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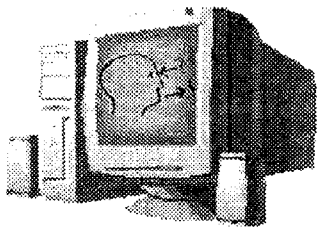

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Cognitive Tool for the Representation of Test Results of the Blended Education

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Abstract. It is given a brief review of the use of learning technologies in high education. The description of an on-line simulator functionality, designed for interactive testing is done. It is proposed to provide a cognitive tool of test results within the blended education. We show the usefulness of the proposed cognitive tool "Target" for the online simulator. It is proposed partitioning of the cognitive tool "Target" on sections in order to display the results of students testing and detect abnormal test results. Also further direction of research is described.

Keywords: Blended education, testing, cognitive tool, circular diagram, "Target", mixed diagnostic tests

1 Introduction

Pedagogical, informational, intelligent, innovative technologies are priority comprehensive educational technologies in the field of higher education. Many authors [1-3] define intelligent educational technologies as technologies for creating new intelligent product in the process of design and implementation of educational activities. These technologies enable the formation of the new intellectual properties of students, and scientific and technological methods of generating and reproduction of new knowledge. They are based on the methods of scientific and engineering creativity (synectics, brainstorming, projects method, etc.).

It would be appropriate to define the educational technology on the basis of the students' activities activation and intensification in the direction of modernization of the existing education system. These technologies include problem-based education, game technology, communication technology.

In traditional training - teacher serves as a "filter" that transmits itself through the tutorial information, in interactive training teacher serves as an assistant in the training group, and - teacher is the only one of the sources of information. In interactive learning teacher acts as the organizer of the participants' interaction within

the new experience gained. The term "interactive learning" means spontaneous or staged learning, based on the interaction. On-line training is based on direct interaction with the learning environment of students and teachers. Learning environment plays a role of reality in which participants find field of new experience of their own. Experience of students serves as a cen tral source of educational knowledge within the process of interactive learning.

The traditional learning in comparison to interactive learning is a different type of interaction of the student with the teacher. The teacher passes activity to students, educational goal is to create conditions for the initiative of students. In this case students are not passive learners but they are full participants of the educational interaction, and their experience is not less important than teachers' experience. Teacher does not only provide ready-made knowledge, but also motivates further research. In-depth work with the available experience is characteristic trait of interactive learning.

Within the framework of the research "Development of hybrid intelligent training-testing system for blended education and training" we suggest to develop a hybrid intelligent teaching-testing system that focuses on learning and blended education (blended education and training) using a competency approach. The establishment of this system is based on the use of a) logical and numerical methods in the process of training and testing, b) mixed diagnostic tests based on weighting coefficients of features included in the test, the students' answers and the tests themselves, c) the threshold elements and fuzzy logic, and d) graphics including cognitive, visualization and validation of the results of decision making.

In this paper the development of the tool of cognitive graphics oriented to users with different skills is proposed.

2 The Approach to Creation of Hybrid Intelligent Teaching-Testing System Based on Mixed Diagnostic Tests

A new education paradigm: "blended education and training" (mixed education and training) has been widely discussed and studied recently.

As pointed out by A.-M. Bliuc in the study [4] the term «blended education and training» is relatively new in educational practice. There are not so many references to that issue before 2000. Since 2000s publications on the creation of hybrid courses, the development of technologies for blended education started appearing. American scientist Charles R. Graham (Brigham Young University, USA) is one of the pioneers in this direction, who provides one of the first definitions of blended learning systems: "Blended learning systems combine face-to-face instruction with computer-mediated instruction" [5]. In 2003, the American Society for Training and Development has identified "blended learning" as a key trend, which appears in the knowledge creation.

In world practice we did not meet our proposed approach to the creation of intelligent hybrid teaching-testing system based on mixed diagnostic tests (MDTs). MDTs were the first proposed by A.E. Yankovskaya [6]. MDTs are a compromise between unconditional and conditional components [7]. The system is based on the elements of the threshold and fuzzy logic, as well as graphics including cognitive, visualization and justification results of decision making. Since the developed system

will significantly improve the quality of training and education of students, its competitiveness on a global scale is not in doubt. Benefits of using MDTs are in the application of consequent solving of task, because the material learned (didactical units) is dependent on that, and in the fact that decision-making is carried out simultaneously with the development of a mixed diagnostic test. It is reasonable to believe that all of these studies are conducted on a world level.

Blended education and training combines the advantages of electronic and traditional learning. Development of mechanisms for effective education and training of a large number of professionals who are able to solve a variety of problems, is one of the urgent tasks of higher education. At that attention should be focused as evidenced by many publications [8-10].

In the simpliest case "blended education and learning" is a learning process, which relies on the use of a variety of resources and tools within a structured and focused curriculum. Organization forms of learning activities, which are used in blended education and training can be quite diverse, including webinars, conferences, video, virtual reality and simulation, game and educational technology, etc. It should be noted that despite the variety of information technologies, including artificial intelligence techniques, and these technologies are very difficult to adapt to a particular area of concern, in our case in the education field. In this regard, as rightly pointed P. Brusilovsky, V. Uskov [10, 11] the development of such systems requires considerable labor, time, and cost.

The implementation of decision making based on MDT in intelligent teaching-testing systems using the fuzzy logic and threshold function within the competence-based approach was first proposed in 2012 [6, 7]. This paper is a continuation of research in this field and focuses on the development of cognitive tool for presentation of results test in the framework of blended education.

3 On-line Simulator

An online simulator for interactive testing and/or demonstration of the variants of the Unified State Examination (USE) in general subjects (Russian language, mathematics, physics and chemistry) was developed at Tomsk Polytechnic University (TPU) [http://exam.tpu.ru]. The use of this simulator allows to explore the test materials (TM) in on-line mode.

3.1 Functionality Descriptions

Graphical interface of the simulator is divided into administrative and user parts. The administrative part of the simulator provides the ability to fill and edit test materials to the database. See for details Fig. 1. Database administrator can indicate the next properties of test materials:

- the type of question (multiple-choice questions, completion questions, labeling and building questions and true/false questions),
- the subject (Russian language, mathematics, physics and chemistry),
- the topics,

– the content of question,
– variants of answers and the correct answer.

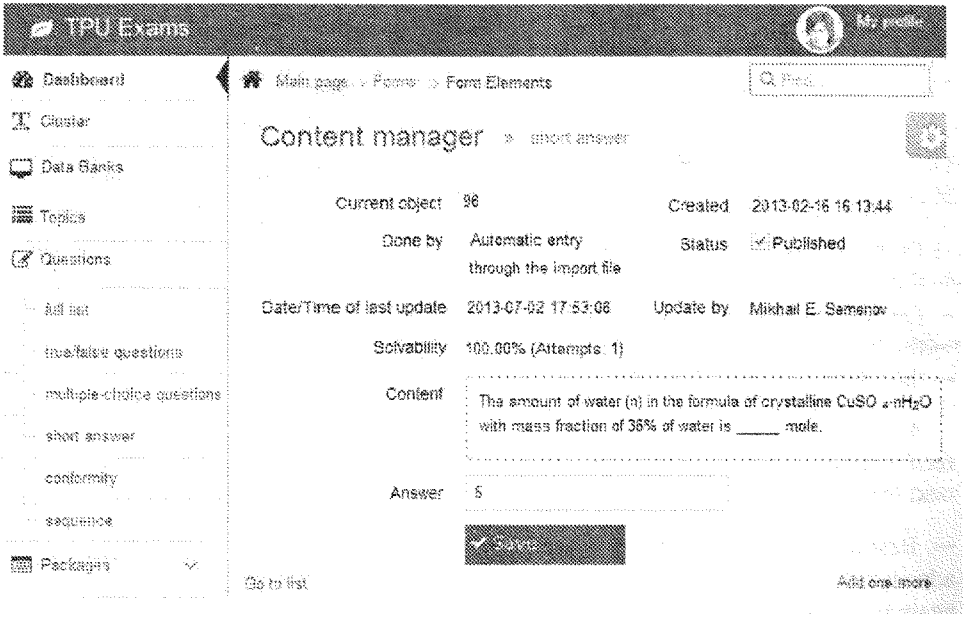

Fig. 3. The interface of the administrative part

In forming the test a user can choice the necessary partitions of subjects in the specification of a generalized version of the plan of TM 2013 on subjects (Russian language, mathematics, physics and chemistry). By default, all sections are included on the test. A set of test items is randomly generated with the users setting. However, the text and variant answers of TM can contain text, formulas, and graphic illustrations. Bank of tests contains more than 500 tasks in each subject that allows to create a representative sample for each test session.

To pass the authorization of the simulator a user can fill the username of the social networks (e.g. facebook.com) or to input login and password of TPU entrant's personal account. This part of the simulator gives user the ability to perform testing tasks in interactive mode. When performing tasks a user can choose the sequence of test task. If necessary user can skip the tasks and come back to them later. User may stop the tests session and return to testing later, and the state will be saved in which the test was terminated. At the time of the test on the screen displays the current information: the total number of test task, the number of completed tasks, the recommended time to perform all tasks, the recommended time for the current test, the level of test difficulty – easy, basic, high complexity, the number of points for the current test.

During test execution the number of correctly completed tasks and the current number of points determines automatically. After pass of the demonstration test of USE an applicant receives a descriptive and statistical information, and advice on the choice of possible specialties. Information on the results of testing includes:

— the discipline (Russian, Mathematics, Physics and Chemistry),
— the number of participants,
— the number of attempts,
— the maximum result in points,
— the minimum result in points,
— the average result in points,
— the current result in points and the number of total possible points.

Upon a user request the following information could be represented at each test attempt:

— the total time for executing test tasks,
— the test number,
— the start time and date,
— the finish time and date,
— the amount points

As a result of the test passing a user receives results in the form of recommendations (qualitative mark). Today the recommendations are available in the next form:

— Result on the subject "Subject A" is above average. Please do not miss chance of admission to a specialty "B". To improve knowledge it is recommended to be tested again in a few days.
— Result on the subject "Subject A" is below average. You have a chance to revenues for the specialty "B", but you need more training. Please repeat the course material and pass the test again. Note the attention on specialty "C" too.
— Result on the subject "Subject A" is high. You have a great chance of admission to the specialty "B" At the moment, your result is the best result. We recommend you to visit our website in a few days and look at the results of the other applicants.
— Result in the discipline "Subject A" is low. You will have a chance to study for the specialty "B" only after hard training. Please repeat the course material and pass the test again. Note the attention on specialty either "C" or "D".

Based on this mark the user can decide whether to re-train (control, test), and the university administration can offer various forms to the user for further study: the leveling course, the elite training, the summer school, etc.

3.2 Results of Representation

A cognitive tool in a pie chart, which we called "Target" and the table is used for the representation of the test results. A user can see the anonymous results of testing of all participants without personal identifiers (name, surname etc). The information in graphical form (Fig. 2) and tabular form (Fig. 3) displays on the screen of a laptop or a cell phone.

The visual information is displayed in the form of a cognitive tool which we call the diagram "Target". The target consists of concentric circles of different colors

(Fig. 2). Each circle represents a certain range of scores (e.g., yellow circle form 100 to 80 points, the red circle from 79 to 55 points, etc) and is divided into sectors which range equals $\pi/6$.

Center of the target (bullseye) corresponds to 100 points. Inside the "bullseye" there is another inner circle of half the diameter. This inner circle is used to display equal (maximum) results, and to display the results of Olympiads winners.

By default, the target shows the points that correspond to the number of points earned by the participants of the tests. Coordinates of the point (ρ, φ) are defined as follows. Here ρ is the radius vector of length equal to the total number of points obtained by a user, and φ is the angle which is selected from the interval $[0, 2\pi]$ by a certain rule. This rule is functionally dependent on the time testing of participant. For example, in the interval $[0, \pi/6]$ on the target shows the results obtained during the more than 12 times less than the time available for testing. See for details Fig. 2.

Upon a user request the test results of other participants can be hidden or shown on the diagram. For this action a user should press the button only.

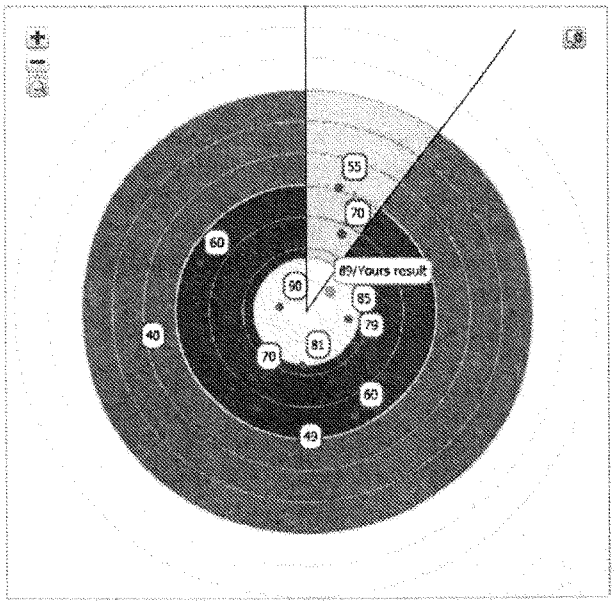

Fig. 4. Cognitive tool "Target" with results

In addition to the graphical representation results are available on the table mode too. An example of this table is shown in Fig. 3. In the table it is displayed:

— name, surname of participants,
— total score for each participant testing (Russian, Mathematics, Physics),
— category of participants,
— document of participants (copy or original),
— recommendation of other specialties.

№	Name, Surname	Math.	Phys.	Rus.	Total	Category	Document	Other specialties
1	Mary M.Ratko	98	98	90	286	Common	Copy	2-011200 (Institute of Physics and Technology) 3-140900 (Institute of Physics and Technology)
2	Inna K. Besheva	98	94	92	284	Common	Copy	2-223200 (Institute of Physics and Technology) 3-131000 (Institute of Natural Resources)
3	Maxim G Shibanov	94	96	98	282	Common	Original	3-010400 (Institute of Cybernetics) 3-222200 (Institute of Physics and Technology)

Fig. 5. Example of table with results and recommendations

It should be noted that the proposed cognitive tool can be used to display the results of any testing of students, not only in the framework of the Russian Unified State Examination.

For development of the simulator under manage of operation system Linux the following technologies were used: programming language PHP 5.4, framework Kohana 3.3.0, Oracle Database 11 APP_EXAM @ STORE (connect by PDO), templates Smarty and Bootstrap, client library jQuery, and web-server Apache + Nginx. Cognitive tool is implemented with using multimedia platform Adobe Shockwave.

4 Conclusion

Analysis of the priority comprehensive educational technologies and an approach to the creation of intelligent hybrid teaching-testing system in framework the blended education and training was given in the paper.

The functionality and on-line simulator, designed for interactive testing and/or demonstration of the variants of the Russian Unified State Examination (USE) in general subjects (Russian language, mathematics, physics and chemistry) are described in this paper.

A cognitive tool in a pie chart "Target" for graphical visualization and presenting the testing results in framework of the blended education is first proposed. The efficiency of the proposed cognitive tools in the online simulator is shown. Partitioning of cognitive tools "Target" on sectors can be used to display the time as the test results of students, and to detect abnormal test results over time.

It is proposed to use the proposed cognitive tool to display the results of training, monitoring and testing of knowledge in the application of any comprehensive educational technology.

Further research is associated with a) the programming of the partitioning of diagram "Targets" on sections, b) displaying on this chart the trajectory of individual

students, c) approbation testing of the proposed tool in the first place on the course "Informatics for the humanities" (Tomsk State University, Tomsk State University of Control Systems and Radioelectronics, Russia).

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