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Tools of the Computer Testing of Knowledge in Mathematical Disciplines

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Abstract

Issues of using different forms of test tasks for testing knowledge in mathematical disciplines in computer knowledge testing system OpenTEST2 are presented. It is suggested to use delay of right answers appearance in test tasks of closed type and regular expressions for setting etalons in opened type test tasks.

1. Knowledge testing system OpenTEST2

Recently, testing of knowledge is used for controlling knowledge quality, rating, and students and university entrants selection and for different professional selections. Computer knowledge testing systems are widely used for the improvement of testing quality.

Computer knowledge testing system OpenTEST2 is developed in Kharkov National University of Radio Electronics (KHNURE) [1], at creation of which web-technologies language of server scripts PHP, HTML, XML, and JavaScript languages were used. Database under MYSQL management was used for storage of all information. The group Apache2+PHP5+Mysql5 is a server, and any Internet browser is clients.

A testing process consists of the following stages: creation of test, creation of test groups, setting of testing parameters, realization of testing and its monitoring, getting results and statistics. Every stage is realized by a separate module of the system with verification of authorizing and rights for access. In OpenTEST2 a partly adapted algorithm of knowledge control training will be realized with a random sample of test tasks (questions) from the structured four level test database and group conception of management users.

Testing in knowledge testing system OpenTEST2 is carried out by organization of testing session, which is characterized by the time for testing and the length (by the amount of test tasks). The system supports all basic types of closed form test tasks (choice of one correct answer, choice of few correct answers, matching) and opened form test tasks (free input of a short answer) with arbitrary setting of weight of questions. Primary estimation is determined as a percent (stake) of correct answers for the tasks of testing session. Testing results appear in the arbitrary scale of evaluation (point scales are chosen by a teacher), and the detailed statistics of testing results are also given .

2. Forms of test tasks in mathematical disciplines

According to special purpose options of testing test tasks can be divided into theoretical (verification of knowledge) and practical (verification of abilities and skills).

Special attention is paid to verification of abilities and skills for determination of students' level of preparation in mathematical disciplines. The basic type of questions is a task for solving equations, inequalities and their systems. Special feature of such tasks is that answers are relatively simple but with quite difficult procedure of solving. The basic form of test tasks are closed type tasks with choice of one correct answer [2].

It depends, at first, on a variety of forms of answers presentation, each of which is mathematically correct. For example, for the question of the opened type

"To solve equation

$$\mathrm{Cos}\ 2x + \mathrm{Sin}\ 2x = \mathrm{Cos}\ x + \mathrm{Sin}\ x$$"

answer { $\pi/6 + 2/3\ \pi n$; $2\pi k$ } has a lot of forms of presentation, in particular "π" can be substituted by "180", or by a record "180 degrees". Periodicity of answers for trigonometric equations also can be presented in many ways.

Secondly, a special mathematical characters of type "integral", "derivate", a "root is square" are used in many solutions. In the questions of the opened type an answer is usually entered in a text form, and in the standard computer keyboard there are no characters. The use of standard generators of formulas (MS Office) is not possible because of closed format of presentation of such formulas. Also presentation of ranges has a great difficulty which often is in solutions of mathematical equations.

In test tasks of the closed type, when variants of answers are given to an university entrant together with

the text of the question, a correct answer is easily calculated because of simple substitutions of answer variants in a problem specification. When using mathematical calculators application of selective mathematical questions becomes problematic in general. For example, in a task

"To solve equation

$$\sqrt{2x+4}-\sqrt{x}=\sqrt{x-12}\text{"}$$

with alternative answers { 2 ; ±6 ; ***16***, 8 ; 12 } the method of variants substitution of answers solves in a few seconds, although for its correct solution it is necessary to know the methods of solving irrational and square equations.

In OpenTEST2 to get rid of the above-stated drawbacks of mathematical questions of the closed type in creation of test tasks on mathematical disciplines, it is suggested to use a new type of question: "selective time-lagged appearances of answer". The technology of answer for such question is the following. The text of question with the recommended time for a solution of the task and button "Ready for the answer" appears in the window of browser (Web-interface). A student by all means (on a paper, "in a mind") solves the problem and, in the case of getting the correct answer, pushes the button "Ready for the answer". After it the variants of answers appear in the window of browser for a short time (30 – 45 seconds) and local timer with the indicated time. During this time a student chooses the correct variant of answer, but is not in a position to pick up an answer the method of substitution. Time of variants of answer existence on the screen (time of delay) is specified in tuning of the concrete test in the system and can change from test to test.

After expiration of the delay time indicated in settings of test, the answers disappear regardless of whether the answer was chosen or not. A question is then blocked, so the variants of answers become inaccessible for viewing or their adjustment. During work with such questions a student must use the button "Ready for the answer" very carefully. Pressing it is necessary only in case that a correct answer is ready.

Control of answers variants availability time is carried out on the side of server, therefore any attempts of a user or an operator in manipulations the buttons of managing a browser to prolong time of answer existence on the screen does not give a result. Although answers on the screen are visually present, the reception of variant of answer for a question is however blocked after expiration of delay time. Insignificant time of existence of answers on the screen makes it difficult to copy for subsequent distribution among other students.

While checking theoretical knowledge on mathematical disciplines, as a rule, knowledge of determinations, formulas, values of mathematical constants are checked up. Thus, the use of test tasks of the closed forms only appears insufficient. For the use of the opened forms of test tasks in standards it is suggested to utillize regular sequences [3].

Regular expressions are a modern search system of text fragments in electronic documents, based on a special system of standards for a search record. Standard, which makes the rule of search, sometimes is called a «template» or «mask». Regular expressions are in fact a mechanism, allowing setting a template for a line and carrying out retrieval of data, justifying this template in the set fragment of text. In addition, user facilities to work with them allow getting found information as an array of lines, making replacement in a text according to the template, breaking up a line on a template etc. However their main function on which all the rest is based, is exactly a function of searching information in the text, according to template, described in the syntax of regular expressions. Presently regular expressions have became practically a standard and are used by text editors and utilitues for a search and change text on the basis of chosen rules. The standard of PCRE of regular expressions is used in OpenTEST2. Documents on the syntax of regular expressions are possible to be found in the site http://www.pcre.org/.

While setting standards in the opened form test tasks it is better to use regular expressions for a task exactness of mathematical sizes, for pointing intervals of mathematical values, for the task of expressions, invariant keyboard registers and linguistic lay-outs. In the system OpenTEST2 regular expressions in the standards of tasks with a short answer are framed by «tildas» (~).

For example, for pointing exactness of mathematical constants for a test task «Specify the value of number π" symbols within two signs correspond a regular sequence:

~^\s*3\.14\d*\s*$~ ,

where ^ – beginning of the entered line;
$ – end of the entered line;
\d – any decimal number;
\s – any blank character;
* – quantificator, equal to zero or more, than included in previous character.

For example, for pointing electoral exactness of mathematical sizes (interval of values from 2,51 to 2,53) a regular sequence is set: ~^2\.5[1-3]\d*~.

3. Conclusion

Flexibility and comfort of the offered methods of constructing test tasks allow using them not only for mathematical disciplines but also for programming and design disciplines, where test tasks are widely used for the analysis of formal linguistic constructions.

Long-term experience of the OpenTEST2 system usage in KHNURE by other higher educational establishments of Ukraine and Russia confirms high stability, safety and reliability of the used technologies and approaches to organization of testing students knowledge. The OpenTEST2 system is spread out as free of charge. Developers are interested in distribution of the system and its further development, therefore a product is spread out on principles of open licenses of GNU/GPL type. All information is present on the site opentest.com.ua.

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