ASSESSMENT OF EDUCATIONAL ACHIEVEMENTS IN MATHEMATICS OF UKRAINIAN BASIC SECONDARY SCHOOL STUDENTS WITHIN THE FRAMEWORK OF THE "NEW UKRAINIAN SCHOOL" PROJECT*

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ABSTRACT: *In the article we describe the methods of evaluating educational achievements in mathematics of Ukrainian students in accordance with the implementation of the provisions of the "New Ukrainian School" project. New approaches to assessing the development of students' key competencies during mathematics education are considered, in particular, assessing the ability to work out problem situations and create mathematical models of real processes and phenomena; solve mathematical problems; critically evaluate the results of their activities during mathematics learning. Didactic materials for conducting such an assessment in the form of papers for formative current, thematic and final assessment are proposed, as well as the toolkit for its practical implementation by teachers in the process of teaching mathematics to basic secondary school students is described.*

KEYWORDS: *New Ukrainian School, competence approach, mathematics, assessment, student's educational achievements, learning outcomes.*

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1 Introduction.

Currently, the education reform "New Ukrainian School" (hereinafter - NUS) is underway in Ukraine [1]. The reform is based on a competency-oriented approach to learning and is aimed at turning the student's face, so to speak, and following the learning process from the needs of his/her personal development. The first step in the implementation of this reform was the creation of State Education Standards for elementary school (grades 1-4), basic secondary school (grades 5-9) and senior specialized school (grades 10-12) (see [2], [3], [4]). The next step is to create a basic educational plan and model programs for each educational field, particularly mathematics. Further, on the basis of model programs, author teams of experts in mathematics didactics create textbooks, manuals and other methodological support for the educational process in the NUS.

In the field of mathematics education, 2 model educational programs have been created in primary school and more than 10 model programs for basic secondary school, based on which more than 20 textbooks and manuals recommended by the Ministry of Education and Science of Ukraine (hereinafter - MES) have been written for use in the educational process. Our team of authors (Oleksandr Shkonyi, Yevhen Nelin, Andrii Mylianyk and Yulia Prostakova) also created model educational program in mathematics for grades 5-6 and 7-9, and also creates a set of textbooks and guides for this model program (see [5], [6], [7]).

However, as it turned out, one of the significant problems of the implementation of the NUS reform is the assessment of the educational achievements of students. State standards stipulate requirements for the formation of students' competencies during their studies in primary, basic secondary and senior specialized schools. In particular, for the mathematical field, it is assumed that students are able to: 1) work out problem situations and create mathematical models of real processes and phenomena; 2) solve mathematical problems; 3) critically evaluate the results of

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one's activities and make conclusions and generalizations. It is natural that for each of the above *groups of learning outcomes*, it is necessary to give an assessment on a 12-point scale, which has been in effect in Ukraine since 2001. Moreover, this assessment must also meet the evaluation criteria approved by the MES on the 12-point scale.

Previously, teachers assessed all students' academic achievements in mathematics with one grade on the 12-point scale, but now each group of learning outcomes needs to be assessed separately. This procedure caused significant difficulties both for experts and methodologists, and for practicing teachers of mathematics. In this article, we offer an author's approach to solving this problem and present a specific toolkit for such an assessment.

2 Research results

It is clear that carrying out separate current tests and control works for each of the groups of learning results specified in the State Standard makes the process of assessing the educational achievements of students cumbersome and inconvenient for the teacher. Therefore, we propose to use a comprehensive approach and evaluate the achievements of students in mathematics with one work, but at once according to three groups of results.

Let's show it with an example. Here is a fragment of a student's solution to such an current test task: solve the equation $2x + 3 = 8$. Let the student's solution be as follows: "$2x = 8 - 3$, $2x = 5$, $x = 5 - 2$, $x = 3$. Check: $2 \cdot 3 + 3 = 6 + 3 = 9$, $9 \neq 8$". When checking this solution, the teacher sees that the student has worked out the problem situation, that is, determined that this equation is linear and its solution is reduced to solving an equation of the form $ax = b$. Therefore, it can be assumed that the student receives a positive assessment for the first group of learning outcomes. The teacher determines what this assessment should be. If this is a formative assessment task, then the assessment can be "plus" or "you did well", "great", "well done", etc. If this is a control evaluation task, then it can be assigned, say, 1 point.

Further, when checking the task, we see that the equation of the form $ax = b$ is solved incorrectly. Therefore, for the second group of learning outcomes (solving mathematical problems) in the formative assessment, the student receives a grade of "minus", "unfortunately, you did not manage with it", "you should work more", etc., and in case of the control assessment – 0 points. Finally, checking the solution of the equation by substituting it into the original equation shows that the student is able to critically evaluate the results of his activity. Specifically, he determined that he had solved the equation incorrectly. Therefore, for the third group of learning outcomes in the formative assessment, the teacher can verbally positively assess his/her achievements, and in the controlling one, give, say, 1 point.

The given example shows that it is possible, so to speak, to evaluate ordinary mathematical problems according to three groups of learning results, which are presented in the Certificate of Educational Achievements of the student in accordance with the recommendations of the MES. However, at the same time, the teacher may have certain problems with justifying his assessment for the student, because the task itself does not explicitly require him to show the formation of his competencies corresponding to each separate group of learning outcomes. This problem manifests itself especially significantly in control assessment, which usually has higher stakes for students than formative assessment. Therefore, for the controlling thematic and summative evaluation, we offer another type of tasks, which will be illustrated by an example.

Let the following task be given, which will be evaluated in the control work in 2 points: "It is known that the average thickness of human skin is $c = 3{,}5 \cdot 10^{-3}$ m, and the thickness of a sheet of office paper is $d = 0{,}00007$ m. 1) Which of the numbers c and d is written in standard form?

Specify the order of the number written in standard form. 2) Write in standard form a number that is not written in this form. How many times is the average thickness of human skin greater than the thickness of a sheet of office paper? 3) Can we assume that the numbers *c* and *d* are numbers of the same order? If so, why; if not, by how many orders of magnitude is the number c greater than the number d?"

We see that in this task we ask students to explicitly answer the questions related to each of the three groups of learning outcomes in mathematics. At the same time, it is clear why the teacher can give one of two points for one or another group of learning results during the test. Indeed, for the correct answer to the first question of group 1), the student can receive 0 or 1 point, for the answer to the second question of this group – also 0 or 1 point. Similarly, points are awarded for each of the questions of groups 2) and 3).

Let's give another example of a task, for which each group of learning outcomes is evaluated at a maximum of 3 points: "Tom the cat eats a package of food for 3 days faster than Peter the cat. In how many days does Tom eat a package of feed, and in how many days does Peter eat it, if Tom and Peter together eat 7 packages of this feed in 10 days. 1) Create a mathematical model of this problem in the form of an equation. 2) Solve this equation. 3) Does this equation have a solution? If it is so, can each root of the equation be interpreted as a solution to the original problem; if not, what conclusion can be drawn? Write down the answer to the problem. Also find how many times Tom eats faster than Peter?"

In this task, the first group of learning outcomes assesses the creation of a mathematical model of a problem situation. This mathematical model for this case is a fractional rational equation. Since this group of results must be evaluated from 0 to 3 points, the teacher must understand what exactly these points should be calculated for. We suggest that for entering a variable and expressing the time of eating a food package for each of the cats, 1 point should be awarded. Another 1 point can be awarded for the correct expression of the labor productivity of each of the cats. Finally, we propose to award the third point for the correct composition of the corresponding equation.

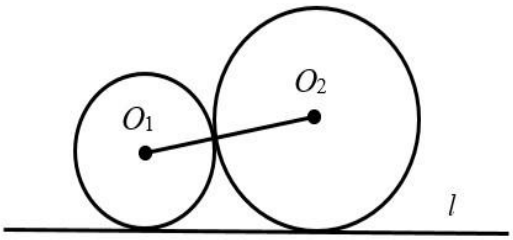
In order to assess the learning outcomes of the second group, it is necessary to check the correctness of the complex equation solution. We concentrate your attention to the fact that the correctness of the solution should be checked even for an incorrectly formulated equation, that is, the result of the activity according to the first group of learning outcomes should not affect the result of the assessment according to the second group. In other words, even if the student made the equation incorrectly, but solved it correctly, the corresponding points should be calculated for the second group of results. Since these points are also three, the first of them can be given from the correct reduction of rational fractions to a common denominator, the second point – for the correct transition to a quadratic equation, and the third point – for the correct final solution of the fractional rational equation.

When evaluating the third group of results, the teacher should also emphasize whether the student is able to interpret the results of his activity during solving problems of practical content. At the same time, this assessment should not be affected by the results of the assessment of the first two groups of learning outcomes. That is, even if the student made the equation for the problem incorrectly and solved it incorrectly, for the evaluation of the third group of learning outcomes, points should be calculated based on the correct answers to the questions related to this group. There are three of these questions, and the student should receive one point for each correct answer on them.

Let us give an example of one variant of the final test for the 7th grade, where each task has a structure that divides the task into three parts in accordance with the groups of learning outcomes

to be evaluated. In general, students can get from 1 to 12 points for this work. The number of points for each task is in parentheses immediately after its number. We have to note that after completing this test, students receive three marks on the Ukrainian 12-point scale for all three groups of learning outcomes in mathematics, which are included in the annual Certificate of Educational Achievement of these students.

1. (3 points) A system of equations is given $\begin{cases} 3x + y = 6, \\ x + 2y = 7. \end{cases}$
   1) Which of the analytical methods of solving this system of equations (substitution or addition) do you think is more appropriate? Explain your answer. What line on the plane does each of the equations of the system define?
   2) Solve this system of equations in the most appropriate, in your opinion, analytical way, as well as graphically.
   3) How many solutions does this system of equations have? Make sure the solutions of the system are identical analytically and graphically, check the correctness of the solution.
2. (3 points) During the renovation, Peter discovered that the floor in his room has the shape of a rectangle, the perimeter of which is 13 m. In addition, he found out that the length of his room is 1.6 times greater than its width and wondered: what is the area of his room?
   1) Make a mathematical model for finding the dimensions of Peter's room.
   2) Find the dimensions and area of Peter's room (in m^2).
   3) Is it possible to solve this problem in another way? If it's so, please provide another solution.
3. (3 points) We have a equilateral triangle ABC with the base AC. We know that the angle A 15^o less, than the angle B.
   1) Make a schematic drawing for the problem. Draw a median perpendicular to the base AC in this figure.
   2) Find the degree measures of all interior and exterior angles of a triangle ABC.
   3) What is the triangle *ABC* – acute-angled, right-angled or obtuse-angled? Does the center of the circle *inscribed* in the triangle *ABC* belong to the median perpendicular to its base *AC*? Justify the answer!
4. (3 points) The schematic drawing shows two circles of different radii with centers at points O_1 i O_2, which are tangent to each other and to the straight line l.



   1) Redraw this drawing in your copybook, marking on it the point of contact of the circles between each other (point *A*) and to the straight line *l* (points *B* and *C*). Draw the radii O_1B and O_2C. What angle do these radii make with the straight line l?
   2) Find the sum of the lengths of these two circles if $O_1O_2 = 10$ cm. Write the answer in mm, assuming that $\pi \approx 3{,}14$. Prove that the straight lines O_1B and O_2C are parallel.
   3) Does the straight line O_1O_2 intersect the straight line l? Why? Will the conclusion change if both circles touch the line *l* but do not touch each other? Justify the answer!

3 Conclusions and prospects for further research

The problem of assessing the educational achievements of the students of the NUS is currently in the stage of active research. Currently, various methodologies of such assessment are being tested for students of grades 5-9 of Ukrainian schools. Now it is too early to talk about the results of this trial, since it actually started only two years ago. However, there are already the first reservations and the first intermediate conclusions from it. In particular, the first reviews of teachers show that this method of control assessment is understandable for students and does not cause them significant difficulties in understanding the conditions of the tasks. However, some students do not understand how detailed the explanations should be during tasks related to the first and third groups of learning outcomes. As a result, these students do not have enough time to complete the test task in the allotted time. Also, teachers and students respond favorably to the above methodology of formative assessment with the help of current test works containing "ordinary tasks", that is, tasks where the tasks for each of the groups of assessment of learning outcomes are not distinguished. This method of formative assessment, provided that the teacher has carefully explained it in advance, is also completely understandable for students.

We plan to continue research in this direction. In particular, over the next several years, a large-scale statistical survey of Ukrainian teachers and students is planned regarding the means and methodology of conducting formative and control assessment for all groups of learning outcomes provided for by the State Standards in accordance with the recommendations of the MES. The results of this survey will be used for further improvement of the system for assessing educational achievements in mathematics of NUS students.

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