

# New approaches to teaching mathematics to students with mental development disorder

(overview essay)

Aleksandr Petrovič Antropov

**Abstract:** *The article refers to new approaches to teaching mathematics in a new textbook for 9<sup>th</sup> grade to students with intellectual disabilities. The article describes the structure of the textbook, shows the opportunities of differentiation and individualization of learning, possibilities for the correction of cognitive activity of students, possibilities for generalization of mathematical knowledge. The correspondence between various kinds of mathematical tasks and stages of learning of children with intellectual disabilities is shown. Particular attention is paid to the formation of positive motivation of students.*

**Key words:** *Special education; students with mental development disorder; teaching mathematics; individual and differentiated approach; problem solving*

## 1 Introduction

In the textbook on mathematics for the 9<sup>th</sup> grade of special secondary schools for children with mental development disorder, instructions in mathematics form an inextricable connection with other disciplines taught at the school, i. e. geography, natural science, history, social orientation, the Russian language and visual art. This connection manifests itself in the contents, the structure and the methodological framework of the textbook.

The textbook follows a new structural pattern and contains, in addition to the usual geometrical material and arithmetic chapters, a supplement, an appendix and a teacher's guide. Geometrical lessons are compiled into a single chapter in order to help the teacher to compose a course schedule under specific conditions set by the learning environment and the school enrolment rate, to organize individual revision and to actualize the images and concepts by means of reference to relevant illustra-

tions. The supplement presents historical and other information, which is aimed to expand the students' notion of the mathematical concepts familiar to them, for example, the history of length, surface and volume measurements, the application of geometric figures in architecture, and the history of numeration. The contents of this chapter can also be applied in out-of-school work. The appendix contains extra photocopiable and modelling materials (paper-patterns for making a right-angled parallelepiped, a cylinder, and a cone; ellipses depicting cone bases, etc.). The teacher's guide contains general methodological recommendations. The new textbook's structure substantially expands the applicable scope of the materials for both class work during the lessons of mathematics and out-of-class work.

The textbook also provides greater opportunities for individual and differentiated approach. The differences in the students' rates of development and achievement necessitate the need to include tasks involving various ways of thinking: students incapable of verbal reasoning will be able to base their learning on visual active thinking and eye-mindedness. Each topic and all revision materials offer a range of tasks from the easiest to the ones requiring a rather high level of generalization and concretization. Simultaneously, all levels of difficulty contain tasks aimed at the establishment of intersubject communications.

## **2 Review section**

The review section has been significantly expanded and now includes all mathematical topics studied during the previous 8 years of instruction. Thus, the teacher may choose the content for revision according to the students' achievement, individual abilities and needs. All tasks are ranked according to their difficulty level; computation exercises and word problems in every sub-topic are offered in ascending order of difficulty. Moreover, the tasks are also differentiated according to the way of thinking or the actions and operations required for their accomplishment. The tasks are sorted under different rubrics, i.e. "Let's design", "Let's imagine", "Let's draw", "Let's construct", "Let's speak correctly", "Let's compare", "Let's calculate", "Let's apply mathematics", "Let's reflect", "Let's review", etc. The "Let's look" rubric introduces samples of geometric figures and bodies, fractions, etc. The tasks under the "Let's construct" rubric prompt students to make models (angle stencils, prism, cone and cylinder models, and a flat model of a standard fraction on a slip of paper). "Let's imagine" tasks imply reference between mathematical concepts and real-life objects. "Let's draw" and "Let's construct" task types involve the development of various graphic skills. Drawing tasks are introduced with specific aims to increase students' motivation and to check the level of their grasp of geometric figures. "Let's construct" task types require the use of drawing devices. The tasks offered under the "Let's reflect"

rubric prompt students to reason, and the “Let’s speak correctly” task types provide utterance examples and speaking patterns for reading or tasks that prompt students to produce grammatical speech, for example, to name the elements of arithmetic operations. In the case with the latter kind of tasks the correctness of students’ responses is evaluated by the teacher. “Let’s apply mathematics” task types introduce problem solving situations, which are viewed specifically as a way of applying mathematical knowledge.

### **3 Contents of the problems**

The authors endeavoured to bring the contents of the problem solving situations in line with the students’ knowledge level and their interests, as well as with probable applications of mathematics in their everyday and future professional life. The main topics of the problem solving situations include foodstuffs (sensible nutrition, grocery shopping and food consumption), construction and repairs (furniture arrangement, home improvement and redecoration, tending a garden), production (manufacturing and packaging), transportation (distance, time and speed), percentages (taxes, money transfers and bank transactions), geography (surface, length and height measurements), biology (animal body weight), history (length of historical periods, lifespan of historical figures), etc. Many of the problem solving situations are equivalent to the ones that students may encounter in everyday life, for instance, how many rolls of wallpaper are required to paper a room, or how many tiles are necessary to tile a kitchen, how much money an employee will be paid after tax, what fee needs to be paid to transfer a certain sum of money to another city, etc.

For the higher-achieving students who cope well with the academic programme, the textbook provides explanations that tie mathematics with various spheres of life, as well as extra materials – recommended, but not required – which will expand the knowledge students acquire within the programme (i. e. multiplication and division with a calculator, or the use of diagrams to find the missing elements of arithmetic operations). The texts can also be viewed as part of methodological guidance for teachers.

### **4 Generalization**

The textbook facilitates generalization of the learned material, which allows the teacher to form students’ knowledge in spheres other than mathematics. For example, this provides an opportunity to bring the students to a new level of generalizing such concepts as “a number” (whole numbers, fractions, numbers as results of calculations or measurements), “a geometric figure/body” (two-dimensional figures and

three-dimensional bodies), “a measurement” (old Russian measurements and other measurements), “a definition of quantity” (what it means to measure the length, the surface, etc.), “an arithmetic operation” (operations with whole numbers and fractions, with results of calculations and measurements; a new algorithm for division), “a problem solving situation” (real-life situations), etc. Generalization in its own turn facilitates the interconnection between the different sections of the course, between arithmetical and geometrical material, and forms the conditions necessary for regarding mathematics as a unified science. All the extra materials are accentuated with a special font and frames. Similarly to the review section, the decision on which materials are to be included in the learning process is made by the teacher. The authors regard the freedom of choice for the teacher in terms of materials’ selection and individual differentiated approach as crucial in view of the differences in students’ individual levels of achievement, abilities and needs. The textbook is merely a teaching medium, and the principal role in the learning process is reserved to the teacher.

## 5 Summary

The textbook facilitates the environment that promotes correction and further development of students’ cognitive activity, i. e. correction of perception (various forms of presentation for similar tasks), memory (a large quantity of revision tasks and frequent reference to major notions, concepts, operations, etc.), thinking (consistent use of comparisons, analysis of real-life situations, “Let’s reflect” and “Let’s apply mathematics” task types, generalization, specification, etc.), speech (a great number of problem solving situations and real-life situations, numerous examples of grammatical speech and prompts to practice correct utterances), imagination (tasks that require to establish where certain operations or calculations may be of use in every-day life). There are also a large number of tasks aimed at comparing exercises, problem solving situations, solution methods, etc.

The role of visuals and demonstratives has been increased in this textbook in order to further promote the development of the students’ understanding of mathematical representations and concepts. The textbook includes around 450 illustrations of various types that naturally compliment each other, such as photographs of real objects, drawings and diagrams (i. e. images of objects that resemble geometrical figures and bodies, images of buildings and architectural elements, geographical maps to illustrate some of the problem solving situations, drawings of students undertaking some tasks, diagrams to facilitate the solution of equations with unknown quantities, etc.). These illustrations will help to create suitable conditions for abstraction and generalization when learning new concepts and for specification during revision.

The texts required for memorization, such as the definition of per cent, the rules for calculating surface and volume or the algorithms for arithmetic operations, are

highlighted in bold. At the end of each topic and review section there is the “Essentials” rubric that reviews the most important material. Thus the emphasis is placed on the knowledge essential in everyday and professional life, and ultimately students are expected to form necessary life skills and competences.

There are several types of templates and task completion examples in the textbook. Such templates are presented with the new material a) before problem solving situations, b) in explanations, c) immediately before the task.

Templates are also provided in the review section under the “Check yourself” rubric and immediately after the task questions. The various types of templates correspond to the different stages of knowledge acquisition: the preparation for and introduction to new material and new knowledge; revision and acquisition of knowledge and skills by means of various exercises; generalization and consolidation of knowledge.

The authors devoted much attention to the importance of students’ positive motivation in the process of studying mathematics in an attempt to demonstrate that mathematics ranks with other school subjects (biology, geography, etc.) in importance, as it also studies the environment – from the point of view of quantity, form, size and measure, and relative positions of objects in relation to each other. The textbook features recurring characters, who represent students’ peers and parents (or ideal parents), and who have to solve different real-life problems.

The textbook for children with mental development disorder establishes positive conditions for the development of their integral worldview and for regarding mathematics as a unified science which has considerable practical importance in various spheres of life.

## Literature

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Aleksandr ANTROPOV, Ph.D.

Dean of the Special Education Faculty

Herzen State Pedagogical University of Russia (St Petersburg)

Address: 197046 Санкт-Петербург, ул. Малая Посадская, д. 26.

Phones: office: +7 (812) 233 50 32;

mob.: +7 921 651 7494.

E-mail: alexantropov@inbox.ru