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## **Application of mnemonic technology in the educational process**

Nowadays modern technologies allow people to be effective and perform several tasks simultaneously in a short time. However, the brain is a muscle and it also needs to be loaded and trained. Thus, if human beings rely only on technology and do not strain their brain at all, then this will lead to degradation. As a result, people can experience a deterioration in memory, the complexity of perception and assimilation of information. The article discusses ways to improve the memorization of human beings through different types of mnemonic technologies. The evidence that mnemonics has existed since ancient times and remains effective to this day has been proven. Also, mnemonic technology is classified into linguistic, visual, verbal and spatial methods and involved in education to make students more productive in their study. The authors provide examples for each method of mnemonics. Introduction ways of receptions to memorize in educational process of biology, chemistry and general training are treated.

**Keywords:** mnemonics, new technique, memory, human development stages, digital amnesia, education, spatial mnemonics, visual mnemonics, verbal mnemonics.

### *Introduction*

Human being is the highest, dominant creature among all other living things. Through continuous evolution that has lasted for centuries, this living entity has passed several stages of formation as a civilized person. Civilization, in turn, consists of three stages of the historical development of society:

1. Pre-industrial or agrarian society. Here the population was engaged in the most important type of material production, agriculture and the main source of exports was considered raw materials and products made of natural stuff.

2. Industrial society. The descriptive changes of the industrial society include the widespread use of machinery, the predominance of factory production and the formation of democracy, the emergence of urbanization. At the same time, during this period achievements of science began to be used in various spheres of life and universal education increased.

3. Post-industrial society. It is characterized by sustainable scientific and technical prosperity, a high standard of living, and knowledge and development of information technologies [1].

The twenty-first century is the era of technological expansion. Currently, computers, mobile phones, the Internet, television, and other gadgets have become an integral part of our lives, as these modern tools facilitate our lives and allow humanity to save time, one of the important values of our life. The diversity of information technologies permits people with disabilities to get education and work. Primarily, through the Internet people can find the necessary information in the short space of time. However, despite announced benefits, these gadgets have led every citizen and global society to such great consequences as cyberterrorism, health deterioration, technical dependence, spiritual trifle, and memory degradation.

Large numbers of individuals do not know that the development of digital technologies and the Internet has a negative impact on people's memory. Researchers of "Kaspersky Lab" surveyed more than 1000 people regarding this question. About half of the respondents (44 %) answered that they cannot remember phone numbers and other information about their close ones. To this phenomenon, scientists have given the name "Digital amnesia". Digital amnesia appears when people start to store all daily information on their smartphones, instead of remembering that data in their brain [2]. The reason for this, according to Professor of Neurosurgery and Biological Sciences, Tatyana Vladimirovna Chernigovskaya, is that the brain develops by solving complex tasks, conducting daily exercises, in a word, making an effort on the brain [3].

The current issue that people are faced with leads to a decrease in the quality of students education. In this case, mnemotechnical methods of studying started to be applied.

### *Materials*

Mnemonics (from the Greek “mnemonikon” — the art of memory) is a set of ways to facilitate the process of remembering and increasing the amount of memory of the brain, creating artificial associations. According to mnemotechnics, a person stores information in the brain, transforming it into a combination of visual images. In this method, the actions of summon into mind and recalling material are fully controlled. The term was introduced into science by Pythagoras of Samos (6th century BC). The works of Cicero and Quintilian on mnemonics are preserved approximately in the records of 86–82 BC (“History of mnemonics”). Then mnemonic methods for improving human reminiscence were widely used by the ancient Greeks (Yates, 1966). In archaic times, it was an integral part of rhetoric to learn ways to enhance mind to speak publicly for a long text. The inscription of the great Pliny about the Roman Cyrus, who knew by heart the names of all the men in his army can be an example of this. It was assumed that another Roman, Lucius Scipio, knew the names of all the Romans. Mithridates of Pontus preserved information about the knowledge of the languages of the twenty-two peoples who inhabited his domain. Francis Yates confirms that during the time of G. Leibniz, a technique was used to improve memory, which proved the way of differential and integral reference from the ancient Greeks and Romans [4].

In the way of illumination, intellectual movement, our historical figures made so much effort. Among them, the endeavor of Altynsarin is hardly estimated. Ybyrai Altynsarin is a poet, folklorist, methodist who opened the first Kazakh-Russian boarding school on our steppe [5].

He believed that for Kazakh children it would be easier to learn the subjects in their own language. Therefore, in the training of his students he used a new grammar, the Kazakh alphabet expressed in Russian letters, presented by N.I. Ilminsky. Altynsarin thought that a real pedagogue has to explain his lesson in an interesting way, to consider a simple method of memorizing information, combining the subject with life [6].

From this, we can see that in the 19th century our ancestors got a theory of mnemonics, even if there was no corresponding term to determine this technique. If be more specific, Altynsaryn’s teaching of children with a Cyrillic alphabet coincides with the technique of mastering foreign words by the mnemonic method. In accordance with the basic structure of learning foreign words in the work of K. Dudin “Memory, like an elephant”, new words are associated with the image arising from them. If another language term in our mind creates an image, we connect its translation and association, then visualize it and check if it decodes the word’s translation. If it does not cause any picture in the mind, we find the consonant resemblance to the word and formulate a connection [7].

A disciple of Ybyray Altynsarin, Mirzhakyp Dulatov is another sage who awakened the desire for knowledge in the people. On the way to his enlightenment, M. Dulatov proposed a new direction in accordance with the scientific and didactic basis of education. In his opinion, teachers should inculcate children to study effectively and keep maximum data with full meaning in their memory after class. Also, M. Dulatov explained that conducting a lesson only in the form of a lecture does not give the planned results, thus teachers are needed to include creativity in it.

Therefore, M. Dulatov supported words of the Russian pedagogue K. Ushinsky that it is necessary to use senses of vision, sight, and touch to preserve the lesson material in long-term memory [6; 238].

The explanation of this action can also be interpreted by mnemonics. All objects surrounding humanity have inherent features in space, such as color, shape, smell, sound. Through the analysis and distinction of these features the brain generates polymodal contacts and places the information in our memory [8].

As an example, take pears. Information about it comes to humans from different analyzers: shape and color from analyzer of visual sense, smell from olfactory apparatus, taste from gustatory sense, chewing sound from auditory sense, receptors of taste give information about tastiness and somatosensory sense informs us about smoothness or roughness of its surface. All these particle descriptions are linked together and the image of the whole pear appears in the brain.

Nowadays, modern mnemonics has advanced significantly in a theoretical and technical way and it allows not only to fix the sequence of text material in memory but also to accurately remember any specific information. Even a list of phone numbers, chronological and various digital tables, personal data, extensive texts, numerous terminologies, foreign words, the sequence of processes in memory, etc. can be kept in mind. Mastering this method can be compared to learning blind printing as both need a formation of skills. The duration of information storage in memory is fully controlled and we can recall it in direct or reverse order [8; 6].

*Types and methods of mnemonic research*

Mnemonic learning provides effective educating strategies for children with different perceptual abilities in various situations. There are several sections of mnemonic learning strategy: linguistic, spatial, visual, physical, and verbal methods.

I. At linguistic mnemonic methods, such as Pegword and Keyword, an association of a new concept is bounded with an already clear word or phrase. The Pegword method works on the Eidos system consisting of two parts. In the first part, the student memorizes the numbers 1 to 5 (more or less) in rhyming or associative form. In the second part, new words are connected with these images. For example, 1-arrow, 2-Swan, 3-fork, 4-chair, 5-hook, etc., thus, numbers can be replaced with similar items by association. The words that need to be remembered are apple, Lotus, potatoes, knife, and car. Now we link the sequence of numbers and new words. For instance, we imagine a swan eating a lotus, or how we shoot and hit the apple with an arrow.

The Keyword method consists of three parts:

1. Find a keyword that has an acoustic match to the target word.
2. Create an associative connection between keywords and target words.
3. Create a representation in our brain. For example, let us take the word “Bucket” which is consonant with the Russian word «Быкет», the meaning is “Bouquet”. So, we bind these words, leaving in memory the sentence “There is a bouquet in a Bucket”.

II. Memorizing material by spatial method involves adding a new concept to a familiar place, photo, or finger.

1. According to the method of loci, we draw a familiar place, room, or home, in the imagination. Then pay attention to objects of that space, as if we were walking in that place [9]. To use that method close your eyes and visualize: remember the door of your house, its color, the handle. The moment you pull up, you notice that one little bear scratches your door. When you open the door and go in, you get into the Hercules porridge, which is scattered all over the hallway. Stepping on it, you go into the hall. There you see dancing twins. Escaping from them, you enter your bedroom and notice a crown with large jewels. In this way, it is easier to store in mind all notifications such as Little bear, Hercules, Gemini (twins), and the Crown constellations.

2. The meaning of grouping in space is based on the formulation of writing. Here we try to make a sample or forms from these words, instead of writing them in a column. As an example, we can take the words written on the walls of a triangle.

3. By the method of fingers, children associate each word with their fingers. This method helps children in memorizing numbers, days of the week, and months of the year.

III. Visual mnemonics, according to its title, uses visual objects to create targeted conceptual associations in human thought. This technology corresponds to M.A. Baiturymuly's “explaining-visual method of teaching biology” [10].

1. In visual mnemonics information released on the paper list is used as the main tool of it. Matching printed words with its definition can be an example of this type.

2. Visual overview and images reveal the meaning of the target words through their images or scene [9; 178–182].

IV. Verbal methods.

1. Grouping or semantic organization. Classifying target information by common features helps to store words related to each other in long-term memory and it will be easy to reproduce them. If a student remembers one of the connected words, then others will come to mind along the chain [9].

For example, target words are ostrich, golden jackal, squirrel, kiwi, wolf, rabbit, mouse, and Arctic fox. They can be classified into rodents (rabbit, squirrel, mouse), species of birds (ostrich, kiwi), and species of dog breeds (wolf, golden jackal, Arctic fox).

2. Story-telling or the narrative chain. In this type of verbal method, students choose a specific topic and compose stories, including target words within the topic [9].

V. Physical Responses Methods. For assimilation of information in types of physical sensations, movements or parts of the body of the person are used.

1. Physical response method. To memorize a word, a student should move in such a way as to reveal the meaning of the term [9].

For example, if our purposeful word is flinch, they can well understand the action through the repetition of a movement that causes the body to flinch.

2. The physical sense. The strategy of physical sensation, coined by Oxford and Scarcella in 1994, is based on the preservation of the responsible body reaction in memory [11].

For example, when we hear the word “stomatitis”, we can remember the pain in the mouth.

#### *Application of mnemonics in teaching and learning chemistry and biology*

The use of mnemonic strategies in teaching chemistry was initiated by a review published 50 years ago. Flipper and Morris believed that chemistry knowledge formulates from basic proficiency that we get by learning by heart fundamental information of it. Mnemonical technology directs us to proper training [12].

The authors included the name of elements, the laws of gas, and classification depending on the solubility of inorganic salts to the basis of chemical knowledge. References are used as illustrations of the main terms in a reduction-oxidation reaction. For example:

1. OIL-RIG (Oxidation Is Loss, Reduction Is Gain [of electrons]).
2. LEO the lion says GER (Losing Electrons is Oxidation, Gaining Electrons is Reduction));
3. Envisage OXen going up a mountain (as well as oxidation number of an OXidation goes up) and RED blood flowing down the mountain (just as the oxidation number of a REDuction goes down).
4. “EOH” reminds us to include atoms of electron, hydrogen, and oxygen to complex equations;
5. “GEORA” & “LEORRA” (Gain Electron-Oxidizing Reduction Agent, Lose Electron-Oxidation Reducing Agent) [13].

Memorizing consecutive data can be used in chemistry teaching. Here the preface of each word resembles the name of the elements. For example, the reactivity of several metals is encoded as follows: Kamila Naughty Canor Mingles with Alice and Zendaya to Fearlessly Plunder Cupboard of Silver and Gold. Lanthanide elements can be encoded as: Ladies Can't Put Nickels Properly into Slotmachines. Every Girl Tries Daily, However, Every Time Youngsters Lose [14].

It can be seen that one topic can be represented in several mnemonic ways.

Biology is one of the subjects rich in content. Therefore, it is hard to summon into mind all learned materials. Using mnemonics in biology lessons, which includes frequent repetition, retelling, and monitoring, teachers can easily indoctrinate the students in biology themes; that is why it is paramount for students with a weak perception of lesson topics.

Another model of mnemonic technology is the abbreviation FARM-B. It depicts 5 classes of vertebrates, i.e. F-fish, A-amphibian, R-reptile, M-mammals, and B-birds. As B is a missing letter, we can add it to the end of the abbreviation [15].

The next type of mnemonics technique is a specific way of encoding words. It can be used to memorize terms related to the nervous system in biology research. Figure 1A suggests the idea of remembering the term “synapse”. The synapse is located at the end of the axon and there is a space between two neurons or between one neuron and a muscle. “Naps” (means “to sleep”) is a part of the word “synapse”. In this regard, a man sleeping between two neurons is drawn.

In Figure 1B, the term that has to be remembered is “synaptic vesicle”. Synaptic vesicles are located at the end of the axon. Synaptic vesicles have neurotransmitters inside. In this picture, we can move in two ways: basic (i.e., testicles) and by using transport (vesicles), and people in vehicles can be neurotransmitters [15].

As the most obvious example of the application of mnemonic methods in teaching biology, it is possible to provide the use of abstract coding of words, i.e. phonetic coding for remembering the actions of neurotransmitters (Fig. 2).

Figure 2A shows how to remember a situation that occurs when the serotonin level is low. Here, the student draws a picture of sir Rotten. “Rotten” means “nasty”. So we associate low levels of serotonin in the brain with bad mood.

Figure 2B represents a way to understand how acetylcholine affects muscle. Since Acetylcholine is involved in the contraction of our muscles, as a mnemonics, it can be described in the form of an ACE card with contracted muscles.

The next neurotransmitter is dopamine, which has different effects depending on the level. “High level causes schizophrenia”. In this sentence, the student associates the word “Dose” with Dopey, the name of a dwarf, the word “High” with the word “Tall” (height), and the part “Ski” of the word skizofrenia (schizophrenia, written in Indonesian) with skiing. Thus, the effect of dopamine is hidden in the sentence “Tall Dopey is skiing” because the presence of a tall dwarf cannot be a truth like delusions of people who suffer from schizophrenia.

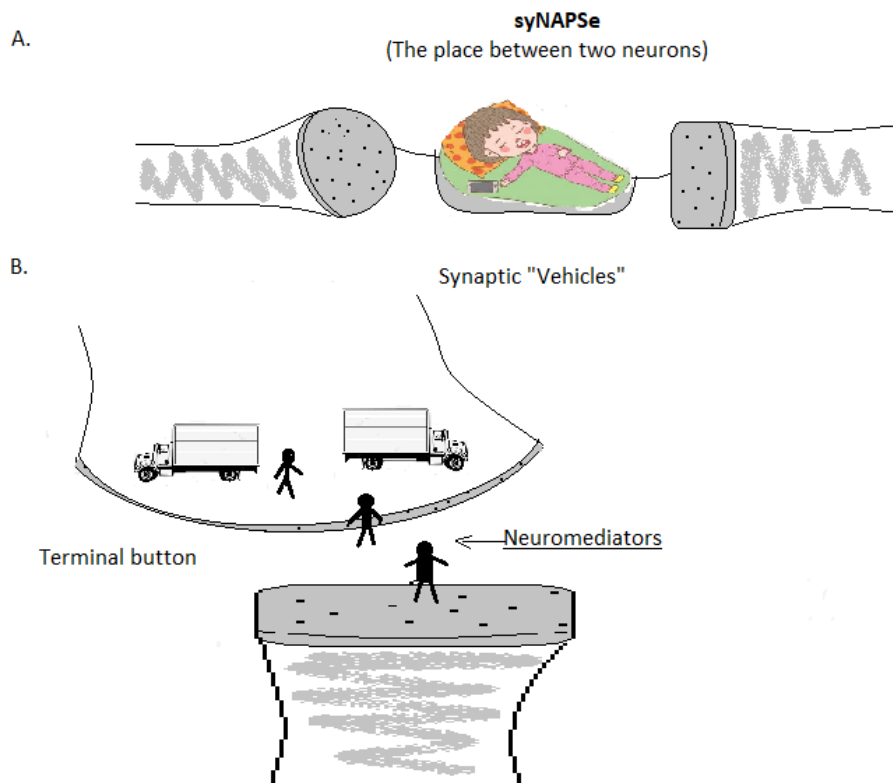


Figure 1. Drawings of a student who prepared for the international certificate in biology (Upper Secondary School in Mazowieckie)

By the previous method, we use the fact that a low level of dopamine causes Parkinson's disease. We connect the word "Low" with "Small", the part "Parkin" of the word Parkinson. Suchwise, in the sentence "Small Dopey is parking a car" the reaction of dopamine at the low level is encoded [15].

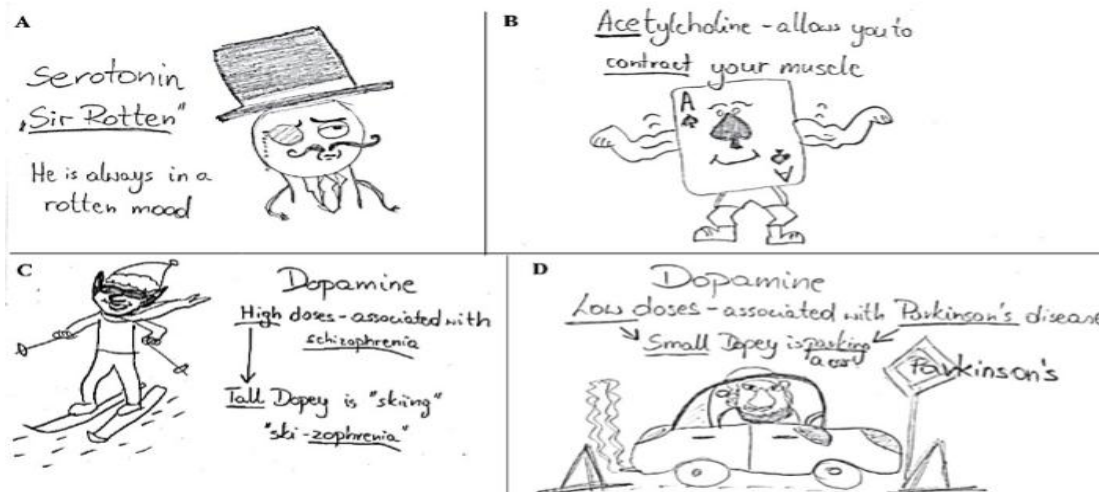


Figure 2. The reaction of neurotransmitters

The abbreviation MR GREEN could be the next example of mnemonics in biology. It characterizes common properties of all living things: movement, reproduction, growth, respiration, excretion, environmental sensitivity, and nutrition. Following the same pattern, classes of invertebrates can be proposed by CAM SEA: Cnidarians, Annelids, Mollusks, Sponges, Echinoderms, and Arthropods.

### Conclusions

Mnemonics provides systematic work of human memory and forms skills of creativity of the brain. Through this approach, people associate the concept difficult to remember with familiar information and store new information in long-term memory. Studies on mnemonics show that mnemonic techniques help to understand and remember complex information such as people's faces and names, the Constitution, learning a foreign language, names of the countries and their capitals, hieroglyphs, etc., and contribute to its easy recall.

For example, students can be a little confused about the fluid-mosaic model of a cell membrane defined by S.J. Singer and L. Nicolson, which is a double membrane layer consisting of phospholipid molecules. Usually, students cannot remember which part (tail or head) of phospholipid is hydrophilic or hydrophobic. To clarify it, we propose the following: In the word "hydrophilic", draw attention to the part Phil and associate it with the character Phill from the TV series "Interns". He played a smart role as an Intern; thus, affiliate Phil with the brain or the head. From this, you immediately remind that the head is hydrophilic.

In the field of molecular biology, the main goal is to study large biological molecules. In particular, it is hard to keep in mind the names of proteins, especially the sequence of purine and pyrimidine bases contained in them. We believe the following methods of mnemonical technologies are the solution to this problem.

		second letter					
		U	C	A	G		
first letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA stop UAG stop	UGU } Cys UGC } UGA stop UGG Trp	U C A G	third letter
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G	
	A	AUU } AUC } Ile AUA } AUG Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G	
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G	

Figure 3. The table of genetic code

It can be noticed that any protein is formed from 3 structural levels. For example, GCU forms alanine. How is it possible to learn this table? Remembering that the bases in the table of genetic code (Fig. 3) are in UCAG sequence, imagine the following:

There is a chest of drawers in front of you. Think of its color, shape, mirror, and doors. You open the first level drawer and see the hair dryer (фен) wrapped around the ruler (линейка), earrings (серьги), shooting gallery (тир), treatment of cystitis. Looking at the second level of the drawer you again see the hair dryer (фен) wrapped around the ruler, as shown above, the driver's license (права), a bag of plaster (гипс) and clay (глина), a silver ring. By visualizing these images, we can store them in memory and decode them if it is necessary.

The hair drier (фен [fen]) recalls phenylalanine. The first letters of the Russian translation of the word ruler «линейка» ([lineika]) is consonant with leucine's first letters. Information that these two are mentioned together means that they are in one cell of the whole table. As hair drier ([fen]) of these two is reminded first, it means that phenylalanine is located on the first lines and leucine is on the last lines of the cell. Russian translation of earrings «серьги» decodes the word serine while shooting gallery (тир [tir]) reminds us of tyrosine. The phrase "treatment of cystitis" helps us remind tryptophan and cysteine which are also located in one cell.

Proline, which is located on the lower level of the drawer or the second line of the table, is connected with the driver's license (Rus. права [prava]). Plaster (Rus. гипс [gips]) and clay (Rus. глина [glina]) are reminiscent of histidine and glycine. A silver ring decodes the word arginine because at the periodic table of Mendeleev silver is interpreted as the Latin word Argentum.

These advantages have become the main reason for the introduction of mnemonics in the educational process of biology. During the lesson, the teacher directs students to easy ways of receiving information and saves time. This saved class time can be spent on practical or individual work of students. In this regard, students can quickly learn the theory and pay more attention to its application and experiences.

Auditory analyzer leads to the brain only 10 % of the information taken from the external environment, therefore, lessons held in the form of a lecture are not well learned. It is more effective to conduct a lesson in the form of practice because in experiments visual sense (80 %) and somatosensation (3 %) are introduced [16].

According to this, we can prove that mnemonics facilitates the process of teaching students and conducting classes by teachers. Altogether, it will improve the quality of education.

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## Оқыту үрдісінде мнемоникалық техникаларды қолдану

Бүгінгі таңда заманауи технологиялар барша адамзатқа тиімді әрекет етіп, қысқа мерзім ішінде бірнеше жұмыстарды тындыруға мүмкіндік береді. Алайда, ми-бұлшықет жұмысы шынықтыруды қажет етеді. Сол себепті, егер біз күнделікті өмірде технологияларға көп жүгініп, миға еш жүктеу жасамайтын болсақ, уақыт келе оның қабілетінің нашарлауына алып келеміз. Нәтижесінде адамдар есте сақтау қабілетінің әлсіреуімен, ақпаратты қабылдау мен қорытудың қиындауымен беттеседі. Мақалада мнемоникалық технологиялар арқылы адамның есте сақтау, жылдам түсіну қабілетін жақсарту жолдары зерттелген. Мнемониканың ерте заманнан қолданыстағы үдеріс екендігінің дәлелі келтірілген. Сонымен қатар, оқушылардың сабақта продуктивті болуы үшін мнемоникалық технологияның вербальды, кеңістіктік және визуалды сияқты әртүрлі жолдары ұсынылып, әрбір

мнемотехника әдісіне анықтама мен мысал келтірілген. Есте сақтаудың тәсілдерін биология, химия және жалпы сабақ оқу үдерісінде енгізу жолдары қарастырылған.

*Кілт сөздер:* мнемоника, жаңа техника, жады, адамзаттың даму сатылары, сандық амнезия, білім, кеңістіктік мнемоника, визуалды мнемоника, вербальды мнемоника.

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## Использование мнемотехники в процессе обучения

Современная технология позволяет человеку быть эффективным и за короткое время параллельно выполнять несколько задач. Однако мозг — это мышца, и он тоже нуждается в тренировке и небольшой нагрузке, поэтому если мы ежедневно будем полагаться на технологию и никак не будем развивать или же напрягать свой мозг, это приведет к ухудшению способностей мозга, и люди будут в себе замечать такие симптомы, как сложность восприятия и усвоения информации, плохая память. В статье рассмотрены пути улучшения запоминания людей посредством вербальной, визуальной, пространственной мнемонической технологии. Приведены доказательства того, что мнемоника существует с раннего времени и до наших времен остается столь значимой. Широко классифицируется мнемоническая технология при обучении. К каждому методу мнемотехники приведены определения и примеры. Интерпретированы пути внедрения приемов запоминания в учебном процессе биологии, химии и обучения, в целом.

*Ключевые слова:* мнемоника, новая техника, память, этап человеческого развития, цифровая амнезия, образование, вербальная, визуальная и пространственная мнемоническая технология.

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