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Methodology and Implementation of Practice-Oriented Mathematics Teaching in Modern School Education

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Abstract

Background: Modern pedagogy increasingly emphasises the need to adopt practice-oriented teaching methodologies in mathematics. This trend is relevant to aligning school education with the demands of the digital economy and contemporary educational paradigms.

Objective: This research aimed to study the methodology of practice-oriented mathematics teaching in schools, describe the specific features of its implementation, and predict the outcomes of its application within the school educational framework.

Methodology: The research employed an integrated approach, utilising descriptive methods, the analysis of pedagogical practice, modelling, and generalisation techniques to evaluate the effectiveness of the proposed teaching framework.

Results: The study identifies the cognitive features essential for forming mathematical thinking in students and outlines the requirements for implementing practice-oriented instruction. Modelling the advantages of this methodology revealed significant improvements in students' cognitive abilities, specifically in their capacity to analyse, compare, and generalise mathematical concepts. Furthermore, the findings indicate a shift in student values regarding learned content and an enhanced ability to mobilise knowledge in practical situations.

Conclusion: The application of practice-oriented mathematics teaching significantly enhances students' understanding of the essence of mathematical tasks. It successfully bridges the gap between theoretical learning and real-life conditions, thereby increasing learner motivation and fostering independence.

Unique Contribution: This research advances the system-activity approach by demonstrating how practice-oriented learning develops initiative and involves the family unit in the

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educational process. It provides a scalable model for fundamentalising general education by developing logical thinking and algorithmic action.

Key Recommendation: School administrators and mathematics educators should formally integrate practice-oriented modules that simulate real-world emergency or decision-making scenarios. Such an approach will further enhance intellectual development and ensure that students can effectively apply mathematical logic beyond the classroom setting.

Keywords: school education, educational paradigm, mathematical thinking, digital economy, system-activity approach, fundamentalisation of general education.

Introduction

In the modern educational paradigm, teaching mathematics in schools is considered the foundation for building a technologically and economically advanced society. This is a strong competitive advantage in the digital economy. Therefore, raising the level of mathematical training of schoolchildren is an urgent strategic task today. After all, it is known that it is at the level of general education that the foundation of a person's intellectual culture is laid, which determines the further development of the individual in society. In this scientific field, within the context of implementing the system-activity approach, answers should be obtained to questions regarding the goals, content, forms and means of learning, methods for achieving the planned results, methods for forming skills, etc. The importance of mathematical knowledge in society's life has increased manyfold in recent decades (Young, 2017). Pedagogical practice, in fact, lays the foundations of mathematical training. At the same time, its fundamental nature should be preserved alongside modern requirements for a school graduate (Schoenfeld, 2016). That is, the fundamentalization of general education, the focus of learning on the acquisition of fundamental knowledge, is a prerequisite for modern school education to meet the needs of a post-industrial society. Mastery of mathematics, and, therefore, the style of thinking inherent in it, is important for a person engaged in any field of activity. As part of the general culture, mathematics is essentially a "school of rational thinking" (Stein & Smith, 2011).

Modern challenges affect the learning process. The teacher should pay attention to innovative teaching technologies and educational resources that are freely available – analyse them, select the relevant ones for each specific case, explain to students how to use them and choose a convenient way to control them - this will help minimise educational losses. The mathematical way of reasoning is useful not only for professional mathematicians but also for anyone in the information society, whose defining feature is the need to analyse data, the basis of statistics. It is also important to introduce students to computer dynamic geometry to conduct "planimetric experiments" and form ideas about spatial bodies using virtual reality. The significant humanitarian component of the modern school, which focuses students on research and project activities, exacerbates the problem of orienting the educational process toward creating conditions for the use of subject knowledge and skills in everyday life and when choosing a future field of professional activity. Practice-based learning is one of the traditional types of mathematics teaching. The main idea of such teaching is to prepare students for various activities in society, to demonstrate the effectiveness of mathematical methods for studying and transforming reality.

E-ISSN: 2735-9891 DOI: https://doi.org/10.5281/zenodo.20205584

The purpose of the research is to investigate the methodology of practice-oriented mathematics teaching in schools, to describe the features of its implementation, and to predict the results of its use within the school educational paradigm. This purpose led to the implementation of practical objectives, in particular:

1. to describe the cognitive features of the process of forming mathematical thinking in students;
2. to propose the peculiarities of implementing the methodology of practice-oriented teaching of mathematics in modern school education;
3. to model the advantages of using the methodology of practice-oriented teaching of mathematics for the development of students' cognitive abilities;
4. to formulate practical recommendations for the implementation of the methodology of practice-oriented teaching of mathematics in the school system of education.

Literature review

An analysis of scientific sources shows that methods of teaching mathematics are being actively researched in modern pedagogy. All scientific works can be conditionally divided as follows:

1. studies related to exploring cognitive ways of developing mathematical thinking;
2. studies related to investigating methods and approaches to teaching mathematics at school, with the introduction of digital tools (Agelli Genlott et al., 2019; Howard et al., 2019). The integration of electronic textbooks and digital materials into classroom work is accompanied by organisational and methodological difficulties. Teachers face unequal access to technology among students, overloaded teaching hours, and the need to adapt ready-made digital content to a specific class.
3. studies related to the peculiarities of training mathematics teachers who are able to fully implement such methods in pedagogical practice (Viberg et al., 2023; Voloshena, 2021).

A number of scholarly works (Stein et al., 2008) emphasize that nowadays it is possible to state that significant changes are taking place in the organization of the educational process at school: electronic textbooks and didactic materials that teach in a computer environment are being created and actively used; elements of project and research activities are being introduced; problem-based learning methods are being used more often. Boaler (2016) emphasises that one of the goals of education is to master the general forms and methods of human activity. The researcher also argues that appropriate pedagogical technologies are needed to achieve learning outcomes; however, doing so is quite difficult within the classroom system alone. Hiebert and Grouws (2007) raise the issue of the quality of mathematics teacher training, rightly pointing out that the success in achieving the goals of school mathematics education is largely determined by the professionalism of the teaching staff. According to Schoenfeld (2016), the ability to mathematically investigate real-world phenomena should be the main outcome of mathematics education. At the same time, students should develop the ability to understand reality as mathematicians do. Stein and Smith (2011) emphasise the importance of practice-oriented learning for the formation of a scientific worldview. This, in their opinion, is facilitated by the awareness of the connection between the ideal and the real, the origin of mathematical abstractions from practice, the nature of mathematical science's

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reflection of the world around us, and the role of mathematical modelling in scientific cognition and practice.

Achieving significant results in teaching mathematics within the modern educational paradigm will be possible by combining the fundamentals of mathematics education in schools with new approaches to building an educational system. An important direction in improving school mathematics education, and, thus, the methodological training of mathematics teachers, is the formation of students' functional mathematical literacy (Lampert, 2001). Some practical experience in testing such literacy has been accumulated. Demonstrating the importance of mathematics in social life is essential to teaching students. The formation of students' mathematical literacy is associated with the development of students' applied mathematical skills. The purposeful development of such skills is closely related to mathematical modelling, which is the methodological basis of practice-oriented mathematics teaching in schools (Matiash et al., 2025; Viberg et al., 2023). The introduction of new educational standards and the improvement of technical support for the educational process require meaningful changes in teaching methods. Ukrainian scientists (Voloshena, 2021) have developed didactic requirements for competence-based mathematics tasks for the school curriculum. Madu (2014) analysed the advantages and disadvantages of different methods of teaching math. Serin (2023) studied strategies to improve how students solve mathematical problems in school. Yackel and Cobb (1996) put forward the concept of socio-mathematical norms, that is, the normative aspects of mathematical discussions that are specific to students' mathematical activities. He et al. (2021) consider the role of mathematics in STEM education, which combines the four disciplines of science, technology, engineering, and mathematics. In their view, the main aspects of STEM education include providing a real-world context through design problems, effectively promoting the integration of interdisciplinary knowledge, developing students' ability to learn concepts and skills, and applying their knowledge to solve real-world problems.

Despite a significant number of scientific articles, the peculiarities of implementing the methodology of practice-oriented mathematics teaching still require a deeper study. Therefore, our research focuses on studying the peculiarities of implementing this methodology in school practice and predicting the results of its use within the school educational paradigm, outlining specific didactic approaches to integrating sciences into a mathematical problem.

Research methods

The methodology of studying the methods of practice-oriented teaching of mathematics is based on the syncretism of the following theoretical and practical methods:

– the descriptive method (to describe general approaches and principles of implementation of the methodology of practice-oriented mathematics teaching);

– the method of research and analysis of practice, which involves analysing the practical pedagogical experience of teachers who have implemented such a methodology;

– the modelling method (for creating mathematical models using practice-oriented tasks in mathematics lessons). The modelling method in practice-oriented learning consists of formalising real-life situations through mathematical constructs. The teacher encourages students to identify parameters, variables, and constraints that describe a specific real-life problem. Students then build a model, check its accuracy, and analyse the results.

E-ISSN: 2735-9891 DOI: https://doi.org/10.5281/zenodo.20205584

Results

The mathematical "world view" is formed in students while solving relevant tasks within the practical mathematics program. They had different synonymous names – practical, applied, contextual, etc. Nowadays, tasks for testing functional mathematical literacy are becoming more common and are often referred to as practice-oriented. Practice-oriented tasks are mathematical tasks that describe situations in the world around us and support the development of practical skills in applying mathematical knowledge and skills needed in everyday life. The solution to this type of problem is based largely on building a model of the real situation described in a particular task. Such a compilation model requires a high level of mathematical training and is the result of training that is appropriate to call the general cultural one. Practical, applied, and contextual tasks share a common focus on real-life situations, but differ in their didactic function. Applied tasks focus on applying specific algorithms under given conditions. Contextual tasks emphasise the plot and interpretation of data. Functional mathematical literacy tasks are oriented toward decision-making in open situations, where the student determines the strategy, limitations, and criteria for evaluating the result.

Mathematical thinking is based on consistency, evidence, and accuracy. It forms the habit of analysing conditions, separating the essential from the secondary, and verifying the validity of conclusions. This style is useful in any professional field that requires working with information, risks, and alternative choices. Mathematics disciplines thinking, teaches how to control decision logic, and is responsible for its consequences. In the system of practice-oriented learning, the following practical experience is formed: comparison, evaluation of phenomena and processes, identification of cause-and-effect relationships, setting tasks, and the need for further enrichment of subject knowledge. Implementation of practice-oriented learning involves considering practice as a source of knowledge and as a subject of knowledge, with an integrated approach to the analysis of facts and knowledge as such (Makedon et al., 2025). Therefore, the organisation of the educational process within the framework of the practice-oriented approach contributes to the creation of a level of actualisation of students' knowledge that recognises their social and personal needs alongside their cognitive needs. It is also appropriate to use information technology and to integrate mathematics with computer science (Viberg et al., 2023). The main goal of practice-oriented mathematics teaching is to prepare students to solve problems that arise in everyday practice and to develop their readiness to apply knowledge and skills throughout their lives. The principles of organising practice-oriented learning are as follows: motivational support of the learning process, the connection of learning with practice, the consciousness and activity of students in learning, and an activity-based approach. Practice-oriented learning plays a huge role in the development of students' creative activity. It promotes the development of intrinsic motivation to learn and creates conditions for the realisation of cognitive search, self-expression, and creativity.

Mathematical thinking is formed through a step-by-step restructuring of cognitive operations. Students first master formal structures, symbols, and logical connections. They then relate these structures to real-life situations by analysing conditions, identifying variables, and establishing cause-and-effect relationships. Practical application occurs when an abstract scheme begins to perform an instrumental function. This transition activates operational thinking, reduces the cognitive isolation of mathematical knowledge, and develops the ability to transfer logical actions to real-life tasks.

E-ISSN: 2735-9891 DOI: https://doi.org/10.5281/zenodo.20205584

We consider the following aspects of practice-oriented education of students in mathematics lessons to be separate:
1) studying mathematical models of the economy in the school mathematics course;
2) the geometric component of the natural world picture in teaching high school students;
3) the use of "methodological reality" in teaching mathematics at school, which combines the concepts of polytechnicism and applied learning;
4) building a model of teaching algebra and the beginnings of analysis for natural science profiles based on the logic of applied mathematics.

Practice-oriented teaching of mathematics will allow students to better understand and comprehend the surrounding reality and processes in different contexts; it will allow them to apply the acquired knowledge and skills in everyday life, including applied contexts. The described methodology enables students to develop logical and associative thinking, observation, the ability to perceive and process information, apply the knowledge gained to analyse observed processes, and draw conclusions using imaginative and analytical thinking (Serin, 2023). Some examples of tasks that integrate mathematics with other disciplines and everyday life are given below (Table 1).

Table 1. Examples of mathematical problems based on the integration of disciplines

Integration of sciences	Description of the case study	An example of a math problem
Mathematics and physics	It is related to the laws of mechanics and trigonometry	Calculate the force required to lift a 50 kg load to a height of 10 m using an inclined plane with an angle of inclination of 30
Mathematics and economics	It is related to economics, financial literacy, and exponential growth	Calculate the interest rate at which a deposit of UAH 10,000 will grow to UAH 12,000 in two years
Mathematics and biology	It is related to exponential growth and biology	Determine how the number of bacteria in the colony will change if the number of bacteria doubles every 3 hours, starting from 500
Mathematics and geography	It is related to geography, topography and geometry	Calculate the area and volume of a mountain lake given its shape (approximately a trapezoid) and average depth
Mathematics and cooking	It is related to proportions and arithmetic	You are cooking a cake according to a recipe for 4 servings, but you need to make 7 servings. Calculate the amount of each ingredient you need
Mathematics and sports	It is related to linear functions and physical training	Determine the distance an athlete will run in 1 hour if his speed increases linearly from 8 km/h to 12 km/h
Mathematics and ecology	It is related to ecology, algebra and proportions	Calculate the amount of CO_2 emissions per year for a car that consumes 8 litres of

E-ISSN: 2735-9891 DOI: https://doi.org/10.5281/zenodo.20205584

	gasoline per 100 km if the average annual mileage is 15,000 km

Building a mathematical model of a real situation stimulates the simultaneous work of imaginative and analytical thinking. The student first imagines the situation as a whole, then identifies parameters and relationships. Analytical thinking provides formalisation and justification of actions. Imaginative thinking supports verifying the model's adequacy to reality. Such tasks show how mathematics helps solve practical problems by integrating with various fields of knowledge. Mathematics makes students think constantly and in many ways. In addition, students can be asked to complete projects such as “Buying on Credit”, “The Housing Issue, “Calorie Content of Purchased Foods”, and many others. As homework, you can assign a task that students can complete with their parents. An example of such a task is the task “Repairing a house (apartment)”. The solution of practice-oriented tasks is effective when students have encountered the situation described in real life: in everyday life, on an excursion (Figure 1).

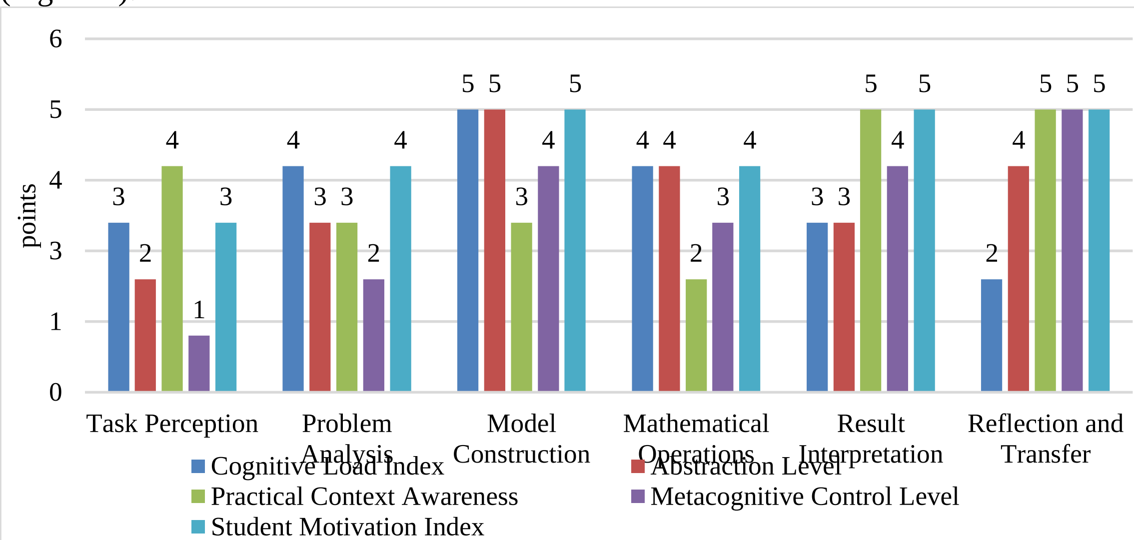

Figure 1. Quantitative Indicators of Cognitive Process Dynamics in Practice-Oriented Mathematics Learning
Source: authors’ development

Fundamental mathematical knowledge forms a universal intellectual framework for the individual. It enables work with uncertainty, complex systems, and abstract models. Post-industrial society needs not fragmentary skills, but a deep understanding of patterns. It is fundamental training that lays the foundation for adapting to technological change, interdisciplinary collaboration, and continuous learning. It enables quick rethinking of information and informed decision-making in a dynamic environment.

Involving parents in solving practical homework assignments changes students' attitudes towards mathematics. During joint discussions, students see how mathematical operations are applied in everyday solutions. Mathematics ceases to be perceived as a purely academic requirement. Unlike individual work, joint activities increase responsibility, reduce anxiety,

E-ISSN: 2735-9891 DOI: https://doi.org/10.5281/zenodo.20205584

and form a sense of the usefulness of acquired knowledge in real life. We believe that the methodology of practice-oriented mathematics teaching develops analytical thinking and significantly increases motivation to learn mathematics, as students see the real benefits of applying their knowledge in everyday life (Figure 2).

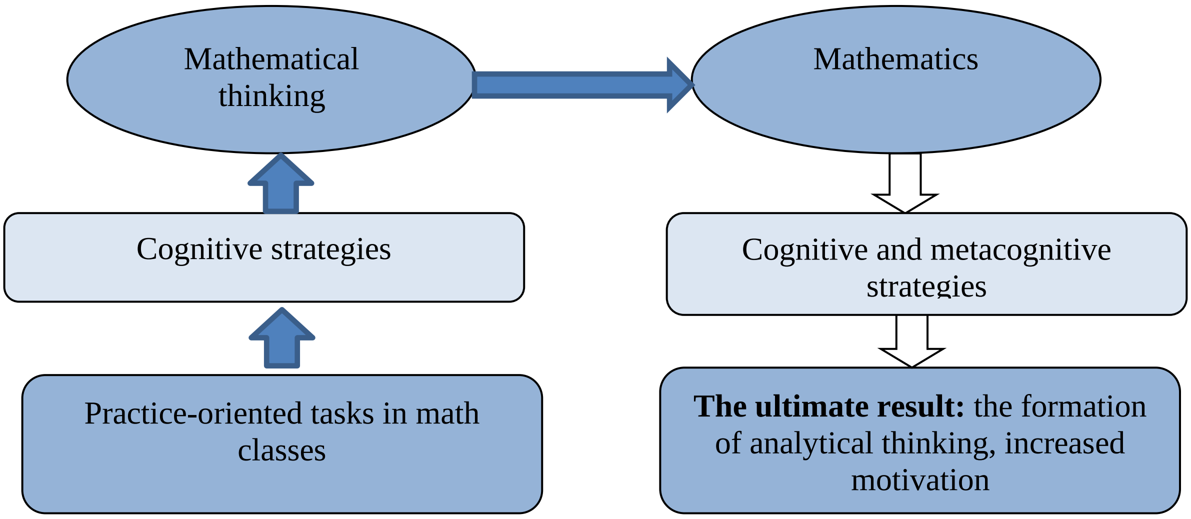

Figure 1. Cognitive features of the formation of mathematical thinking
Source: authors' development

Pedagogical experience shows that applying the methodology of practice-oriented mathematics teaching helps students better understand the essence of tasks. The number of students with a sufficient level of intellectual development (the ability to analyse, compare, generalise, make analogies and classifications, think logically, and act on algorithms). The ability to mobilise knowledge is assessed according to several criteria. The first criterion covers the speed and accuracy of problem identification. The second concerns the ability to select relevant mathematical tools without external prompts. The third criterion concerns the transfer of knowledge to new, non-standard conditions. In addition, the logical sequence of actions and the ability to verify the result obtained are taken into account.

Discussion

We agree with the opinion of Makedon et al. (2025) that a practice-oriented task has not only didactic value but also provides tools for mathematical solutions, visualisation, diagrams, etc. In practice-oriented tasks, it is not the mathematical understanding of the situation described in the storyline that is important. In this situation, students rely not only on mathematical knowledge, but also on experience. If this understanding is absent or insufficient, mathematical problem-solving becomes difficult. "Implementation of cross-cutting STEM education requires updating the structure and content of academic subjects, special courses, competency-based forms and methods of teaching. In order to involve students in practical activities, it is desirable to expand the range of forms and methods of teaching, ways of learning interaction" (Voitenko & Katerynenko, 2023). Tytarenko and Strelets (2018) are absolutely right to emphasize the positive impact of practice-oriented tasks in STEM education on the formation of a sustainable motivation in learning mathematics, better development of creative thinking, a comprehensive understanding of problems, and even the choice of a future profession, and

E-ISSN: 2735-9891 DOI: https://doi.org/10.5281/zenodo.20205584

argue that the task of universities is to train (and quickly retrain) teachers who could implement STEM education today or tomorrow and help secondary and high schools organize such training not separately for each of the STEM disciplines, but in a complex.

STEM integration is implemented through project tasks that combine mathematical calculations with scientific assumptions, technological tools, and engineering logic. Students work on complex problems that do not have a single correct solution. This format stimulates the transfer of knowledge between disciplines. Mathematics performs a coordinating function, ensuring the accuracy, verifiability, and structure of solutions within a common cognitive space.

The shift in emphasis from reproductive tasks to practice-oriented learning is associated with increased internal motivation. Students are given the opportunity to independently choose strategies, test hypotheses, and propose alternative solutions. This stimulates creative activity and initiative. The learning process takes on the characteristics of research, in which the result depends on intellectual effort rather than the reproduction of a ready-made algorithm.

Relevant to our study is the approach of Davidson (2021), according to which one of the features of practice-oriented tasks is their non-standardisation, i.e. uncertainty in the structure of the task and its individual components. Another feature is the presence of varying degrees of rationality, that is, several ways to solve the problem. To balance theory and practice in teaching, it is worth promoting the review of theory, and more time should be allocated for students to research theorems independently and present their findings in various formats. The rest of the time should be devoted to solving problems.

Based on our preliminary findings, we offer the following recommendations for a practice-oriented approach to teaching mathematics at school:

1) It is necessary to create methods for the formation of concepts, mathematical skills, and methods of mental activity of students, the basis for which may be the method of mathematical modelling.
2) Practice-oriented teaching of mathematics can be considered as a means of achieving meta-subject educational outcomes of students, the formation of universal learning actions, which also requires methodological justification.
3) In order to implement such methods, appropriate didactic materials are required that confirm the practical significance of the research and complement the content of mathematics education at school with systems of multi-level tasks for practical applications, project and research tasks, and course programs for the choice of applied content for basic and advanced mathematical training of students.
4) It is necessary to improve the system of current and final control of the formation of students' applied mathematical skills. For this purpose, it is necessary to build a system of such skills, compare appropriate methods of formation, and develop a system of tasks and exercises. This will make it possible to highlight the results of practice-oriented mathematics teaching for individual groups of students who agree with the content of mathematics teaching in general, to assess the formation of functional mathematical literacy in basic and secondary education.
5) It is necessary to support practice-oriented mathematics teaching at school with a set of electronic educational resources by level of difficulty. One of the purposes of such

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software products in teaching can be to demonstrate the connection between theoretical and applied mathematics and to conduct a computer experiment to test the model of a real situation.

6) Children can also be actively involved in the preparation of practice-oriented tasks, including engaging them in creating tasks and conducting surveys to identify areas of practical life that are interesting to a particular audience. Practice-oriented learning leads to more lasting learning because it forms associations with specific actions and events. When doing math homework, you can involve parents, and the effect of working together is enormous. Students begin to perceive math differently.
7) It is necessary to expand the methodological training of teachers for practice-oriented mathematics teaching not only at the bachelor's level but also at the master's level and in the system of teacher training. This can be facilitated by specially designed disciplines for full-time study and by the creation of various electronic educational resources that contribute to the accumulation and dissemination of methodological experience in teaching students to apply mathematics in practice.

Conclusion

The conducted research has led us to the conclusion that practice-oriented learning technology allows to transform a student from a passive object of pedagogical influence into an active subject of educational and cognitive activity, develops cognitive abilities, forms mathematical thinking and increases motivation to learn mathematics. Practice-oriented tasks can be used at all stages of learning, not only after solving a sufficient number of standard mathematical tasks on the topic under study. The teacher nowadays should become a designer of new pedagogical situations and tasks aimed at using generalised ways of activity and at creating students' products in the process of mastering knowledge. When organising an educational project, it is also extremely important that the educational material is applied, that is, something that children deal with in their daily lives. The inclusion of practice-oriented tasks in certain sections of school mathematics is an important direction in the development of school mathematics education. After all, today's information society requires human learning, the ability to learn independently, and the willingness to act and make decisions. This determines the importance of mathematics, which is defined as the development of students' skills for solving problems that arise in the course of practical human activity. The methodology of practice-oriented learning offers advantages such as the development of new skills, bringing the learning process closer to real-life conditions, fostering initiative and independence, increasing motivation to learn, and involving the family in certain tasks. The advantage of a lesson with practice-oriented tasks is the high information content and interpenetration of mathematics, real-world processes and related disciplines at all stages of the lesson.

Declarations

AI Use Statement: The author confirms that no Artificial Intelligence tools were used in the writing or production of this manuscript.

Data Availability Statement: The data supporting the findings of this study are derived from pedagogical analysis, modelling results, and published educational research. All relevant materials are available from the corresponding author upon reasonable request.

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Author's Contribution: LH conceived and designed the study, performed the analysis, developed the methodology, and wrote the manuscript. The author read and approved the final version of the manuscript.

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