REQUIREMENTS FOR THE SELECTION OF CONTENT FOR HEURISTIC TASKS IN THE TEACHING OF ELEMENTARY MATHEMATICS TO FUTURE MATHEMATICS TEACHERS

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ABSTRACT

The article analyzes educational and methodical literature on elementary mathematics for students of mathematical faculties of pedagogical universities for its focus on the development of cognitive competence, consider existing requirements for the selection of content and adapt them to the problem of research.

INTRODUCTION, LITERATURE REVIEW AND DISCUSSION

The development of cognitive competence of future teachers of mathematics in a teacher training college is closely related to the organization of students' activities for independent acquisition of new knowledge. The main sources of knowledge in elementary mathematics should be considered teaching aids for students in this discipline, as well as teaching aids aimed at systematic repetition and deepening of elementary mathematics, addressed to school leavers, teachers and students of mathematical faculties.

As a result of the analysis of the content of educational and methodical literature, their insufficient focus on the development of cognitive competence was established. The presented material to a greater degree serves the development of information and operational components: as a rule, the information is generalized to the types and methods of problem solving, samples of solutions, tasks for independent solution are given. In this case, some manuals give hints on the choice of method. Less pronounced is the orientation to the development of the motivational component. As a rule, the main goal of the topic under study is stated in the manuals, but in the discussions of the solutions given, the choice of the method of solution and the goal of identical transformations are rarely substantiated. In other words, the emphasis on microe goals does not occur when solving a problem, and, therefore, generalization and transfer of knowledge will be more difficult in this case. In the considered manuals, their influence on the development of the evaluation component of competence is not sufficiently expressed. In most of the manuals, it is suggested that control should be performed by reconciliation with the answer, or with a similar solution if there is one. As an exception, we can mention the manual "Mathematics for an Applicant" by V.V. Tkachuk, which contains algorithms of self-training. The reader is offered to choose one of three levels of self-education. For each level, the degree of knowledge of theoretical information is determined, which is also fixed with the help of multilevel exercises, tips on how to organize problem solving are given, self-assessment after each lesson is supposed to be performed, as well as the reader's prediction of his or her assessment at the exam.

Heuristic tasks can be seen in each of the manuals under consideration, but there is usually no special emphasis on heuristic in the texts of the manuals. Mechanisms of mastering heuristics as a means of acquiring mathematical knowledge are also not covered in the manuals.

The above leads to the need for the special design of training tasks aimed at developing cognitive competence.

The course of elementary mathematics in the curricula of the bachelor of pedagogical education in the direction of "Mathematics" is studied in 5-8 semesters. The selection of the content of this discipline is determined by the fact that in the course of its study, the professional training of a bachelor to perform the functions of a teacher of mathematics. That is why the tasks that are proposed for the solution of the content cover, first of all, the material of the mathematics program for secondary school. In contrast to school mathematics, the main idea of the discipline is to show the wealth of methods and techniques to solve such problems.

One of the content lines of elementary mathematics is the line of equations and inequalities. The language in which equations and inequalities are described is more familiar and understandable to most students than the language of functions or geometric bodies. For the formation of cognitive competence, it is important how one receives information and how it is transformed into knowledge. Therefore, it is necessary to choose the language that will be available to most students.

The analysis of programs of elementary mathematics, pedagogical institutes of higher education shows that equations and inequalities are studied in 5-6 semesters, and training is aimed at the systematization of students' knowledge based on methods of decision. Let's enumerate the main types of equations and inequalities, as well as methods of their solution and special heuristics used in the process of acquisition of knowledge by students in the programs of the discipline "Elementary mathematics".

The design of a task material aimed at the development of cognitive competence should be done in accordance with certain requirements (or principles) for the selection of its content.

Ya. I. Grudenov developed universal principles required for the task material: uniformity of exercises, continuous repetition, counterexample, comparison, completeness. The uniformity of exercises means that their system contains a large number of exercises of the same type. As associations arise on the basis of repetition of the same actions, the uniformity of exercises is necessary for the assimilation of knowledge. Continuity of repetition is that the system of exercises on a new topic includes tasks from the previous sections. These can be tasks which are similar in appearance to the tasks on a new topic or "combined" tasks which include material from the previous topics.

The principle of counter-example is to include tasks in the system of exercises that provoke students to make mistakes. Its implementation helps to identify and eliminate mistaken associations among students. The principle of comparison is understood as an alternation of exercises for direct and reverse operations, an alternation of tasks that are difficult to distinguish between students, mixed by them. The system of exercises, which satisfies the principle of completeness, ensures mastery of the topic and eliminates the possibility of forming erroneous associations.

In addition, Ya. I. Grudenov speaks about the possibility of subordinating the system of tasks to other principles. The analysis of methodical literature allows us to assert that complexes of special mathematical problems can satisfy specific principles/requirements. Thus, for example, E.I. Scafa defines the following five requirements for the system of heuristic mathematical problems: 1) completeness of heuristic representation; 2) reasonable ratio between heuristic

and logical components at each stage of learning; 3) possible awareness of the main mathematical ideas by bringing intuitive reasoning to the level of conscious logical processes according to the scheme of "ocognition" - formalization - "postknowledge", ensuring the motivation of this transition; 4) ensuring the breadth of approximate activity; 5) focus on discovery.

Since many authors consider heuristic tasks in training as non-standard, let us note as an example of the principles of selection of the content of non-standard mathematical tasks given in the dissertation study E. N. Kachurovskaya. This is the principle of unity of the subject content and individual cognitive needs of the individual, the principle of aesthetic appeal, the principle of consistent increase in the complexity of problems, novelty and creativity, the principle of integrity.

Let us define the principles of selection of the content of heuristic tasks aimed at developing cognitive competence. In the study, heuristic tasks are used to organize the process of knowledge acquisition.

They have features associated with the creative activity of the student in their solution (awareness, formulation and principled solution of the problem, implementation of the solution). It is expedient to introduce principles: novelty, optimization of the subject content, creativity, reflexivity and perspective.

The principle of novelty consists in the expediency of including in the content of elementary mathematics training heuristic mathematical problems at different levels, the use of which allows to create conditions for searching new knowledge, methods of solutions and new situations for knowledge transfer. The principle is related to the need for future teachers of mathematics to master new mathematical information (theorems, properties, methods of problem solving, methods of control and error detection). Tasks should contain material that allows generalizing and specifying mathematical information and establishing analogy.

Let's give an example to illustrate the construction of a new mode of action. When studying the topic "Logarithmic inequalities", the task "Solve the inequality log2(x + 2)>l-x" is proposed. The appearance of the inequality allows us to conclude that it will not be possible to solve it using known methods, since it contains logarithmic and linear expressions as the components. For its decision, it is required to construct "a special" way, i.e. there are conditions for a search of new knowledge and ways of decisions. The search can be started with the discussion of the general methods of inequality solving (method of equivalent transformations, method of intervals, graphical method). Suggest that students characterize the difficulties encountered in using each of the methods for this inequality. Pay attention to the "ease of drawing" of function charts at = log2 (x + 2) and at = \.(Fig. 4), and the choice of a graphic method of solution. Then it is necessary to specify the point of intersection of the function charts. It is easy to check that at x = 0 we get log2 (0 + 2) = 1 and 1-0 = 1. The answer is x > 0.

The principle of optimization of the subject content consists in the necessity to include in the content of elementary mathematics teaching heuristic mathematical problems of different levels, the ways of solving which optimally combine heuristic and non-heuristic methods, different ways of solving, the use of special heuristic methods. Tasks should cover all key information within the framework of the topic under study: definitions and identities, types of equation and non-uniformity disturbances, basic special heuristic methods.

The principle of creativity is to create conditions for the development of readiness of future mathematics teachers to produce fundamentally new ideas and search for optimal methods of solution. Tasks are characterized by openness (presentation of conditions and requirements of the problem in different mathematical languages, solution of the problem in several ways) or incompleteness for the integration of new elements (problems with unformulated requirements, problems - special cases, problems - generalizations).

For example, when studying the topic "Logarithmic Inequalities", a problem is proposed. "The function /(x) = loga+2.Jx2-2xJ is given. Think of at least four different requirements and solve each of the resulting problems".

As examples of requirements, we can give such ones: 1) Solve the /(x)>-1 inequality at a = -Ъ. 2) Determine how many solutions depending on a have equation f(x) = 0. 3) Solve the inequality /(x)>0. 4) Find out, at what a inequality /(x)>0 is executed at all x of [3;4].

The principle of reflexivity consists in the need to include in the content of elementary mathematics teaching tasks that contribute to the formation of students' skills to identify their own difficulties in the process of finding a solution to a problem, to record them, to analyze the causes of the difficulties, to design a way out of the problem, to build a plan for overcoming the problem. Tasks are ready-made solutions that contain errors and require their detection using the languages of the logic of statements or the logic of predicates, and then their correction. These tasks are presented in two forms: assigned by the teacher or designed by the student.

The principle of perspective consists in the expediency of including heuristic multilevel mathematical problems in the content of elementary mathematics teaching, which allows forming the ability of future teachers of mathematics to plan their educational and cognitive activities, to anticipate possible difficulties in the process of solving the problem, to discover the prospects of using the acquired knowledge within the framework of the topic under study. Tasks are selected so that the set of the basic operations necessary for their decision, was complicated from elementary (carried out "automatically", then made independently) to a combination of elementary operations which use allows to solve more difficult heuristic tasks.

The complexity of a task in pedagogy is understood as the complexity of the process of its solution [16]. This characteristic of the problem is considered as an objective category (G.A. Ball, G.S. Kostyuk, I.Y. Lerner). In the pedagogical literature, the factors influencing the degree of complexity of the problem are defined.

Thus, I.J. Lerner concludes that the complexity of a problem depends on three factors: 1) the composition of these conditions to be taken into account and mutual correlation for a successful solution; 2) the number of judgments, logical links to be passed to find a solution; 3) the number of series of conclusions to be made as a result of the solution of the problem. L.G. Sokolova identifies six components of the complexity of the physical educational problem: 1) implicit assignability of elements characterizing the process or phenomenon in the task; 2) manifestation of several regularities in the situation; 3) complexity of the task (belonging to several types of learning tasks); 4) combined nature of the task (possibility of division into subtasks); 5) use of units not included in one system; 6) a number of mathematical operations. The degree of complexity of the task was calculated as the sum of expression levels of each complexity component.

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V.I. Zagvyazinsky offers a different assessment of educational tasks - the degree of their problem, which can be expressed by "the ratio of the number of non-stereotypical, non-template steps necessary to find an answer to the total number of steps."

O. B. Episheva, V. I. Krupich believe that "the complexity of the problem is an objective characteristic, independent of the subject, it is determined by the number of elements, connections and types of connections that form the internal structure of the problem. Elements are such minimal components of a task on which the main relation is implemented. There are two types of connections: explicit and implicit. In the chain of actions when solving a problem (equation), identical and equivalent transformations are distinguished (respectively: expression transformations and formula transformations). Equivalent transformations give rise to identities and play the role of bonds in the generation. Identical transformations do not violate the equilibrium of equations, so the equations obtained as a result of these transformations are assumed as elements of the internal structure of the original equation. The complexity of the problem is calculated using the formula S = t + p +/, where t is the number of elements, p is the

number of explicit links, /is the number of types of links. The number/can only have three values: 0 - one element in the structure of the task (there are no explicit or implicit links), 1 - in the structure of the task either only explicit or only implicit links, 2 - in the structure of the task both types of links. By circling the elements of the structure of the equation, and connecting only those elements that directly follow each other (are not separated by equivalent transformations) with lines, we obtain the internal structure of the task of the equation. The number of lines drawn is the number of explicit links.

We will show the correspondence of the levels of development of cognitive competence and the levels of complexity of the proposed tasks. The study identified three levels of development of cognitive competence: normative, constructive and promising. The normative level is characterized by the following manifestations of the development of components of cognitive competence: the goal of the educational activity is set by the teacher, the student accepts it, the change in the mic goals of the activity is random; The student identifies key mathematical information with the help of a teacher, builds solutions to problems using samples; with the help of the teacher detects and corrects errors. All level 1 tasks and partially level 2 tasks correspond to this level. The constructive level of cognitive competence is characterized by the ability of the student to choose the goal of educational and cognitive activity from those proposed by the teacher, by the manifestation of interest in finding new stars, the change in micro-goals when solving the problem is recognized by the student, with the power of instructions from outside the student independently reveals key mathematical information; in the standard situation, the student uses special means of mathematics to simulate mathematical information and plans to solve the problem; in the standard situation, substantiates its actions and corrects errors. All level 2 tasks and partially level 3 tasks correspond to this level. The perspective level is characterized by the fact that the student independently sets the goal of his activities in solving the problem, shows a steady interest in self-search for but high knowledge, anticipates possible difficulties in new situations and finds ways to overcome them; knows how to find and correct errors in his solution of the problem, using the means of mathematics for this. All level 3 tasks and partially level 2 tasks correspond to this level.

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