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A PROBLEM-BASED APPROACH TO INTEGRAL TEACHING OF MATHEMATICS

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ABSTRACT	KEYWORDS
In given article it is considered an approach to maintenance of continuity of training to the mathematician in secondary specialized, professional and higher educational institutions by means of systems of problems.	problem-based approach, basic problem, system of multi-level problems, one-type problems, educational activity, levels of mastery.

Introduction

This approach is based on the idea of a multilevel problem system [2,3]. The essence of this idea is as follows: first, the topic, content elements of the course are determined, then the main issues are determined, and a multi-level system of issues is created around them.

For example, the basic problems of the topic "Derivation and its application" of the general education mathematics course are as follows:

1) Calculation of the derivative of the function by definition;
2) Calculation of the derivative (using the table of derivatives and the rules for calculating the derivative);
3) Checking the function for monotonicity;
4) Checking the function to the extreme;
5) Calculation of the largest and smallest values of the continuous function in the section;
6) Fully check the function and draw its graph;
7) Finding the equation of the experiment;
8) Applications of the derivative.

A system of multilevel problems can be realized through its matrix description. The matrix description is based on an ordered system (list) of the main content elements and their corresponding base problems and levels of mastery (reflecting the ability to solve familiar, modified and unfamiliar problems).

Such mastery levels correspond to the mastery levels of knowledge and skills (α_1, α_2, α_3) proposed by V.P. Bespalko [1]. Such a matrix model can be given as follows (Table 1):

Table 1

		Subject-content levels (defined by the levels of basic issues)			
		1	2	…	N
The degree of fluency in situational movement skills	α_1				
	α_2				
	α_3				

The matrix of the system of problems built on this basis consists of 3 rows corresponding to three types of educational situations that arise when solving problems, and N columns corresponding to the levels of the system of separated basic problems of the subject (Appendix 1).

Educational activity in the process of solving educational problems included in the first line of the matrix has a reproductive character. The student distinguishes (recognizes) familiar problems from similar problems, can repeat learned methods and algorithms of actions, applies the acquired knowledge in a class of problems of the same type, and receives new information based on the application of the mastered pattern of activity.

The problem used in this - exercises are distinguished by a clear connection between what is given and what is sought, the solution of which is to repeat exactly known facts, formulas and algorithms, substitutions. The block of problems in the first line serves to form the technique of performing the indicated actions and to strengthen skills and competencies. They determine the minimum mandatory results of education in mathematics, defined in the state educational standard.

In solving the problems of the second line, the reproductive learning activity combines with the reconstructive activity, in which the activity samples are not simply restored from the memory, but are reconstructed in a slightly changed condition. When completing this line, the base problems are filled by the algorithm, technical complexity, the form of giving the condition of the problem, and by the complex implementation of these substitutions.

When solving the problems of the third line, the educational activity will have a variable creative character. The student needs to take direction in new situations and develop principled new programs of action. Solving these block problems requires the student to acquire a stock of processed and frequently used algorithms; transfer information quickly from one form to another (from symbolic form to graphic form and vice versa); requires a systematic view (visualization) of the course.

These problems are hidden not in the direct use of the old algorithm in terms of new and increasing technical complexity, but in the implementation of learned algorithms and their combination. These issues have a complex logical structure and are characterized by latent connections between the given and the sought. These problems require knowledge of general heuristic methods, sometimes additional special methods.

We use the concept of homogeneity of the problem to formulate such problems. Problems characterized by the following general parameters (invariants) are called one-type [3]:

I1: problem-solving algorithm or any element of basic (basic) educational content does not change (algorithm is not reconstructed, not supplemented);

I2: unchanged technical complexity (replacements are not complicated, additional operations are not required);

I3: invariance of the form of presentation of the problem situation.

Thus, the three parameters (invariants) I1, I2, I3 determine a problem of a specific type in a three-dimensional array of problems of the same type. Therefore, one type of problem (I1, I2, I3) can be said to be problems in which triplets overlap [4].

Changing one of the parameters, especially 2-3, leads to other types of problems. By changing the parameters, it can be used to create problems with different levels of complexity and difficulty. It is worth noting that changing even one parameter of the problem motivates the learner, which is valuable from a psychological point of view. It prevents the development of false associations, renews perception, activates attention [5, 6].

As an example, let's look at the algorithm for finding the maximum and minimum values of a differentiable function in the interval (a,b) continuous on the section $[a,b]$. As a result of changing the parameters I1, I2, I3, we can get the following group of problems, even if the same algorithm is used in these problems, but they differ sharply from each other in terms of complexity.

Example 1. $y = x^2 + x + 1$ *find the largest and smallest values of the function* [- 2; 3] *on the intercept.*

Example 2. $y = -x^2 - 6x - 4$ and $y = x^2 - 4x + 3$, where $x \in [-4;4]$, find the largest and smallest values of the length of the vertical section between the graphs of the function.

Example 3. $y = \sin 2x$ *find the set of values of the function in* $[arctg\frac{1}{2}; arctg 3]$ *intercepts.*

If in the first problem it is self-evident that the standard algorithm can be used, in the second problem this algorithm is hidden by a different form of problem presentation. From the presentation of the third problem, it is clear that the standard algorithm should be used, but there are technical complications of implementing the algorithm, it is necessary to involve additional knowledge (universal trigonometric substitution), a careful analysis of the critical point belonging to the given interval.

Thus, we take an element of educational content (the base problem) and change the critical parameters of the same type of problems built around the base problem using a sequence of purpose-built problems [7, 8]. Changing the triplet (I1, I2, IZ) without changing the basic problem leads to creating a "ε-surround" of problems around this problem. Such issues can also be built around other underlying issues [9]. The problem environment of the basic problem reflects the zone of close mathematical development of the student, a strong student can solve this array of three-dimensional problems by himself, with the help of an average student-teacher, and a loose mastering student can solve it together with the teacher [10].

The above-mentioned method of creating a system of issues also allows to see the development of educational elements that are repeated in educational stages, their connection with other educational elements. For example, if we look at the first base issue, this issue is also addressed in higher education. If in college it is limited to simple rational functions, in higher education you can look at irrational, trigonometric, exponential, logarithmic functions and their linear combinations. Also, it will be possible to look at the derivatives of piecewise given functions, their relationship with the one-sided derivative problems [11].

Solving the array of problems corresponding to a given element leads to the formation of a new level (or partial level) in the system of mathematical knowledge, skills and abilities of pupils (students), establishing connections between elements of knowledge, methods, methods, methods [12]. The next restructuring of new and old knowledge, analytical-synthetic reprocessing of old and new knowledge, evaluation will appear. It means mastery.

We note that the matrix presentation and use of the system of problems of the subject allows for the automatic implementation of the principle of coherence. Continuity is the law of development, which means that the developing object preserves its previous properties, parameters and functional characteristics in a new level of development.

Mechanisms of activity that make it possible to implement the principle of continuity in education are based on the transfer of old experience to the conditions of new activity: at first, something new that occurs in an activity becomes its (activity) product, and then enters it and subsequent activities as internal conditions.

For this reason, the purpose, content, forms, methods and tools of education should be based on the results of previous education and development at each concrete stage and at the same time take into account future development prospects and potential trends. This is reflected in the filling and future use of the matrix of the issue system of the topic. Each time students go through the familiar, changed, unfamiliar situations encountered in solving problems at one subject level and return to these situations at a higher subject level. This system of issues can be used to implement the principles of differentiation and individualization in education.

The above-mentioned method of creating a system of problems can be used to create sets of problems, to create a unified educational environment in mathematics for the stages of secondary-special, vocational and higher education.

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Appendix 1

		Subject-content levels (defined by the levels of basic issues)			
		1	2	…	*N*
The degree of fluency in situational movement skills	α_1	Find the derivative of x^2+x functions	Find the derivative of the function $(x+1)\cdot x^3$		
	α_2	At what values of x does the derivative of the x^2+2x function equal zero	At what values of x the $(x-2)\cdot\sqrt{x}$ derivative is undefined		
	α_3	$(x^2+x)^2$ find the derivative of the function	$(x^2+1)^2(1-3x)$ find the derivative of the function		