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Methods of Teaching Students to Solve Text Problems in Elementary School Mathematics

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A B S T R A C T

Mathematical problems are a basic tool for acquiring mathematical knowledge and realizing the objectives of mathematical education. Therefore, it is especially important to understand the methodology of solving mathematical problems, which is related to the actual solving of a given problem, as well as how the solving of a specific problem forms knowledge in the students for solving problems. In this paper, we will turn our attention to the methodology of solving a given problem, and we will focus on the four steps, which according to many authors, occur during solving a given problem, although the activities in the steps are not always given in the same order. Namely, we will separately direct our attention to the following four steps of solving mathematical problems: understanding the problem, developing an idea and devising a plan for solving the problem, practical realization of the plan for solving the problem, additional work after the problem is solved. We will make an effort to answer how and at what age the separate steps of mathematical problem solving should be learnt through adequate examples.

A R T I C L E I N F O

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Obtaining the instructional goals of the subject mathematics is conditioned by solving adequate mathematical problems. Naturally, the problems should not be isolated, but a part of a methodologically properly organized system of problems, which should be organized in a way that will allow the realization of the instructional functions of the problems. The instructional functions of the problems can be: · common instructional functions, i.e. functions of problems which are important not only for the mathematics instruction, but also for all other disciplines of the natural sciences-mathematics area, · special instructional functions, i.e. general functions which are important only for the mathematics instruction, and · specific instructional functions, i.e. functions important for attaining specific mathematical knowledge. Due to their importance, in our further analysis we will focus only on the common instructional functions. Nevertheless, here we will note that, for example, forming specific notions is a common instructional function; forming a notion about the natural number is a special function, and forming a notion about the number 2 is a specific instructional function. Further on, the following are the common instructional functions of the problems: 1.repetition of the notions in order to learn them adequately and retain them permanently, 2. to establish the relations among notions (from the general to the specific and vice versa, as well as intra-subject and inter-subject relations), 3. learning the basic rules for making conclusions and enabling their adequate application, 4.forming the notion of a mathematical model, 5. Discovering processes and understanding relations, 6. Developing skills and habits for proper oral and written expressing, both in spoken and symbolic language, and 7. developing skills and habits for working with sets, instruments, using literature, etc. It is well known, that education,

above all, educates through the content, i.e. through facts and their interpretation. However, the realization of the educational function also depends on how the instructional material is presented to the students and the organization of the lesson, both in terms of the entire class and every student separately. In fact, each problem incorporates one or another educational function, and it depends on the teacher or the author of the textbook, or compilation, if and to which extent the function is realized. The learned material and the instructional process, meaning all problems, should be completely placed in the function to: 1.raise and develop the students' interest in mathematics, 2. educate for a responsible attitude towards the school subject, 3. create habits for continuous and planned work. Further on, the functions which develop the creative abilities of the students (developing functions) refer to all functions, which are directed towards the development of the students' thinking process, forming qualities, characteristic of the scientific thinking and learning approaches, for effective mental work. The developing functions can be common and special. The common developing functions of the problems include the following:

1. Learning the methods for scientific learning,
2. Developing abilities for inductive and deductive reasoning,
3. Developing abilities to perform elementary modeling and use of the existing or creating new models to learn the properties of the objects,
4. Developing skills to classify the learned objects, systematizing knowledge, discovering the cause – consequence and structured relationships between the objects on the level of the already attained knowledge.
5. developing skills to choose tools and methods to obtain the set objective, according to the existing conditions,
6. Developing skills to discover the connection between the learned material with the practical work in life,
7. Learning the basic qualities, characteristic of the scientific thinking.

The special developing functions of the tasks include:

1. forming and development of knowledge and skills to deductively affirm and negate mathematical statements,
2. developing skills to plan the solving of a given problem, to exclude the unimportant information in the problem and to add information that is missing, to choose methods, tools and operations to solve the problem and to check the accuracy and the sense of the solution,
3. forming a clear image about the logical structure of the mathematics course, and the fact that the abstract character of mathematics as a science is the basic reason for its many uses in the remaining sciences, in techniques and life in general,
4. developing skills to define the mathematical terms,
5. developing and perfecting skills for making fast and accurate calculations, with or without the help of technical aids,
6. Perfecting the skills to use the language of the mathematical symbolism.

Steps in Solving Mathematical Problems One of the objectives of the mathematical education are the realization of the functions of the mathematical problems. This can be accomplished by solving specific mathematical problems, and in order to do this, the students have to adequately learn the methodology of mathematical problem solving. Taking into consideration the previously mentioned, it is necessary to devote special attention to the methodology of mathematical problem solving starting from the initial education. This methodology, according to many authors, recognizes the following four steps in mathematical problem solving: a) step one – understanding the problem, making a preliminary analysis of the problem, i.e. crystallizing the condition and the conclusion, analysis of all statements presented in the condition and the conclusion, determining which of the objects in the problem are given facts and which are unknown, i.e. what needs to be calculated in the problem, proven or constructed. In other words, in

this step the students assess the information in the task, which can be: · basic information, which characterizes the type of problem and directs the students towards the common ideas and methods for solving problems of the specific type. The separating of this information aims for the students to see what is essential in the problem, which is an assumption for generalization of the knowledge. Hence, if the teachers do not overcome the specific in the given problem and focus on its essential elements, then we are safe to say that the educational function of the problem solving process has been neglected. · Specific information, which is characteristic of the specific problem, however not of the problem type. This information determines the individuality of the problem and instructs the students to concretize the common ideas and methods, determined by the basic information, and to devise a plan to solve the specific problem, which is why separating this information directs the students in each problem, apart from the general, to look for specific things, which develops habits for careful observation of the objects and essential study of the relations between the objects and the data related to them, and · non-essential information, which does not influence the solution to the problem, but can influence the pedagogical value of the problem. For example, through the content of the so-called word problems, the educational component can be strengthened, followed by correlation to other school subjects, etc. This step is managed by the teacher. The teachers use different approaches, such as reading the entire text of the problem or separate parts, illustrating the problem with a drawing, scheme, sketch or a model, etc. Regardless of which approach is chosen, it is important that the students understand the problem well. Namely, the teachers who skip to step two immediately, without making sure that the problem is understood, make a rough methodological mistake. b) step two – developing an idea and devising a plan for solving the problem, which requires the highest intellectual involvement and starts parallel to understanding the problem. While carrying out this step, learning, i.e. the way to the solution should be revealed gradually. However, in the interest of time, the teacher, or a student, often present a readymade solution, an action which annuls the importance of the development of an idea and devising a plan to solve the problem, which is methodologically wrong. Namely, the greatest amount of time should be devoted to this step, since the functions of the problems are best realized by performing these steps. The following two cases are possible when realizing this step: · the type of the problem is familiar, the structure of the solution and the solving method are known, thus, in this case the plan for solving is to concretize the known structure and method and use them. When solving problems of this type, the student carries out the following activities: identifies the type of problem, chooses the adequate algorithm and uses it in the specific problem, formulates the answer and discusses it. · the structure of the problem is unknown, and the algorithm for solving is unknown as well. There is no pattern which would produce a solution to these problems. Hence, we could say that they have the reatest educational and developing value. However, these problems are rare in initial education, since they are introduced later - when the students have attained a greater quantum of mathematical knowledge. c)step three – practical realization of the plan for solving the problem, where the students face the least amount of difficulties. However, this step is given the least amount of time in practice, since it requires the solution to be correct, complete, and as short as possible, which is why sometimes; more attention should be given to training the students to form solutions to the problems. It would be beneficial to address this issue in initial education, however the forming of the solution can fully be mastered in the period from grade V in primary school to year I in high school, when the students learn the majority of the mathematical symbolism and terminology, when they are trained to form solutions and proofs of theorems, i.e. when they develop skills to organize the judgments in a logical order. This step should be given more attention, since it establishes the knowledge and skills of the students, and they also learn how to adequately express themselves mathematically in oral and written form. d) Step four – additional work after the problem is solved – which is an essential step. Therefore, after the problem is solved or after several similar problems are solved, it is desirable to pay attention to some of the following questions: · Is the result correct and why? (Check should be made, if there is a possibility.) · which other problems can be solved with the method used for solving this problem? · which other methods can be used to solve this problem and which method would be the most efficient in this case? · what is interesting and important about the solution? · Can this problem be generalized? · What else can be found in the problem, apart from what is required? · Which other data can lead to the elements requested by the task? In other words, the creative work after the reformulation of the problem should be realized in this step, i.e. in this step, the students should move from the area of current to the area of future development. This is why, while carrying out this step, the teacher should approach

the students very carefully, and it is desirable to carry out this step with each student individually or in smaller groups. Before we analyze some examples, which were used with students of the adequate grades in practice, we should note that the students have to learn the given didactic scheme for solving problems by repeating it several times. Thereby, having into consideration that the most important step in the process of problem solving is developing an idea and devising a plan for solving, which is related to understanding the problem, we would like to mention once again that these steps should be given most of the attention, and the students should not be offered readymade solutions in the interest of time.

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