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МЕТОДИКА ПРЕПОДАВАНИЯ МАТЕМАТИКИ
METHODS OF TEACHING MATHEMATICS

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**METHODOLOGICAL ASPECTS OF FUNCTIONAL LITERACY FORMATION
OF SCHOOLCHILDREN IN MATHEMATICS**

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Abstract

The main goal in the state programs for the development of education and science of the Republic of Kazakhstan is to increase the global competitiveness of Kazakhstan's education and science. In this regard, work has been carried out in the country to introduce the updated content of education into the educational process of secondary schools, aimed at developing the functional literacy of schoolchildren. The article touches upon considerations on these issues and considers methodological aspects of students functional literacy formation when teaching mathematics in accordance with the requirements of the state secondary education mandatory standards. The goals and objectives of teaching mathematics in the secondary education system, the content of teaching, methods and techniques of organizing the educational process, means and their capabilities in the implementation of the applied orientation of teaching mathematics are reflected. The authors define the methodological system for students functional literacy formation in mathematics and the content of its internal structural elements, the level of training in international studies PISA, TIMSS. Also, based on the analysis, methodological requirements and recommendations have been developed aimed at students functional literacy formation literacy of students in the process of teaching mathematics in a secondary school.

Keywords: functional literacy; mathematical literacy; methods of teaching mathematics; methodological system; mathematical problems.

Аннотация

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**МЕТОДИЧЕСКИЕ АСПЕКТЫ ФОРМИРОВАНИЯ ФУНКЦИОНАЛЬНОЙ ГРАМОТНОСТИ
ШКОЛЬНИКОВ ПО МАТЕМАТИКЕ**

В государственных программах развития образования и науки в Республике Казахстан основной целью является повышение глобальной конкурентоспособности казахстанского образования и науки. В связи с этим предпринимались усилия по внедрению в учебный процесс общеобразовательных школ страны обновленного образовательного содержания, направленного на развитие математической, функциональной грамотности учащихся. В статье рассматриваются эти вопросы и приводятся методические аспекты формирования функциональной грамотности учащихся в области преподавания математики в соответствии с требованиями стандартов государственного обязательного среднего образования. Обозначены цели и задачи обучения математике в системе среднего образования, содержание обучения, методы и способы организации процесса обучения, средства и их возможности в реализации прикладного направления обучения математике. Авторы определяют методологическую систему формирования функциональной грамотности учащихся по математике по данным международных исследований PISA, TIMSS и содержание ее внутренних структурных элементов, уровни подготовки. Также ими на основе анализа сформулированы методические требования и рекомендации, направленные на формирование математической, функциональной грамотности учащихся в процессе обучения математике в общеобразовательной школе.

Ключевые слова: функциональная грамотность; математическая грамотность; методика обучения математике; методическая система; математические задачи.

Аңдатпа

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МЕКТЕП ОҚУШЫЛАРЫНЫҢ МАТЕМАТИКАДАН ФУНКЦИОНАЛДЫҚ САУАТТЫЛЫҒЫН ҚАЛЫПТАСТЫРУДЫҢ ӘДІСТЕМЕЛІК АСПЕКТІЛЕРІ

Қазақстан Республикасында білім беруді және ғылымды дамытудың мемлекеттік бағдарламаларында негізгі мақсат – қазақстандық оқу білім мен ғылымның әлемдік бәсекеге қабілеттілігін бұданда мықты, сапалы етіп айқындалған. Осыған байланысты елімізде мектеп оқушылардың функционалдық сауаттылығын дамытып, ілгері жұмыс жасау үшін көзделген жалпы білім беретін мектептердің оқу процесіне жаңартылған білім беру мазмұнын енгізу бойынша жұмыстар жүргізілді. Мақалада осы мәселелер туралы ойлар қозғалған және мемлекеттік жалпыға міндетті орта білім берудің стандарттарының талаптарына сәйкес математиканы оқытуда оқушылардың функционалдық сауаттылығын қалыптастырудың әдістемелік аспектілері қарастырылған. Орта білім беру жүйесінде математиканы оқытудың мақсаты мен міндеттері, оқыту мазмұны, оқу процесін ұйымдастыру әдістері мен тәсілдері, құралдары және олардың математиканы оқытудың қолданбалы бағытын жүзеге асырудағы мүмкіндіктері көрсетілген. Авторлар PISA, TIMSS халықаралық зерттеулері бойынша оқушылардың математикадан функционалдық сауаттылығын қалыптастырудың әдістемелік жүйесін және оның ішкі құрылымдық элементтерінің мазмұнын, дайындық деңгейлерін айқындайды. Сондай-ақ, талдаулар негізінде жалпы білім беретін мектепте математиканы оқыту жүйесінде оқушылардың математикалық, функционалдық сауаттылығын қалыптастыруға көзделген әдістемелік талаптар мен ұсынымдар жасаған.

Түйін сөздер: функционалдық сауаттылық; математикалық сауаттылық; математиканы оқыту әдістемесі; әдістемелік жүйе; математикалық есептер.

Introduction

The standards of state compulsory secondary education (primary, basic secondary, general secondary education), and curricula contribute to the formation of functional literacy in schoolchildren at a high level compared to previous years. Students will master at school the system of competencies necessary for the further meaningful development of their personality, along with a good assimilation of mathematical knowledge, skills, and skills [8].

Considering several studies conducted concerning the concept of "functional literacy", it is clear that in the considered works of well-known domestic and foreign scientists, there is no consistency, consistency in the interpretation of the concept of "functional literacy", in the disclosure of the effective meaning.

To further improve the educational system in Kazakhstan, a set of measures is being implemented. The country has adopted high-quality state programs to provide quality education and stimulate lifelong learning opportunities for students [1].

The national project "quality education" Educated Nation", approved by the Decree of the Government of the Republic of Kazakhstan dated October 12, 2021 No. 726, defines important, main directions for the development of quality education [2]. One of the strategic indicators and objectives of the national project is to improve the quality of secondary education and a qualitative increase in the level of functional literacy of students according to the results of the international PISA, Timss testing.

Functional literacy is one of the main, especially important factors contributing to the active participation of people in social, cultural, political, social, and economic activities in general and lifelong learning.

It is known that as a result of scientific and methodological research work and differentiation of literature, functional literacy is divided into several types, that is, it is several types: the first type is reading and writing literacy; the second type is mathematical literacy; the third type is natural science literacy; the fourth type is computer literacy; the fifth type is financial literacy and others are divided into.

In the international testing of RISA, TIMSS, the results of assessing the educational achievements of students at school are evaluated according to three types of the several types of functional literacy listed above – literacy in reading and writing, mathematical literacy, and natural science literacy.

The analysis of students' functional literacy levels based on the results of international comparative studies has shown that there are many gaps in school education and a large gap remains. Kazakhstan has participated five times in the international PISA program for assessing the academic performance of fifteen-year-old students of the OECD (every three years from 2009 to 2021) and four times in the TIMSS study (2007-2019). The International Association of the IEA for Assessing the Quality of Student Education. The study

results revealed gaps in academic performance in the language of instruction and the socio-economic level of the family in villages, districts, and cities.

In international PISA studies, Kazakh school students ranked 53rd in mathematical functional literacy in 2009 with 405 points, 49th with 432 points in 2012, 42nd with 460 points in 2015, and 53rd with 423 points in 2018. These final results show a lower-than-average indicator compared to OECD countries [3].

If we consider the experience of leading countries, such as China, Singapore, Sweden, Japan, and Taiwan, on the development of functional mathematical literacy based on the results of PISA 2018 studies, the following studies can be distinguished:

-In Zhikui Hu's work "Chinese reform of teaching mathematics based on the management of basic literacy of creative knowledge", the objectives of the curriculum have moved from a "dual base" (basic knowledge and basic skills) to "three-dimensional goals" (knowledge and abilities, process and method, value of emotional communication) [4].

- A study by James Badger states that "in Singapore mathematics, instead of memorizing rules and exercises for repetition, students focus on the depth of a better understanding of mathematical concepts, with fewer topics in the curriculum, devoting more time to it, paying more attention to solving problems in real everyday life and prioritizing computational skills and conceptual strategic thought processes " [5].

- In the study conducted by Margareta Sandström, Lena Nilsson, and Johnny Lilja titled "Reflection of Mathematical Literacy: A Student's Story About Mathematical Activity," the researchers analyze the various aspects of mathematical literacy that are discussed by students as they recount their experiences in different mathematical activities, including working with numbers, solving simple mathematical problems, and completing test tasks. The study also explores how students' mathematical literacy, which encompasses numerical understanding, problem-solving skills, and the ability to communicate mathematical ideas, is shaped and developed through their dialogues about mathematical actions [6].

- Authors Wen-Chun Tai and Su-Wei lin show that "the relationship between problem-solving style and mathematical literacy" can provide significant benefits in everyday life and the ability to solve problems in the workplace [7].

In the above works, mathematical knowledge is aimed at ensuring that students can apply the acquired knowledge and skills in everyday life.

"Quality education. The main task of the national project "educated nation" according to the PISA international study is recognized as improving the quality of school education in mathematical literacy from 2021 to 2025 from 423 points to 480 points and reducing the gap in the results of the level of education of students between regions [2].

To fulfill this task and achieve the strategic indicator, it is necessary to revise the methodological system of teaching mathematics in schools, i.e. the objectives of teaching the subject, content, methods, forms, and methods of effective lesson organization, the means used, i.e. the system of improving the functional literacy of schoolchildren in mathematics and to study the teacher's activities.

An important issue in improving the quality of education is the development of a methodological system of teaching appropriate mathematics that meets the requirements and tasks of international programs conducted for the formation of functional literacy of students in mathematics. An urgent problem is to determine the methodological foundations of the formation of functional literacy in schoolchildren to teach them the ability to effectively apply the acquired mathematical knowledge in practice and real life.

Materials and methods

The standards of state compulsory secondary education (primary, basic secondary, general secondary education), and curricula contribute to the formation of functional literacy in schoolchildren at a high level compared to previous years. Students will master at school the system of competencies necessary for the further meaningful development of their personality, along with a good assimilation of mathematical knowledge, skills, and skills [8].

Considering several studies conducted concerning the concept of "functional literacy", it is clear that in the considered works of well-known domestic and foreign scientists, there is no consistency, consistency in the interpretation of the concept of "functional literacy", in the disclosure of the effective meaning.

The theoretical and practical study of functional literacy is reflected in the works of many scientists: Akatova T.I. considers aspects of linguistic functional literacy about the language culture of students; Perminova L. M., Lebedev O.Y. – technology of formation of functional literacy of students; Polishchuk L. N. - technology of formation of functional literacy of students in secondary special technological educational

institutions the formation of literacy; Famous scientists: V.A. Perolenko, R.L. Perchenok, S.Yu. Chernoglazkin presented his works on the technology of formation of functional literacy of students in the system of general, professional and additional education; N.N. Smetannikova studied functional literacy as part of a strategic approach to teaching reading.

In the monograph "The concept of functional literacy of schoolchildren: mathematics and computer science" (Moscow: Editus, 2016. – 220 p.), written by a team of authors M.V. Ryzhakov, Y.A. Sedova, A.Y. Abylkasymova, etc., "functional literacy is the formation of a person's subject knowledge, skills, abilities, and skills.-the existing system of opportunities for free use in the public environment under various situations," expressed his opinion [3]. In modern society, the concept of functional literacy has been formed and is widely spread as a certain criterion, a specific indicator of various types of activities. We meet such types as musical, technical, informational, computer literacy, etc. These terms are used to assess a person's ability to solve habitual life tasks based on applied knowledge in various spheres of daily life and activity. Consequently, several types of functional literacy can be observed (Table 1).

Table 1-several types of Functional Literacy

<i>Literacy content indicator</i>	<i>Competencies content</i>
<i>Reading literacy rate</i>	<ul style="list-style-type: none"> - reads any text correctly, deeply, and with understanding; - asks questions to any text and gives comprehensive answers to questions; - connects the read text with real life and gives examples; - read any text, and express your opinion on the content.
<i>Writing literacy indicator</i>	<ul style="list-style-type: none"> - write correctly, cleanly, and without errors; - be able to correctly apply grammatical, syntactic, and punctuation norms and rules in the process of writing, to prove why; - the ability to express your thoughts on a complete, versatile, systematic paper.
<i>Mathematical literacy indicator</i>	<ul style="list-style-type: none"> - understands, and knows the place of mathematics in real life; - reads, can analyze numerical information presented in various forms of mathematics; - finds, performs, and checks himself, can relate to real-life effective ways to solve any problems; - can effectively, and rationally apply mathematical knowledge in solving various problems in life situations.
<i>Natural science literacy indicator</i>	<ul style="list-style-type: none"> - understands, compares, analyzes, classifies, systematizes, and generalizes phenomena occurring in the world around us, nature; - can distinguish between basic, indirect signs of surrounding objects and phenomena; - rationally uses the acquired knowledge, and skills of elementary scientific research.
<i>Computer literacy indicator</i>	<ul style="list-style-type: none"> - independently searches for information on the computer; - works on the computer at will; - easily and actively programs various types of programs on the computer.
<i>Information literacy indicator</i>	<ul style="list-style-type: none"> - Independently searches for, and selects information; - Analyzes, processes, and summarizes any information; - formulates, remembers information, and applies it to the problem that has arisen.
<i>Communication literacy indicator</i>	<ul style="list-style-type: none"> - Knows how to handle anyone; gets along quickly. - can participate in the discussion, to express his opinion in a reasoned manner; - listens and understands the other person - knows how to ask the appropriate question and give a clear, comprehensive answer.

From this table, it can be seen that under the influence of certain criteria, depending on each type of functional literacy, it is possible to use an assessment of the readiness of schoolchildren for life, and the level of adaptation to the social environment. Competencies are obtained in the table as a criterion. We see that the development by students of a system of essential competencies that allow them to effectively and efficiently use their knowledge in practical everyday situations and the system of social adaptation gives successful results in the development of functional literacy of students. A functionally literate person, by the values of society, acts under the habitually formed interests of the social situation. Currently, choosing the right profession makes rational decisions, gets acquainted with the subtleties of modern information technologies, and plunges into

the desired social, developed environment. Therefore, the most important, rational features of a functionally literate person are considered to be: an authoritative person who knows how to live daily in any social environment, has communication, has certain qualitative qualities, and fully owns common core and subject competencies [9]. As is known, functional literacy of school students is formed by solving various tasks in various spheres of human activity, the relationship of integral social relations of labor productivity and socio-economic development with educational content that can be fully perceived by the student.

Functional literacy the school considers indicators of cognitive abilities and effective work of students as the level of education. This indicator is based on the applied nature of the content of school education in solving problems in various spheres of human life and knowledge that students did not receive promptly for certain reasons. Thus, mathematical functional literacy should be understood as "the ability of everyday human activity to favorably use the knowledge, skills, and abilities acquired at school to solve a large volume of real-life tasks in any tasks."

Results and discussions

The formation of functional literacy, reflecting the ability and willingness of students to influence the content of the acquired knowledge, is the most important of the main tasks of teaching all disciplines in secondary schools, especially mathematics. To increase Kazakhstan's competitiveness in the field of education and achieve high performance in international PISA studies, it is necessary to improve the quality of student's education, which means monitoring and strengthening the practical application, and orientation of education based on updating the content and technologies of high-quality mathematics teaching.

Based on the goals and objectives defined by the curricula of schoolchildren of modern updated content, to solve the problems of improving the functional literacy of students, it is necessary to develop thinking and the overall quality of student's knowledge, to work with the school staff in education. The heads of methodological associations of each school, scientific and methodological deputy directors of the school, and deputies for academic work need to improve the methods of teaching mathematics. There is a large number of research papers on the qualitative formation and effective development of mathematical knowledge and literacy of secondary school students. Qualitative methods of mathematical education at school, including the development of cognitive curiosity of students, continuous improvement of theoretical material and methods of teaching mathematics from the famous methodologist Abylkasymova A. Y. [10], improving the quality of teaching mathematics at school based on the effective application of a system of tasks of various levels, i.e. age. Iskakova [11], teaching the solution of special applied problems in the school course of mathematics, the works of Tanatarov K.A. [12], etc. The methodical system of teaching mathematics has five interrelated system-forming elements: the purpose of teaching, the content of teaching, the form and method of teaching, and the means of teaching (Fig.1)[10].

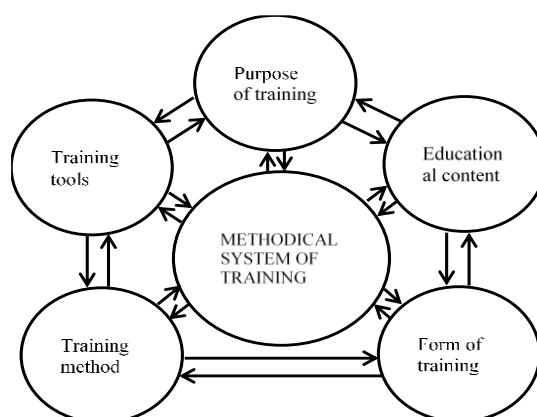


Figure 1. Methodological system for teaching mathematics

To implement this methodological system in the process of continuous formation of functional literacy of students, it is necessary to determine the conditions that reveal the qualitative properties of the system, the relationships, and the relationships between its constituent elements. This requires theoretical-methodological and scientific-methodical research. We have defined logical connections, and relations between them, defining the purpose, content, form, method, and means of each of the components of the system for the formation of functional literacy of students in mathematics by the principles of system analysis (Fig. 2).

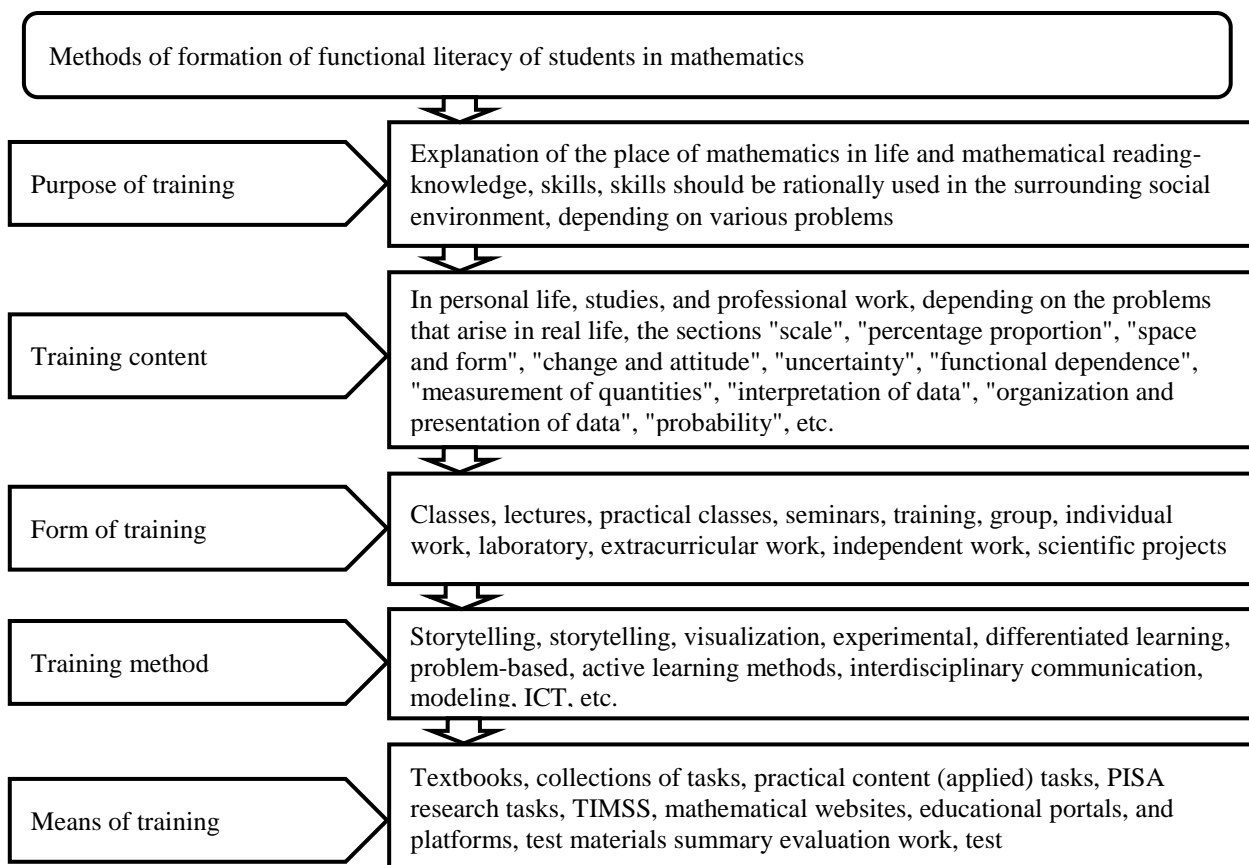


Figure 2. Methodical system of formation of functional literacy of students in mathematics

N.V. Borisova formulated that "in accordance with the objectives of teaching and the content of education, the educational activities of students should be carried out in clear and adequate forms and methods of teaching" [13]. Requirements for the choice of such teaching methods we believe that the system of forms and methods of teaching should be compatible with the level of knowledge of students.

The levels of assimilation of mathematical knowledge by students are determined in the international studies PISA, and TIMSS by the criteria "to know (to represent)", "to apply (to establish connections)" and "to think (to reason)", and under the standard of state compulsory secondary education based on Bloom's taxonomy, i.e. "to know," to understand", "to apply", "analyze", "generalization", "evaluation".

In her research work, Turganbayeva Zh.N. showed the ratio of the levels of mastering mathematical knowledge by students according to international studies PISA, TIMSS, and the updated content of education as follows: "to know (represent)" - "to know – to understand"; "to apply (establish connections)" - "to apply"; "to think (reason)" - "analyze - accumulation-evaluation" In addition, a correspondence was established between the levels of mastering mathematical knowledge and learning goals and methods and techniques of active learning were determined to achieve learning outcomes [14].

According to international studies of RISA, and TIMSS, knowledge indicators, which are the result of the formation of functional literacy of students in mathematics, can be divided as follows [15]:

The indicator "know (imagine)" – "know – understand" – to apply familiar facts, familiar methods, and techniques in known situations, recognize mathematical real objects and properties, perform acquired skills, effectively apply known algorithms and technical skills, transform familiar, familiar mathematical expressions and formulas, perform calculations to the fullest. Description and calculation of mathematical terms, and numbers according to the properties of students in this indicator; obtaining data from the graph and the table of functions; effective correct use of funds; classification, recognition of mathematical information objects; ability to perform tasks requiring a certain order of solution; ability to select and apply facts based on various information sources; ability to interpret processes and solutions; ability to use a reference book and mathematical computing tools, to make practical calculations using formulas; be able to recognize statistical information, numerical data, graphs, diagrams it consists of axes, analyses, etc.

The indicator "applicability (ability to establish connections)" – "applicability" – resembles the general content of the problem, in which chapter of mathematics the school should use the material most effectively and what familiar methods and techniques. Every day in such problems there are requirements for explaining the solution of the problem, suggesting to establish various connections between several concepts of the problem described in the report, or establishing a difference between those given in the conditions of a mathematical problem. Students' choice of an effective, correct and effective approach to solving; analyze and present mathematical information qualitatively; model; perform tasks related to a given sequence; solve standard, meaningful tasks; be able to develop and systematically link various tasks, including the correct display of symbols and rational direction to specific aspects of the situation, demonstrate the formed dexterity in solving problems; work with a sample of complex problems; solve problems, sample-related ability to identify, compare, evaluate, and process specific strategies for detection; be able to demonstrate a developed strategic thinking system and logical skills; describe and study specific features using functions, present tasks with graphs; interpret process graphs; model meaningful and practical situations based on learned mathematical formulas and properties of figures; calculate the dimensions of simple objects: length, area and volume, statistical data for a qualitative description of phenomena and processes, the ability of those around us to effectively use the elements of probability, etc.

"Thinking (the ability to reason)" - the indicator " analysis – accumulation – evaluation " – is built as a development of the past indicator. To solve the problems of this indicator, a certain inner intuition is required when choosing mathematical tools, creativity, integration of knowledge from several chapters of the mathematics course, and development of an algorithm for independent activity. In the conditions of general tasks, it contains many solutions, in most cases, it requires students to generalize, interpret or justify the result obtained. In this indicator, students analyze the known relationship between objects; generalization, synthesis of various ways of solving problems; proof of correctness or error of the above; solution of standard and non-standard problems; ability to think quickly and count quickly from a mathematical point of view; ability to correctly process strategies of situations that otherwise would not be reproduced, leading to a new, effective approach to solving problems; modernity, processing of solution strategies tasks in unfamiliar situations, the development of mathematical models to be able to: solve applied problems related to geometric, physical, economic, etc., etc. Let's consider possible ways of forming functional literacy in students in mathematics:

1) interdisciplinary connections of mathematics with other sciences and in combination with real life are the basis of mathematical education;

2) training in solving practical (applied) mathematical problems under theoretical knowledge.

Such approaches to the formation of functional literacy of students strengthen the practical significance of the school mathematics course, contribute to the emergence of new, deeply grounded interdisciplinary connections, and contribute to the humanization of mathematical knowledge by expanding the applied aspect. This, in turn, makes it possible to realize the goals of mathematical education.

When compiling the applied content of the mathematics course, the teacher should pay more attention to making the educational material interesting and understandable to students. In this context, we propose the following requirements aimed at improving the mathematical literacy of students:

- the student should be covered with understandable, fascinating, interesting, and useful thematic material for deep assimilation of the content of mathematical education;

- to deepen theoretical knowledge in mathematics (in-depth study of mathematics, i.e. deepening of individual topics), to carry out its practical orientation and interdisciplinary connections;

- should be aimed at familiarizing students with important techniques and methods of applying the acquired knowledge in mathematics in practice;

- the course of theoretically grounded training of students, should be aimed at involving them in relevant practical activities, drawing up reports from real life;

- materials not included in the curriculum of the discipline should be taught through the content of the course, i.e. the content of the course should not necessarily duplicate the content of the studied mathematical education;

- should be aimed at studying methods for solving various mathematical problems;

- it should be compiled in such a way as to make full use of active forms of organization of the educational process, information, and project work;

- individualization of education, socialization of the student, and, taking into account individual characteristics and level of training, the expansion of the acquired knowledge should contribute to the preparation for higher education in connection with the future profession, the choice of a future profession.

Conclusion

Functional literacy is a basic factor contributing to the active involvement of people (individuals) in social, cultural, political, and economic activities and education throughout life. Functional literacy is a constant increase and improvement of people's knowledge, regardless of their activity, or age. It is necessary to take into account the following functional qualities: activity, creative thinking, the ability to make the right decisions, the ability to choose your profession correctly, etc. The teacher must be deep and skillful in choosing the content of the educational material when teaching mathematics (in combination with interdisciplinary connections and life). We give the following methodological recommendations to teachers:

1. acquaint students with materials and information of a cognitive nature so that they can demonstrate the current level of science and its development through practical informative reports.
2. disclosure of scientific research, results, and publications with the help of practical informative (applied) reports.
3. to show the need for geometric methods to explain the phenomena of everyday life, and knowledge.
4. to show students the practical aspects of scientific and theoretical knowledge, and the possibility of applying the knowledge learned in the lesson in solving everyday and practical problems in human life.

Summing up, it can be seen that the developed methodological system and recommendations are practical ideas in the formation of functional literacy of students, improving the quality of knowledge in mathematics.

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