Section 4. Natural Sciences and Informational Tehnology

L.A. Altynnikova,
associate professor
of American University of Central Asia
E.R. Atamanov,
active professor
of American University of Central Asia
S.N. Sklyar,
professor
of American University of Central Asia

Using a Specific Pedagogical Theory in the Construction of Mathematics Placement Tests for Incoming School-Leavers at the American University of Central Asia

The oldest test survived in a textbook is more than 37 centuries old. There are 84 mathematical items in it. It was written on ancient papyrus and has a length of over 5 meters (9).

The first attempt of scientific substantiation of the quality of impositions was done at the beginning of the twentieth century in France. This test estimated intellectual abilities of children. A. Bene and T. Simon were the authors. The results of test takers' answers were represented like points on a plane. The children's ages were placed on the X-axis, and the fraction of correct answers for any age group were placed on the Y-axis. Further, the authors averaged all the points and joined them together in a curve graph. After that, they made conclusions about intellectual correspondence at various ages (1). Later, M. Richardson used that same method (2).

At present, tasks in test forms are gaining a noticeable role in pedagogical theory and practice. Teachers can prepare problems or questions for students of low or high intellect, then do a computer check of the level of qualification and a review to help in placement. Some of the characteristics may change depending on the goal of the test. These changes may be caused by content and by level of difficulty.

Lecture form and other types of pedagogical activity represent only the teacher's side of pedagogical process. The other side of this process is the students' achieving of the learning outcome. It is the most important aspect of education (3).

There are basic kinds of steps in pedagogical theory:

- question;
- example;
- original task;
- test;
- course grade or diploma grade.

At the moment, a test is the most popular form of task. Teaching without the tests is ineffective and destructive (3).

We can define pedagogical tasks like methods of development of studying, training and education. They contribute to the development of personality and the increase in effectiveness of pedagogical work. The tasks which correspond to each step provide maximum growth of knowledge, skills and habits to most students (4).

When teachers are preparing tasks, it is very important to follow the given principles:

- principle of replacement of task;
- principle of correspondence (the level of difficulty must correspond with the qualification level of students);
- principle of adaptability of task (the tasks become adaptable if students can understand them fast and correctly);
- principle of informative and logical accuracy of task (there are many different equations and examples in a test which have tasks with incorrect conditions).

There are four main characteristics of correct ideation in logic (5):

- determinateness;
- rightness;
- noncontradiction;
- supportability.

When teachers are preparing tasks, it is very important to do everything so that there is not more than one view about one task in that test. For example, students must choose only one right answer between others, and it is incorrect that there are answers not connected with the same condition of question. It is very easy to estimate these answers as wrong, and then the test becomes an ineffective one (6).

It is incorrect to include controversial points of view in tasks. Teachers should enunciate tasks clearly. It is incorrect that one question will reproduce several right answers.

The quality of pedagogical tasks depends on composition and structure (7).

There are many components of creating tasks in composition. Some of them are:

- number of tasks;
- instruction of task;
- text of task;
- symbolic instrument;
- pictures, graphs, diagrams;
- schemes;
- right answer and wrong answers.

Relation and position of all these elements form the structure of the task.

A main reason for educational crisis at universities is a lack of consideration of average work content of students' tasks. All teachers demand that students do their homework. But it is impossible to do everything. Students do not have enough time for all of it.

Regular deficiency, and real coordination of quantity of work content contribute to students' overwork. And so students refuse to do their homework.

A teacher should create such tasks that do not require too many intellectual actions, and the time on the task must be minimal.

We define difficulty of tasks as a statistical measure of its solver. For example, if many students finish a task, it means that this task is easy. There is no place for tasks of indefinite measure of difficulty or for tasks of equal difficulty.

If less capable students answer questions like highly skilled students do, it may mean that the test is not good. In sum, requirements for tests must include:

- shortness;
- technological effectiveness;
- correctness of form;
- logical form of statements;
- similar rules of valuation of answers;
- a place for answers;
- similar instructions for everybody;
- correctness of element disposition ;
- correspondence of instructions for form and support of tasks.

Furthermore, pedagogic tasks must be:

- clearly formulated (without excessive words and symbols);
- pedagogically correct in its list of contents;
- logically exact and noncontradictory ;
- presented in a straightforward way to ensure for universal application regardless of branch of science;
- theoretically supported;
- constructed of algorithms of correct and fast solution (if possible).

It is very important that all pedagogical tasks follow these requirements.

The goal of our work is to show that tests offered to AUCA entrants are in line with main rules for creation of educational tests.

The following is an example of our university's mathematics placement test for the school-leavers entering the American University of Central Asia (8).

See the table (appendix)

The wide experience of test creation reveals that tests offered for university entrants are norm-referenced and ensure differentiation. While developing the test, we aimed at gaining high variation of test scores (high, average and low scores were observed). This allowed differentiating among university entrants.

Literature:

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№	*The tasks*	*Circle the letter that appears before your answer*
3.	Expression $\log_{1/2}(2\sin 15°) + \log_{1/2}(\cos 15°)$ is equal to *Solution:* The function $\mathbf{\log_a b}$ has property, and we can write our expression like: $\log_{1/2}(2\sin 15°\cdot\cos 15°) = \log_{1/2}(\sin 30°)=1$ ***Answer: 1***. (11 points)	*a) -2;* *b) -1;* *c) 0;* ***d) 1;*** *e) 2.*
5.	Inequality $7^{\frac{2}{x}}>0$ has the following set of solutions *Solution:* You must know that the function $\mathbf{a^x}$ is positive everywhere, and so $\mathbf{x\in(-\infty;\,0)\cup(0;+\infty)}$. ***Answer:*** $\mathbf{(-\infty;\,0)\cup(0;+\infty)}$. (11 points)	*a) (-∞ ; 2)∪(2; +∞);* *b) (-2; 0)∪(0; 2);* *c) (0; 2)∪(2; +∞);* ***d) (-∞; 0)∪(0; +∞);*** *e) (-∞; -2)∪(2; +∞)*

<table>
<tr>
<td>9.</td>
<td>You may take 21% of cream from milk, and 24% of butter from cream. How much milk is it necessary to take for making 630 kg butter?

Solution:
Let x kg milk, which is necessary to receive 630 kg butter, and there is y kg cream in milk. Then, we can write the following proportion:

$\begin{vmatrix} x-100\% \\ y-21\%; \end{vmatrix}$ $y=0{,}21x$. Further, it is easy to see that:
$\begin{vmatrix} 0{,}21x-100\% \\ 630-24\%; \end{vmatrix} \Leftrightarrow x=12500\ kg.$
Answer: 12500 kg.
(15 points)</td>
<td>a) 11 500;
b) 12 000;
c) 12 500;
d) 13 000;
e) 13 500.</td>
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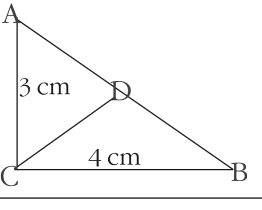
<td>14.</td>
<td>Legs of a right triangle are 3 and 4 cm. Find median of the triangle that has been carried out to hypotenuse.

Solution: If to use the Pythagor's theorem, we can find that:
|AB| = 5 cm; then
|AD| = |DB| = 2,5 cm.

AB is a diameter of the ascribed circle. Point D is the center of this circle.

So |CD| = 2,5 cm.

Answer: 2,5

(19 points)

</td>
<td>a) 2;
b) 2,5;
c) 3;
d) 3,5;
e) 4.</td>
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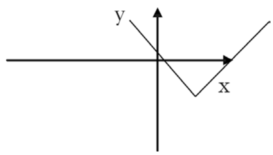
15.	The function graph is given $\mathbf{y= - a - b \cdot \lvert x+c \rvert}$ choose the restrictions on factors ***a,b,c*** *Solution:* We can write this function like $\mathbf{y = - b \lvert x+c \rvert - a}$  It's obvious, that coefficient **(–b)** answer for direction of "croissant" of function graph; coefficient **c** answer for movement axial **OX**; coefficient **(–a)** answer for movement axial **OY**. So, it is easy to see, that ***a>0; b<0; c<0.*** ***Answer: a>0; b<0; c<0.*** (19 points)	*a) a<0; b>0; c<0;* ***b) a>0; b<0; c<0;*** *c) a<0; b<0; c<0;* *d) a<0; b>0; c>0;* *e) a>0; b>0; c>0.*
20.	Sum of all roots of the following equation is $$3^{\log_3^2 x} + x^{\log_3 x} = 6$$ *Solution:* Obviously **x>0**. It is easy to see that $$3^{\log_3^2 x} = (3^{\log_3 x})^{\log_3 x} = x^{\log_3 x}.$$ Then, we have equation: $$2x^{\log_3 x} = 6 \Leftrightarrow x^{\log_3 x} = 3.$$ Find the logarithm of this equation, we will have equation: $$\log_3^2 x = 1 \Leftrightarrow \log_3 x = \pm 1 \Leftrightarrow \left\lvert \begin{array}{l} x_1=3; \\ x_2={}^1/_3. \end{array} \right.$$ Sum of these roots of our equation is equal to $3\,{}^1/_3$. ***Answer:*** *$3\,{}^1/_3$.* (23 points)	*a) $2\,{}^1/_3$;* ***b) $3\,{}^1/_3$;*** *c) $6\,{}^1/_6$;* *d) $7\,{}^1/_3$;* *e) $9\,{}^1/_3$.*

23.	The following expression **lg (tg 1°) + lg (tg 2°) + ... + lg (tg 89°)** is equal to *Solution:* To solve this trigonometrical expression you must remember, that $\mathbf{tg(90^\circ - \alpha) = -\ ctg\ \alpha}$ where $\mathbf{0 < \alpha < 90^\circ}$. If we group extreme members like , **lg (tg 1°)** and **lg (tg 89°)** it is easy to see, that **lg (tg 1°) + lg (tg(90° – 1)) = lg (tg 1° · ctg 1°) = 0.** If to continue these argumentations, we will have finally that our expression is equal to **lg (tg 45°) = 0.** ***Answer: 0.*** (27 points)	*a) -1;* ***b) 0;*** *c) 1;* *d)* $^{\pi}/_{4}$*;* *e) 2.*

С.Н. Скляр,
д. ф.-м. н., профессор направления «Естественные науки и информационные технологии», ассоциированный вице-президент по академическим вопросам, Американский университет в Центральной Азии
М.А. Рылов
научный сотрудник Института коммуникаций и информационных технологий, Кыргызско-Российский Славянский университет

Об аппроксимации уравнений движения в задачах о циркуляции жидкости в водоеме

Математическая модель циркуляции жидкости в водоеме основана на системе полных нелинейных уравнений гидротермодинамики**,** записанных в традиционных приближениях, и включает уравнения движения, статики, неразрывности, переноса тепла, а также уравнение состояния [4]. В настоящей работе мы рассмотрим только систему