

## THE ROLE OF MATHEMATICAL LITERACY IN THE IMPROVING THE THINKING SKILLS OF SCHOOLCHILDREN

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**Abstract.** This article examines the role of mathematical literacy in the development of students' thinking abilities and skills. During the analysis of domestic and foreign articles, an extensive definition of the concept of mathematical literacy was given. In the process of forming students' thinking skills, mathematical problems, conclusions, analysis are considered separately, the significance of which is in the formation of appropriate thinking skills (analytical, critical, creative, logical). In addition, a study was conducted on how well the country's schoolchildren have mastered the concept of mathematical literacy. For this result, studies were conducted on the results in the direction of mathematical literacy of students under the PISA program - the international program for assessing student achievement. As a result of the study, it was revealed that the concept of mathematical literacy in the country has not yet become widespread, the level of Kazakhstani schoolchildren is relatively low, that mathematics in the minds of students is associated only with special laws, formulas, arithmetic operations. Ways of solving these problems were considered, including taking into account their understanding. New methods and techniques of fixing mathematical literacy in the minds of students, effective world-class approaches are considered. New approaches to the formation of the concept of mathematical literacy in the secondary education system are discussed. The results of scientific research can be both useful and auxiliary tools for mathematics teachers studying in special educational institutions, in schools, etc.

**Keywords:** mathematical literacy, PISA, thinking skills, HOTS, schoolchildren.

### **Introduction**

The XXI century is the century of information technologies. Currently, there are a huge number of new technologies and new sources of information, which is significantly lower than the possibilities of perception of information in society. The substance, unknown and not found many years ago, has now fallen out of use in society.

According to some previous studies, modern society needs not only the content of this knowledge, but also the ability to think. These are critical thinking, analytical mindset, creativity, activity, adaptability, flexibility, communication, independent learning, responsibility, social productivity, leadership, as well as information literacy. One of such literacy is mathematical literacy.

The formation of mathematical literacy of schoolchildren is a priority task in ensuring the quality of school mathematical education. The Concept of the development of mathematical education notes that mathematics acts as an element of general culture, mathematical literacy and everyday use. Modern society expects from the school thinking, initiative, creative graduates with a broad outlook and solid knowledge. The school, in the context of the modernization of the education system, is looking for ways that would allow it to fulfill this order of society.

School mathematical education includes material that creates the basis for mathematical literacy, which is necessary for those who will become scientists, engineers, inventors, economists and will solve fundamental problems related to mathematics, and for those for whom mathematics will not become a sphere of direct professional activity.

### **Methods and materials**

Mathematical literacy does not imply detailed knowledge of calculus, differential equations, topology, analysis, linear algebra, abstract algebra and complex mathematical formulas, but rather a broad understanding and understanding of what mathematics is capable of achieving. This article discusses what mathematical literacy is; the essence of mathematical literacy; and the nature of Mathematics. It also discusses what constitutes mathematical literacy and lists the competencies required to achieve mathematical literacy. It is important to note that the mathematics we study and the mathematics we need to know are two different things. The need to make this distinction is due to the fact that not all the content of mathematics that we encountered as schoolchildren can be applied in our daily lives as adults.

**Thinking Skills.** The role of mathematical literacy in the formation of thinking is great, including in the formation of a system of mathematical thinking in particular. A mathematical system of thinking is not like an ordinary system of thinking. The main difference is that humanity, through a system of mathematical thinking, not only directly perceives phenomena and problems occurring in the world, but also critically examines, delves into the problem existing in it, learns to find a solution and at the same time the cause ( Morozova and Tkacheva, 2018: 89).

If we talk about the practical significance and usefulness of the system of mathematical thinking, then, of course, first of all we return to solving mathematical problems. However, the importance of the mathematical thinking system is even deeper. A person with a well-developed mathematical system of thinking has the following advantages:

- easily and quickly solves any problems he faces in life, and understands that if he is looking for, he will definitely find;
- each new question encountered performs according to the same plan, drawing up a solution plan;

• every mistake made in life is considered not only as a mistake, but also as an opportunity (Batura and Batura, 2005).

And the main requirement of modernity is to educate a generation that has already formed the above skills.

The most important aspect of mathematical literacy is making decisions using mathematics in vital issues, clearly realizing the role of mathematics in the world. That is, if a student understands mathematical literacy well and knows how to apply mathematics in life, then the student has developed mathematical thinking skills.

Features of the mathematical thinking system. For many years, our scientists have been unable to determine why adaptability to mathematical calculations prevails over other areas in the general human child. But based on the results of numerous studies and theoretical knowledge; scientists put forward two different judgments. The first judgment may be caused by the indirect influence of speech and word formation, and the next judgment by the intuitive perception of space and time.

To determine which of these judgments are correct, our scientists conduct a little research work. 15 ordinary people and 15 people working in the field of mathematics take part in the research work. They are given tasks consisting of two stages: math tasks and tasks that are not related to mathematics. When performing tasks, the brain of each participant in the experiment is lowered onto a tomographic device. As a result of the study, people working in the field of mathematics found that the anterior, lower, and parietal parts of the brain worked when performing tasks. While in the second group it was not noticed that the mentioned parts of the brain worked, in addition, these parts of the brain had some differences compared to those in the first group. It turned out that the above-mentioned parts of the brain of people who do not work in the field of mathematics worked a little only in the process of producing mathematical calculations (Lailiyah, 2017).

From a scientific point of view, the results of the study showed that the highest level of the mathematical system of thinking is a neural network that accepts numbers and time. This neural network is completely different from the neural network that is responsible for language and speech. The result is reduced to the conclusion that the development of spatial and quantitative thinking has a direct impact on the development of the system of mathematical thinking.

Based on the above information and the results of the study, the system of mathematical thinking or the development of mathematical thinking skills are directly related to mathematical literacy. I.e., how to give students the basics of mathematical literacy and implement the main aspects, it is possible to form a mathematical system of thinking in schoolchildren. Further develops mathematical thinking, solving mathematical and logical problems. This skill is formed by a graduate of the school - a sought-after specialist in the future.

The present time requires a change in thinking skills in many areas of life. Because in the 20th century, the main task of mass education was to teach people to

read, write and count. Then competent workers formed skills for specific professions in technical schools, universities and courses. At that time, professional tasks hardly changed. It was enough to hone a few skills to climb the career ladder. But unfortunately, now having only "basic skills" is not enough. The society now requires new and professional skills. In order to have professional skills, you need to be able to think, that is, have higher-order thinking skills (HOTS).

According to Higher-Order Thinking Skills uses thinking widely to find new challenges. High-level thinking requires a person to apply the new information or knowledge he has and manipulate information to reach possible answers in new situations. Brookhart states that high-level thinking is understood as the end of Bloom's cognitive taxonomic theory. According to King, higher-order thinking skills include critical, logical, reflective, metacognitive, and creative thinking. ( Rizki and Priatna, 2019).

Also we have Lower Order Thinking Skills (LOTS) uses in everyday life. They are the foundational skills and practices you need to have to move to Higher Order Thinking Skills (HOTS). LOTS are the main qualities that a person develops as he grows, for example: observing, memorizing, recollecting, understanding, applying, remembering, etc. We develop them through our basic educational levels.

### **Literature review**

Due to the fact that mathematical literacy plays an important role in the development of students' thinking abilities, and the ways of forming mathematical literacy are highlighted Rizki L.M and Priatna N., Morozova I.K., Tkacheva V.V., Truhanova S.V., Agaf onova T.M., Sheina T.A., Sheina T.A. showed in their works. As well as answers to questions about how well mathematics is taught at school, how functionally literate students are, how well mathematics is taught to teachers. N, Listiani W., Ojose B., we can find answers in the works. The relevance of mathematical literacy at the present time in their work was determined by G. S. Kovaleva, D. T. Kazhibekova.

### **Results and discussion**

#### *Research on math literacy in Kazakhstan*

The concept of mathematical literacy in Kazakhstan appeared in early 2000. Kazakhstan for the first time took part in the International Program for the Assessment of Educational Achievements of Students International Student Assessment Program (PISA) in 2009. Also we participate in five comparative studies - they are PIRLS, TIMSS.

Whenever you want to find information about mathematical literacy in Kazakhstan, the results are not encouraging. You find the same article as "Why did Kazakh schoolchildren fail the PISA international exam?", "Kazakh schoolchildren have low functional literacy", "The Factory of illiteracy: Kazakh schoolchildren are less and less shining with knowledge", etc.

The reason for such articles is that in our school in Kazakhstan, children have studied many subjects well, but they do not know how to use their knowledge in this surrounding world. The proof was that Kazakhstan participated in the PISA 2018 competitions and took 69th place out of 79 countries. This is shown by our students who almost took the last place.

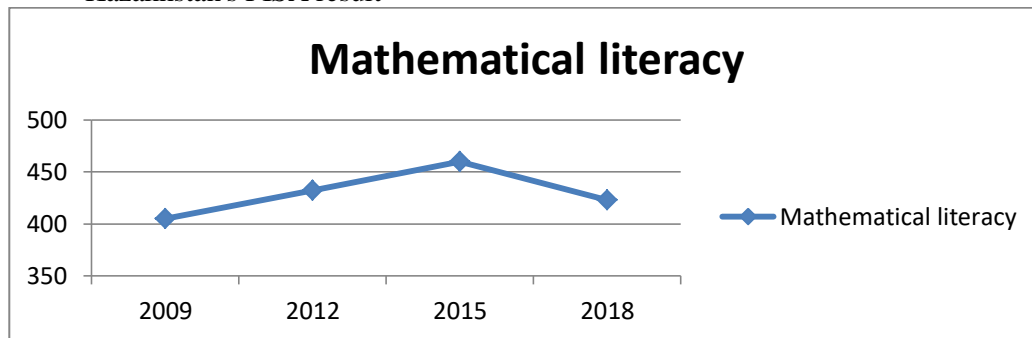
The experience of the first participation in 2009 proved to be a great test for the country. Then Kazakhstan took 59th place in the overall ranking of 69 countries. The study involved 5,590 students from 200 educational institutions.

In 2012, the results were slightly better. 5808 students from 200 schools and 18 colleges, 3522 students with Kazakh language of instruction and 2286 students with Russian language of instruction took part in the testing. The overall result is 45th place in the ranking of 65 participating countries.

In 2015, Kazakhstan's performance in the rating became unexpectedly high (average score – 460). But as it turned out, due to violations in the marking of tasks and the principle of proportional selection, the results of the country were not counted. Out of 5,780 students of schools and colleges, 2,061 were students of the Nazarbayev Intellectual School. (Nurbayev, 2020).

The latest study revealed a lag from the own results of previous years, the indicators of which were lower than the first year of participation in the program.

Kazakhstan's PISA result



According to statistics, mathematical literacy is only growing from 2009 to 2018. But slightly less compared to highly developed countries (for example, Pisa 2018 Singapore-556, PISA 2015 Japan-532, etc.) There is shown only results of PISA.

In Kazakhstan, the concept of "mathematical literacy" is used not only in student achievement assessment programs: PIRLS, TIMSS, PISA, but also in UNT (Unified National Testing). UNT (Unified National Testing) is a system of testing the knowledge of graduates used in the Republic of Kazakhstan. Secondary education received by graduates of the school is checked as a result of this testing. This testing system was introduced in Kazakhstan in 2007. According to the implemented system, graduates took

five main subjects – kazakh language, russian language, mathematics, history and of their choice subject.

But in 2017, changes were made to the testing system. That is, graduates were required to take tests not only in mathematics, but also in mathematical literacy. In general, up to this period, there are problems in mathematical literacy in the course of testing in mathematics. But out of the 25 reports given, only 2-3 were logical, that is, 8-10% of the entire report. Changes in the education system began in 2016. And she is currently having a positive impact.

For the first time, mathematical literacy was included in the UNT not only for students, but also for teachers. Since until now students have mastered only mathematical knowledge, now students have moved on to the stage of using the acquired knowledge.

Despite the fact that mathematical literacy is included in the UNT, the lesson "mathematical literacy" is still not included in the secondary education program. If the subject of mathematical literacy was included in the school curriculum, then students would not only gain mathematical knowledge, but also learn to use it to solve various problems in life.

Maybe now there are questions about how mathematical literacy is related to thinking skills?

Mathematical literacy "consists" of two main components:

- fundamental mathematical ideas: "change and dependencies", "space and form", "uncertainty", "quantitative reasoning";
- mathematical competence. Mathematical competence is defined as a combination of mathematical knowledge, skills, experience and abilities of a person that provide solutions to various problems that need the application of mathematics (Ojose, 2011: 89-100).

Students should be able to solve any tasks assigned to them. Depending on the complexity of the task, three levels of mathematical competence are distinguished: the level of reproduction, the level of establishing connections, the level of reasoning.

*The first level* (the reproduction level) is the direct application in a familiar situation of known facts, standard techniques, recognition of mathematical objects and properties, implementation of standard procedures, application of known algorithms and technical skills, work with standard, familiar expressions and formulas, direct execution of calculations. At the first level, students develop "basic skills" (knowledge, understanding, application), that is, they know mathematical signs, formulas, objects and understand their meaning, and why these formulas are needed for the task, then they know where to use, how to apply all these formulas, etc.

*Second level* (link-making level) it is based on reproductive activity to solve problems that, although not typical, are still familiar to students or go beyond the known

only to a very small extent. The content of the problem suggests the material of which section of mathematics should be used and which known methods should be applied, that is, students choose the most optimal option, considering all the methods of solving the problem. This is how students develop analytical thinking. Usually in these tasks there are more requirements for the interpretation of the solution, they assume the establishment of links between different representations of the situation described in the task, or the establishment of links between the data in the condition of the tasks, they develop abstract thinking.

*The third level* (reasoning level) is constructed as a development of the previous level. To solve problems of this level, students need creativity, a certain intuition, reflection and creativity in choosing mathematical tools, integration of knowledge from different sections of the mathematics course, independent development of an algorithm of actions. Assignments, as a rule, include more data, students are often required to find a pattern, generalize and explain or justify the results obtained. With the solution of tasks of this level, students will have advanced critical and creative thinking (Churilo, 2020: 3).

### **Conclusion**

In conclusion, would like to say that the development of schoolchildren's thinking takes a long time.

Process a huge role in its formation is played by the systematic teaching of mathematical literacy. Math literacy can improve higher-order thinking skills, reasoning skills, presentation skills, and math communication skills.

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### **Оқушылардың ойлау дағдыларын дамытудағы математикалық сауаттылықтың рөлі**

**Аңдатпа.** Бұл мақалада математикалық сауаттылықтың мектеп оқушыларының ойлау қабілеттіліктерін, дағдыларын дамытудағы рөлі қарастырылған. Отандық және шет елдік мақалаларға талдаулар жасау барысында математикалық сауаттылық ұғымының кең көлемде анықтамасы берілді. Мектеп оқушыларының ойлау дағдыларын қалыптастыру барысында математикалық есептер, тұжырымдар, талдаулар сәйкесінше ойлау дағдыларын (аналитикалық, сыни, шығармашылық, логикалық) қалыптастырудағы маңызы жеке-жеке қарастырылады. Сонымен қатар, еліміздегі мектеп оқушыларының математикалық сауаттылық ұғымын қаншалықты жетік меңгергендігіне зерттеу жасалды. Бұл нәтиже үшін халықаралық оқушылардың жетістіктерін бағалау бағдарламасы – PISA бағдарламасы бойынша оқушылардың математикалық сауаттылық бағыты бойынша нәтижелеріне зерттеулер жүргізілді. Зерттеу нәтижесінде елімізде математикалық сауаттылық ұғымының әліде кең таралмағандығы, Қазақстандық оқушылардың деңгейінің салыстырмалы түрде төмен екендігі, оқушылардың санасында математика тек арнайы заңдылықпен, формулалармен, арифметикалық амалдармен ассоциацияланатындығы анықталды. Аталған мәселелерді ой елегіне сала отырып, мәселелерді шешу жолдары қарастырылды. Математикалық сауаттылықты оқушылардың санасына бекітудің жаңа әдіс-тәсілдері, әлемдік деңгейдегі тиімді тәсілдер қарастырылды. Орта білім беру жүйесіне математикалық сауаттылық ұғымын қалыптастырудың жаңа әдіс-тәсілдері талқыланды. Ғылыми зерттеулер нәтижесі арнаулы оқу орындарында, мектеп қабырғасында және білім беретін математика пәні мұғалімдеріне пайдалы, сонымен қатар көмекші құрал болуы мүмкін.

**Кілт сөздер:** математикалық сауаттылық, PISA, ойлау дағдылары, ЖДОД, мектеп оқушылары.

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### **Роль математической грамотности в развитии мыслительных навыков учащихся**

**Аннотация.** В данной статье рассмотрена роль математической грамотности в развитии мыслительных способностей, навыков школьников. В ходе анализа отечественных и зарубежных статей было дано обширное определение понятия математической грамотности. В процессе формирования у школьников навыков мышления отдельно рассматриваются математические задачи, выводы, анализ, значение которых в формировании соответствующих навыков мышления (аналитического, критического, творческого, логического). Кроме того, было проведено исследование того, насколько хорошо школьники страны усвоили понятие математической грамотности. Для этого результата были проведены исследования результатов по направлению математической грамотности учащихся по программе PISA – международной программе оценки достижений учащихся. В результате исследования было выявлено, что понятие математической грамотности в стране еще не получило широкого распространения, уровень казахстанских школьников относительно низок, что математика в сознании учащихся ассоциируется только со специальными закономерностями, формулами, арифметическими операциями. Были рассмотрены пути решения этих проблем, в том числе и с учетом их осмысления. Рассмотрены новые методы и приемы закрепления математической грамотности в сознании учащихся, эффективные подходы мирового уровня. Обсуждены новые подходы к формированию понятия математической грамотности в системе среднего образования. Результаты научных исследований могут быть как полезными, так и вспомогательными пособиями для учителей математики, обучающихся в специальных учебных заведениях, в стенах школ и др.

**Ключевые слова:** математическая грамотность, PISA, навыки мышления, HOTS, школьники.