-1$ &\Ans0 $y=x+1$ &\Ans0 $y=\frac{1}{x}$
\end{answers}

\end{questions}
\end{quiz}
\quad \PointsField{currQuiz}{eqButton}{currQuiz}{hfill} Check out the \hyperref[sol:firorddiffequ01]{solution}.
```

**Figure 04.** A fragment of a code describing the test given in Fig.2 and Fig. 3.

The code given in Fig. 4, between the operator brackets “`\begin{questions}`” and “`\end{questions}`”, contains a description of the task and the field “`\RespBoxMath`” to input and check out the solution; directions “`\begin{answers}`” and “`\end{answers}`” specify a list of correct (“`\Ans1`”) and incorrect (“`\Ans0`”) answers. The command “`\CorrAnsButton`” creates a button to view the answer. The command chain “`\PointsField\currQuiz`” creates a field to display a result, and “`\eqButton\currQuiz`” creates the “Correct” button.

## 7. Conclusion

The authors have tried to create materials forming an integral system of knowledge and skills in the relevant field. Materials have been tested at the Nosov Magnitogorsk State Technical University. We have done a lot of preparatory work to select theoretical materials and problems. Testing materials partially serve to make up a deficit of classroom communication between university teachers and students; therefore, a special focus is given to tasks. Tasks in tests are selected so that a student could pass the test based on a thorough study of materials. A developed electronic resource contains interactive elements. Upon completion of the test, students get their results immediately and may see their mistakes and types thereof, and get references to a relevant theoretical material and a correct solution to the problem. The electronic resource primarily differs from existing online services in its aim, namely training (not control) supposing a deep and thoughtful study of materials in detail. Its feature is that available tests are used not to monitor, but to practice different learning skills and algorithms.

A survey conducted among students and university teachers showed that such tests helped students to study the subject and achieve a required educational level.

Many people mentioned that suggested materials encouraged students into a regular learning activity as testing was arranged in a deadline mode.

Regarding advantages of the resource, university teachers noted a possibility to apply an individual approach to training, and monitor a progress of learning quickly and impartially. Besides, the stated advantage of the resource is that it does not depend on availability and speed of an Internet connection.

A comparative analysis of performance in groups, where testing interactive materials were used for experimental and testing purposes, showed a positive trend in academic performance.

Almost all students assessed a new form of individual work as interesting and useful, having positive effect.

Relying on their experience of testing developed materials described in this paper, the authors intend to continue creating electronic learning resources containing interactive testing materials on different subject matters.

## References

- Abdurazakov, M.M., Aziyev, R.A., Romanov, P.Yu., Sadykova, A.R. (2017). Teachers IT competence structure and content in the field of cloud computing. *The European Proceedings of Social & Behavioural Sciences*, 28, 1-8. <https://dx.doi.org/10.15405/epsbs.2017.08.1>
- Akmatbekova, A.Zh. (2017). Testing as a form of organizing independent work of students on physics. *Herald of Chelyabinsk State Pedagogical University*. 4, 9-13.

- Belova, E.A. (2015). Specifics of use of electronic educational resources with elements of autodidactics for personal development. *Integration of Education*, 19(4), 117–126. <https://dx.doi.org/10.15507/1991-9468.081.019.201504.117>
- Borovik, A. (2010). Information technology in university-level mathematics teaching and learning: a mathematician's point of view. *Research in Learning Technology*, 19(1), 73-85. <https://doi.org/10.1080/09687769.2010.548504>
- Chuprova, L.V. (2016). Design of independent work of students of tuition by correspondence with use of modern educational technologies. *International Journal of Experimental Education*, 2-1, 116-119.
- Karolčík, Š., Čipková, E., Veselský, M., & Hrubíšková, H. (2013). Standardization of quality evaluation of educational software and electronic learning tools – analysis of opinions of selected experts. *Journal of Software Engineering and Applications*, No. 6(11), 571–581. <https://dx.doi.org/10.4236/jsea.2013.611069>
- Kelly, P., Coates, H., & Naylor, R. (2016). Leading online education from participation to success. *Educational Studies*, 3, 34-58. <https://dx.doi.org/10.17323/1814-9545-2016-3-34-58>.
- Kerimbayev, N., Kultan, J., Abdykarimova, S., & Akramova, A. (2017). LMS Moodle: Distance international education in cooperation of higher education institutions of different countries. *Education and Information Technologies*, 22, 2125-2139. <https://doi.org/10.1007/s10639-016-9534-5>
- Kivinen, O., Piironen, T., & Saikkonen, L. (2016). Two viewpoints on the challenges of ICT in education: knowledge-building theory vs. a pragmatist conception of learning in social action. *Oxford Review of Education*, 42(4), 377-390. <https://doi.org/10.1080/03054985.2016.1194263>
- Klimenskikh, M.V., Korepina, N.A., Sheka, A.S., & Windecker, O. (2018). Students' and teachers' perception of the specifics and possibilities of distance learning. *Modern Problems of Science and Education*, No. 1, 41. Retrieved from: <http://science-education.ru/ru/article/view?id=27421>.
- Lamport, L. (1994). LATEX: A document preparation system. Addison-Wesley Publishing Company.
- Lawrence, J.E., & Tar, U.A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International*, 55(1), 79-105, <https://doi.org/10.1080/09523987.2018.1439712>
- Leontyeva, I.A. (2017). Distance learning as one of the means to improve the quality of education of students in the university. *Herald of Chelyabinsk State Pedagogical University*, No. 6, 84-88.
- Maloshonok, N. G. (2016). How using the Internet and multimedia technology in the learning process correlates with student engagement. *Educational Studies*, No. 4, 59-83. <https://doi.org/10.17323/1814-9545-2016-4-59-83>
- Noskova, T.N., Pavlova, T.B., & Yakovleva, O.V. (2016). Analysis of domestic and international approaches to the advanced educational practices in the electronic network environment. *Integration of Education*, 20, 4(85), 456-467. <https://doi.org/10.15507/1991-9468.085.020.201604.456-467>
- Semenova, D.A. (2017). Network and multimedia technologies in contemporary higher education. *Herald of Chelyabinsk State Pedagogical University*, 10, 67-72.
- Songkram, N. (2015). E-learning system in virtual learning environment to enhance cognitive skills for learners in higher education. *Procedia - Social and Behavioral Sciences*, 174, 776–782. <https://doi.org/10.1016/j.sbspro.2015.01.614>
- Story, D.P. (2017). AcroTeX Web Site. Retrieved from: <http://www.acrotex.net/>
- Tomczyk, Ł., Sztokowski, R., Fabiś, A., Wąsiński, A., Chudý, Š., & Neumeister, P. (2017). Selected aspects of conditions in the use of new media as an important part of the training of teachers in the Czech Republic and Poland - differences, risks and threats. *Education and Information Technologies*, 22, 747-767. <https://doi.org/10.1007/s10639-015-9455-8>