






Mnemonic Techniques and Formation of Teachers' Ability to Use Them

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Abstract: The article reveals the problem of the expediency of teachers' training to use mnemonics in professional activities. This problem is caused by the intensification of the educational process, when the amount of information accumulated by mankind is many times greater than the amount of knowledge that can be assimilated by a particular person. It has been established that mnemonics should be used in the process of learning mathematics as a way of perceiving new information through the formation of associative connections with the help of special methods and techniques. The expediency of teachers' trainings for use of different mnemonics methods is substantiated. The classification of software used to create mnemovisual models is presented. The training on mastering mnemonic methods of teaching material development has been developed and implemented. The prospects of scientific research through the development of methodological support for the teachers' training to use the techniques of mnemonics in professional activities are outlined.

1 INTRODUCTION


Modern youth is developing in an environment saturated with powerful and intense information flows. The amount of information accumulated by mankind is many times greater than the amount of knowledge that can be acquired by a person. The constant increase in information, combined with high competition and the demands of society, leads to an intensification of the educational process. On the other hand, the intensification of the educational process leads to a number of problems in the mental and somatic health of students. In such conditions, the problem of the educatee's cognitive load appears, which consists in the fact that a person can achieve the optimal level of assimilation of material only if there is an adequate load on the subject's memory.


The success of training depends on the level of development of mnemonic processes that ensure the memorization, preservation, and reproduction of information in the brain obtained during human interac-


tion with the outside world. Therefore, the introduction of effective approaches to memorizing a variety of information can partially solve the problem of cognitive load. As one of such approaches, we consider the use of mnemonics as a way to improve new information by creating associative relationships using special methods and techniques.


The problem of using mnemonics in the educational process is presented in the following findings:


- Scruggs and Mastropieri (Scruggs and Mastropieri, 2000) describe the effects of specific mnemonic (memory-enhancing) strategies in decision problem of memorizing for academic content;
- Yesavage et al. (Yesavage et al., 1990) describe of treatment elderly, which included imagery mnemonics for remembering names, faces, and lists;
- Richter et al. (Richter et al., 2016) consider memory as medical aspect and proposed consider memorizing as mnemonic representation that links present experience with overlapping past experience;
- Miller and Mercer (Miller and Mercer, 1993) provide examples of acronym mnemonics that have

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been used successfully to improve the math performance of students with learning disabilities;

- Nelson et al. (Nelson et al., 2013) describe the effects of a mnemonic strategy on the retention and application of single-digit multiplication facts with students with math difficulties;
- Manalo et al. (Manalo et al., 2000) touch upon influence of mnemonic instruction on the computational skills performance of 13- to 14-year-old students with mathematics learning disabilities;
- Kayaaltı (Kayaaltı, 2018) touch upon to investigate university Saudi students' attitudes towards the mnemonic keyword method;
- Sarıçoban and Başibek (Sarıçoban and Başibek, 2012) make the comparison analysis of the effects of using mnemonic technique providing some keywords to students and context method on the retention of the vocabulary items;
- Falkovskaya et al. (Falkovskaya et al., 2018) touch upon many mnemonic methods, which, based on the positive resources of native speaker development, contribute to the painless memorization and further use of difficult material.

In the above-mentioned findings, it is proved that mnemonic techniques are used to improve the assimilation of complex information that does not have established logical connections between its elements from the point of view of the person who remembers it. Mentioned above findings and other ones confirm that the use of mnemonics improves the volume and accuracy of memorization and development of cognitive processes, increases the duration of storage and the quality of reproduction of acquired information.

Analysis of findings related to the teachers' training to use mnemonics in Ukraine, revealed the fragmentary nature of such scientific research, for example, a special course devoted to mastering the mnemonic techniques by pre-service mathematics teachers was described in (Drushlyak et al., 2021).

Survey of teachers (135 Mathematics, Physics, Computer science, Ukrainian language, Biology, Chemistry, English, History teachers) on their knowledge of mnemonics showed that only half (55.5% of respondents heard about mnemonics, only a third of these (39.3%) use mnemonics at their lessons, and, as a rule, all ideas are borrowed from the Internet (100% of those who use mnemonics) (table 1).

Therefore, regarding the effectiveness of the positive impact of mnemonics on the results of educational activities and lack of teachers' awareness of various subjects in mnemonics, the problem of preparing teachers to use mnemonics in professional activities is relevant.

The Research Purpose. To describe the common mnemonic techniques to support the educational process and justify the effectiveness of training in mastering the mnemonic techniques for service teachers.

2 RESEARCH METHODS

The achievement of the research objective was facilitated by the use of a set of appropriate methods: analysis of scientific literature in order to establish the state of development of the problem being studied, determining the categorical and conceptual apparatus of the study; synthesis, generalization, systematization for the theoretical justification of the appropriateness of training teachers to use the of mnemonic techniques and methods in professional activities; empirical: diagnostic (questionnaire), statistical (the sign test) to assess the appropriateness of using trainings.

The experimental base of the study is the institutions of general secondary education in Kiev, Sumy and Irpin, Makarenko Sumy State Pedagogical University, Borys Grinchenko Kyiv University.

3 RESULTS AND DISCUSSION

The process of memorizing educational material is more intensive provided that subjects are engaged in active thinking, using their operations of comparison, analysis, synthesis, classification, generalization. Use of memos, tables, instructions, visual supports that help students gradually, without overload, to perceive and remember significant objects are effective.

An essential characteristic of the process of memorization is a measure of understanding the memorized material. Therefore, meaningful and mechanical memorization is usually emphasised.

Mechanical memorization is memorization without awareness of the logical connection between the various parts of the material (memorization of historical dates, statistics, etc.). The basis of mechanical memorization is related associations. One part of the material binds to the other only because it follows it in time. To establish such a connection, it is necessary to repeat the studied material several times.

Meaningful memorization is based on an understanding of the internal logical connections between the individual parts of the material. Two positions, one of which is derived from the other, are remembered not because they follow each other in time, but because they are logically connected. Therefore, meaningful memorization is associated with thinking

Table 1: The results of a survey of teachers on the use of mnemonics in professional activities.

No	Question	Answer	Mathematics teachers	Physics teachers	Computer science teachers	Ukrainian language teachers	Biology teachers	Chemistry teachers	English teachers	History teachers	Total
			22	15	23	12	15	13	18	17	135
1	Do you know the mnemonics techniques?	Yes/ No	17/ 5	6/ 9	13/ 10	7/ 5	7/ 8	6/ 7	10/8	9/ 8	75/ 60
2	Do you use mnemonics at your lessons?	Yes/ No	14/8	5/10	10/13	4/ 8	4/11	5/ 8	5/ 13	6/11	53/82
3	Do you think it is appropriate to use the mnemonics techniques in the educational process?	Yes/ No	17/ 5	6/ 9	13/10	4/ 8	4/11	5/8	5/13	6/ 11	60/ 75
4	What mnemonic techniques did you use at your lessons?	1. Visualization 2. Color Accent 3. Comedian 4. Storytelling 5. Analogy 6. Fiction 7. Rhyming 8. Hyperbole 9. Interpretation	1, 2, 5	1, 2, 4, 5	1, 2, 5, 8, 9	1, 2, 7	1, 2, 5	1, 2, 5	1, 2, 5, 7, 9	1, 2, 4, 6	1, 2, 4, 5, 6, 7, 8, 9
5	Where do you get ideas for mnemonics?	A. Author's B. Internet C. Colleagues' D. Advanced training	B, C, D	B	B	B, C	B	B	B, C	B	B, C, D

processes and relies mainly on generalized relationships between parts of the material at the level of the second signaling system.

It is worth paying attention to the meaningful memorization of the material studied. To do this, it is necessary to divide its semantic group into parts with the separation of the main and essential in each of its parts. In addition, it is necessary to find and highlight semantic support points in each part, that is, thoughts, expressions and images that define the essence of this part and the oral or written formulations of this essence in the form of short headings for each part. Finally, it is necessary to establish links between the selected parts and understand the logical sequence of their location, to draw up a general plan for the location of educational material.

In order to meaningful memorize educational material, mnemonic methods and techniques are determined (figure 1).

The work of Chepurnoy and Bura (Chepurnoy and Bura, 2015) on educational mnemonics as a technology of effective assimilation of information became a reference point for us.

Link Method is a method of combining information units by creating associative links between them.

The method consists of the following techniques: *Storytelling technique* (using stories), *Rhyming technique* (using music, rhyme, chants, poems, songs, counting out rhymes, etc.), *Sequential Associations technique* (sequential associative connections are created), *Bonding technique* (combining information units into a single holistic image with preservation of the main features and functions), *Synthesis technique* (information units are combined into a single integrated image with a common associative connection), *Key Letters technique* (an associative connection is created between the first letters of words, you need to remember, and the first letters of words of a

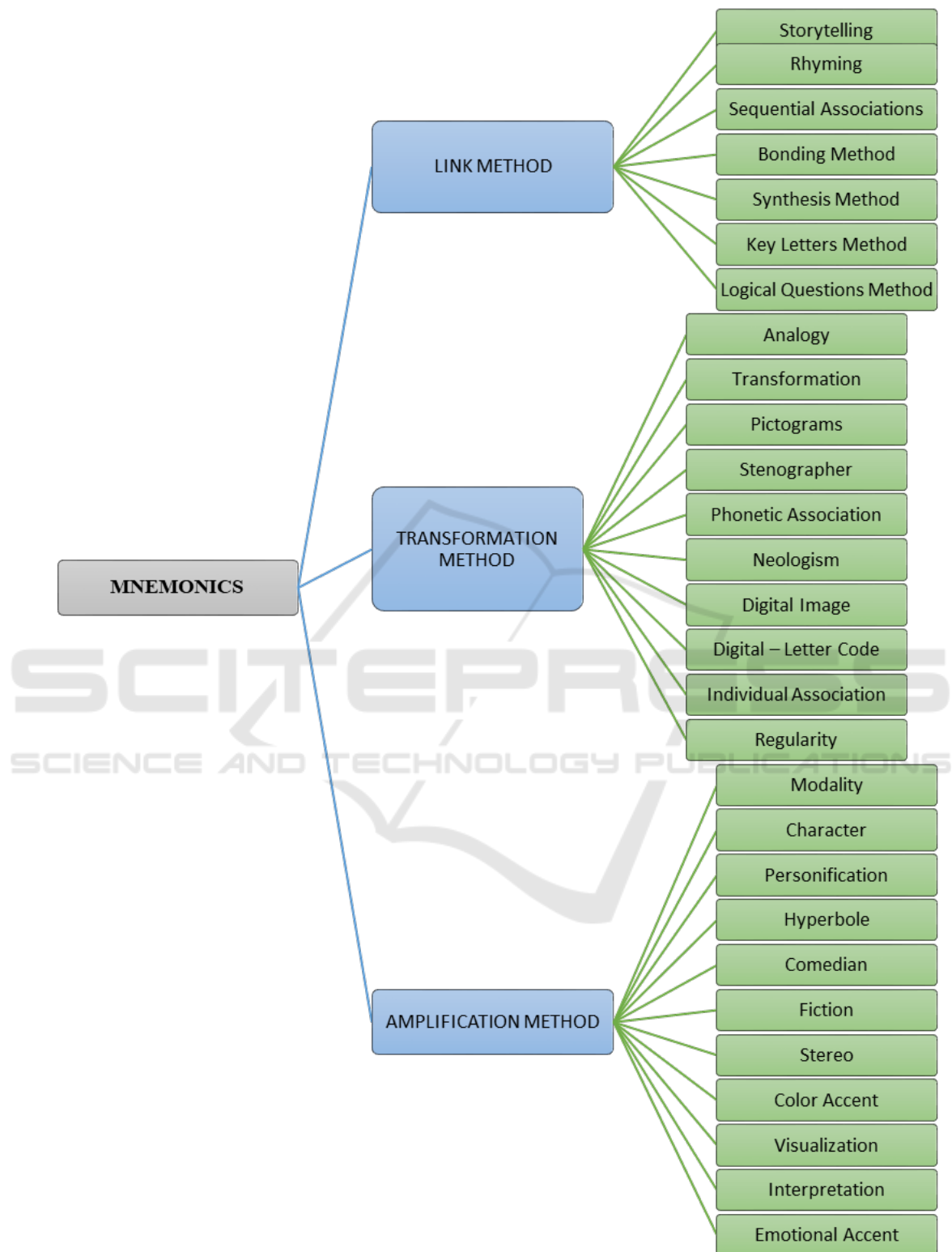


Figure 1: Mnemonic methods and techniques.

specially created sentence), *Logical Questions technique* (an additional logical associative connection is created between images remembered through answers to the main questions – What? How? Why? etc. about the relationship between them).

Key Letters Technique (Mathematics). In the study of the topic “Disclosure of brackets. Similar terms and their construction” it is worthwhile to draw the attention of students to the sign that appears before the brackets. If there is a *minus*, then we change all signs to the opposite, if *plus*, then leave the expression unchanged, for example:

- – (a + b) – “**M**inus” – **M**iniaiemu znaky (in Ukrainian), **M**inus – **C**hange the signs; in Ukrainian, the words minus and change begin with the letter **m**;
- + (a + b) – “**P**lus” – **P**erepysujemo bez zmin (in Ukrainian), **P**lus – **R**ewrite without changes; in Ukrainian, the words plus and rewrite begin with the letter **p**.

Key Letters Technique (English). Memorizing the spelling rules of some words.

Teacher – There is an **ache** in every **teacher**.

Measurement – Be **sure** of your **measurements** before you start work.

Principal – Your **principal** is your **pal**.

Necessary – **N**ever **E**at **C**risps, **E**at **S**alad **S**andwiches, **A**nd **R**emain **Y**oung!

Transformation Method is a method of primary processing of information, which turns information that is difficult to perceive into convenient for efficient reproduction.

The method consists of the following techniques: *Analogy* (between the informational units of the memorable find common signs, properties, qualities, development trends, etc.), *Transformation* (the objects of the memorable are transformed into others in value and in order to facilitate memorization), *Pictograms* (abstract or such information must be remembered, schematically depicted by simplified drawings, pictograms), *Stenographer* (text information that is memorized is recorded using separate key letters, special characters and a number of abbreviations), *Phonetic Association* (a consonant word or part of it is selected to memorize an unfamiliar word, which associatively associated with the meaning of the original word), *Neologism* (to improve the memorization of information (words, letters, symbols) new words, terms, concepts, phrases are created) (figure 2), *Digital Image* (digital information when memorizing is associated with certain images or systems about times), *Digital-Letter Code* digits of numbers in letters to compose specially selected

words for the purpose of their further memorization), *Individual Association* (for information that is memorable, associative connections are found with individually known data, events, information), *Regularity* (for remembering information, certain logical, mathematical or other regular relationships are found and rules).

The *Amplification method* is a method of increasing the efficiency of perception, preservation and reproduction of created associative connections and images formed by the methods of transformation and binding.

The method consists of the following techniques: *Modality, Character, Personification, Hyperbole, Comedian, Fiction, Stereo, Color Accent, Visualization, Interpretation, Emotional Accent*. Examples of the use of some techniques are shown in figures 3, 4.

To confirm the appropriateness of mastering the mnemonic techniques, pedagogical survey was conducted. During March-May 2019, we conducted a survey of 32 service mathematics teachers in Kiev, Sumy, Dnipro and Irpin on the expediency of using mnemonic techniques in professional activities. In May 2021, we conducted a similar survey of 135 teachers, but in different subjects (Mathematics, Physics, Computer science, Ukrainian language, Biology, Chemistry, English, History). The data were integrated and analyzed. In particular, we found that 87% of teachers (Mathematics teachers in 2019) and 44.4% of teachers of various subjects (in 2021) said about the expediency of using mnemonic techniques, of which 77.2% of mathematics teachers were in favour of using mnemonic techniques.

Among the techniques Visualization, Color accent, Analogy, Storytelling, Rhyming and Interpretation are in favour. The figure 5 summarizes the results of the 2019 and 2021 surveys.

Based on the teachers' opinion that Visualization and Color Accent are the most effective techniques, which contribute to the meaningful memorization of educational material. We can paid attention to the software for creating visual models:

- 1) Office software products with Smart objects;
- 2) Mind Mapping software;
- 3) services for creating whiteboard animation (scribing) presentations;
- 4) software for creating infographics.

Let's describe these groups. The office software package (MS Word, MS Excel, MS Power Point) is offered with the function of constructing Smart objects that allow you to efficiently create mnemovisual models in the form of a list, connection, matrix, process, cycle, hierarchy, pyramid (figure 6).

Order of Operations Mnemonics
Please Excuse My Dear Aunt Sally

Par en thesis	()	
Ex po nants	5^2	
M u ltiplication	} Use whichever one comes first	}
D i vision		
A dd ition	} Use whichever one comes first	}
S ub traction		

$$\mathbf{X} \div + -$$

(a)

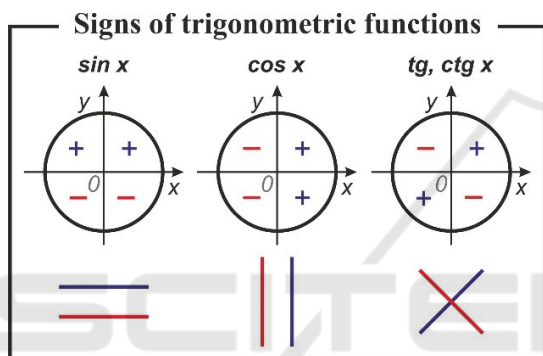
Parts of speech

PAVPANIC {

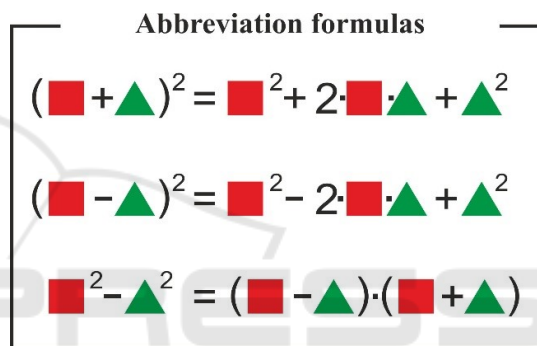
- P** - noun
- A** - adjective
- V** - verb
- P** - preposition
- A** - adverb
- N** - noun
- I** - interjection
- C** - conjunction

(b)

Figure 2: Neologism technique.



(a) "Signs of trigonometric functions".



(b) "Abbreviation formulas".

Figure 3: Color accent technique.

Mindmapping is a technology that allows you to efficiently restore information (past), generate and capture New Ideas (future), draw conclusions and establish connections between them by building mind maps. Mind maps is the development of Tony Buzan – a British psychologist who began developing the concept of smart cards back in the 1970s (Buzan, 2022). Interesting Ideas and technologies for creating smart cards in the process of teaching mathematics are presented in the works of modern scientists: Choo et al. (Choo et al., 2014), Solmi (Solmi, 2016).

To build mind map software X-Mind, Free-Mind, Coggle, Mind-Meister are used. Such software help to fix ideas, organize them into various diagrams, use these diagrams together with other users. The mentioned software allow you to build mind maps (figure 7, 8), Ishikawa diagrams (fishbone diagrams or cause-effect diagrams), tree diagrams, logic diagrams, tables.

The main areas of application of mind maps in the professional activities of teachers include: creating lesson plans of any type; planning educational activ-

ities; algorithms for solving problems; study of new educational material; consolidation and verification of the studied material; systematization and repetition of the studied material in preparation for the state final certification, external independent evaluation.

Scribing technique is used to activate the cognitive and mnemonic activity of educatees, to visualize the educational process. Scribing is a mnemonic technology for the visualization of educational material, which provides the display of key moments of its content (properties of the learning object, its internal and external connections) by using simple graphic elements (drawings, pictograms, symbols, words, circuits, diagrams) sequentially created on the screen in according to the oral presentation (or audio).

The appearance of whiteboard animation (video scribing) is associated with the Andrew Park, who popularized this technology (We are Cognitive, 2023). Sarkar (Sarkar, 2009) notes that this way of presenting information has become more productive for explaining to the audience, because it uses the parallel effect when the audience simultaneously hears

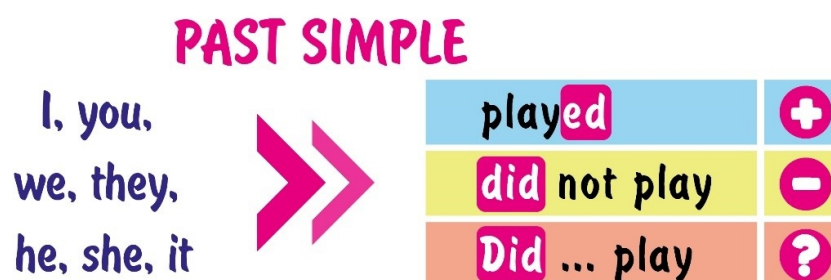


Figure 4: Color accent technique "Past Simple".

The use of mnemonic techniques by teachers

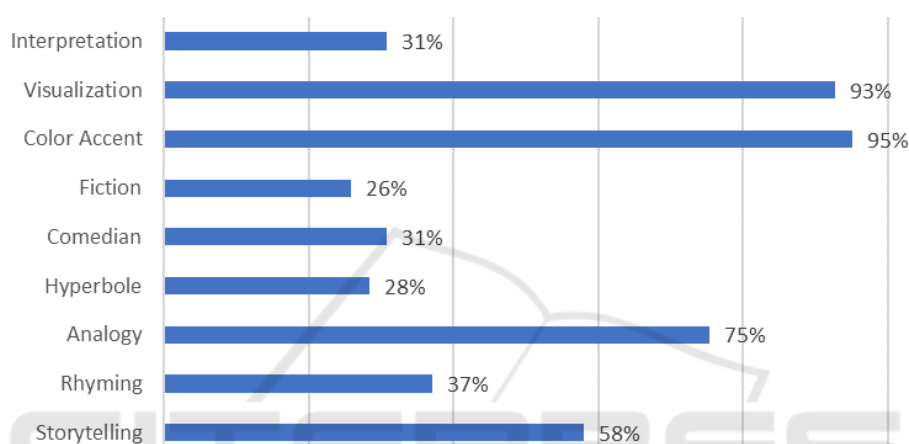


Figure 5: The use of mnemonic techniques by teachers according to the results of surveys in 2019 and 2021 (%).

and sees about the same thing, while the graphic series is fixed on key moments of the audio sequence.

Among a large number of services there are several useful for creating video scribing presentations such as: Sparcol Video Scribe (<https://www.sparkol.com/en/>, figure 9, 10), Powtoon (<https://www.powtoon.com/>), Vyond Studio (<https://www.vyond.com/>), Plotagon Story (<https://www.plotagon.com/>).

Infographics is the technology of the presentation of educational material in the form of statistical graphs, maps, charts, diagrams, tables that "explain". Educational visibility is used not only for illustration, but also as an independent source of knowledge (figure 11). Services for creating infographics are Infogram, Easel.ly, Parchment, Venngage and more.

Starting in 2020, we have launched trainings for teachers on mastering the mnemonic techniques (3 hours) (table 2). Teachers of various subjects were invited to the trainings. The total number of teachers involved in the training was 135 persons. The training is based on training for students, pre-service mathematics teachers (Drushlyak et al., 2021).

We investigated the impact of training on the development of teachers' skills of various subjects to

create and use mnemonic didactic materials.

To determine the level of awareness of teachers in mnemonics, a survey was conducted (135 respondents). 39% (53 people) of teachers confirmed, but fragmentary, the use of mnemonics in their own lessons. Among the positive aspects of the use of mnemonic techniques, teachers noted the revival of the learning process (39%, 53 people) for students and the development of creative thinking for teachers (33%, 45 people). According to them, the lack of time to search for or develop mnemonic didactic materials (30%, 41 people) and the lack of developed mnemonic didactic materials for each topic (33%, 53 people) are negative in the use of mnemonic techniques.

4 STATISTICAL ANALYSIS OF RESULTS

At the beginning of each training, teachers were assessed for their ability to reproduce any of the mnemonic techniques using digital technology (office package and online services was allowed to create

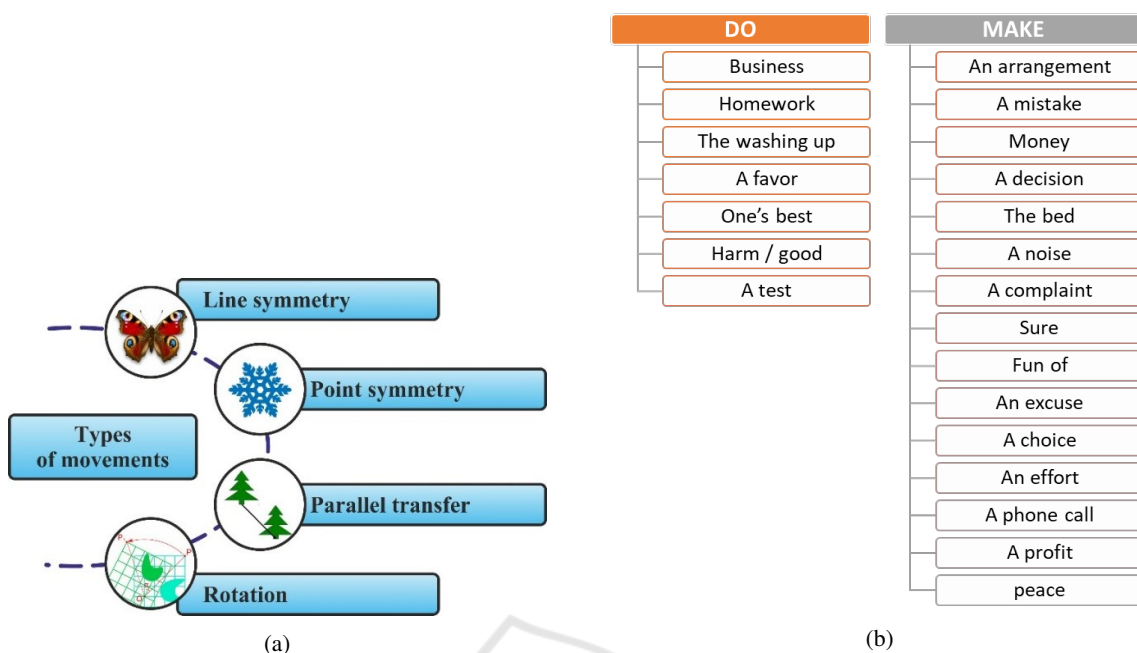


Figure 6: Mnemovisual models created using Smart objects.

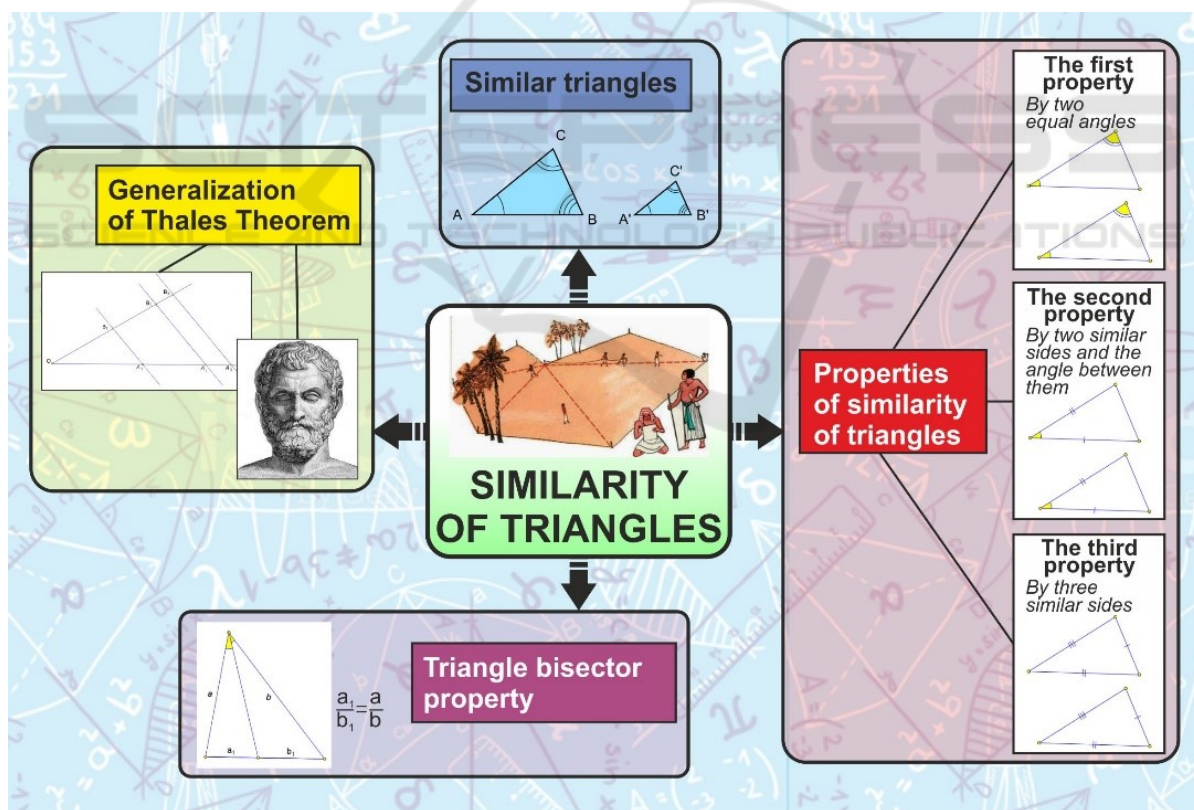


Figure 7: Mind Map "Similar triangles".

images). The evaluation criteria were: comprehensibility of reception (1 point), rational choice of dig-

ital technology (1 point), quality of visual content (1 point), determining the didactic purpose of the created

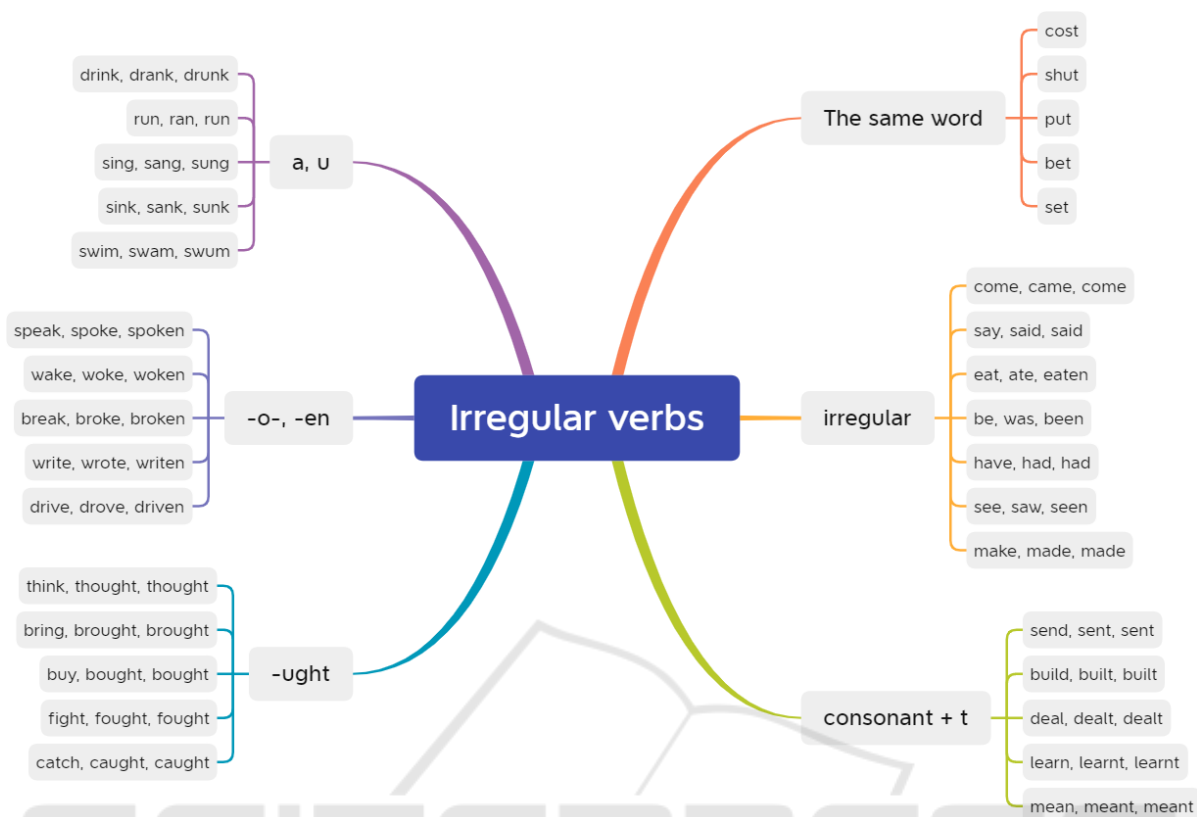


Figure 8: Mind Map "Irregular Verbs".

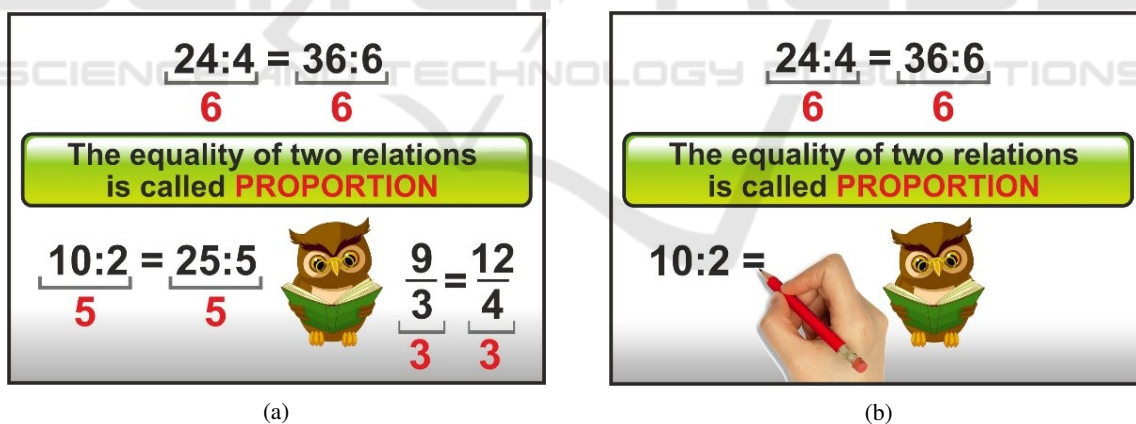


Figure 9: Video scribe "Proportion".

mnemonic means (1 point).

After the training, teacher evaluation was conducted again (a similar task with the same evaluation criteria was used).

Some of the works of teachers are presented in figures 7, 10, 11.

According to the results of data processing, the positive impact of training on the development of teachers' skills in various subjects to create and use mnemonic didactic materials was confirmed.

Statistical analysis of the results was performed on the basis of non-parametric sign test for dependent samples. We compiled comparative tables, which recorded the dynamics of results for each of the trainings (2020 – 2 trainings, 2021 – 2 trainings). Each time the results were collected on samples of 32, 35, 37, 31, respectively. 30 pairs of results taken at random from the total set of results were studied (table 3).

These points (table 4) determined the number of

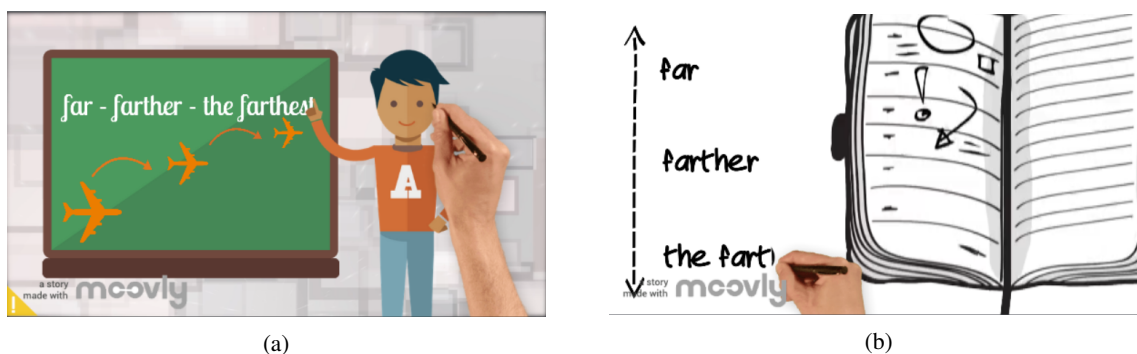
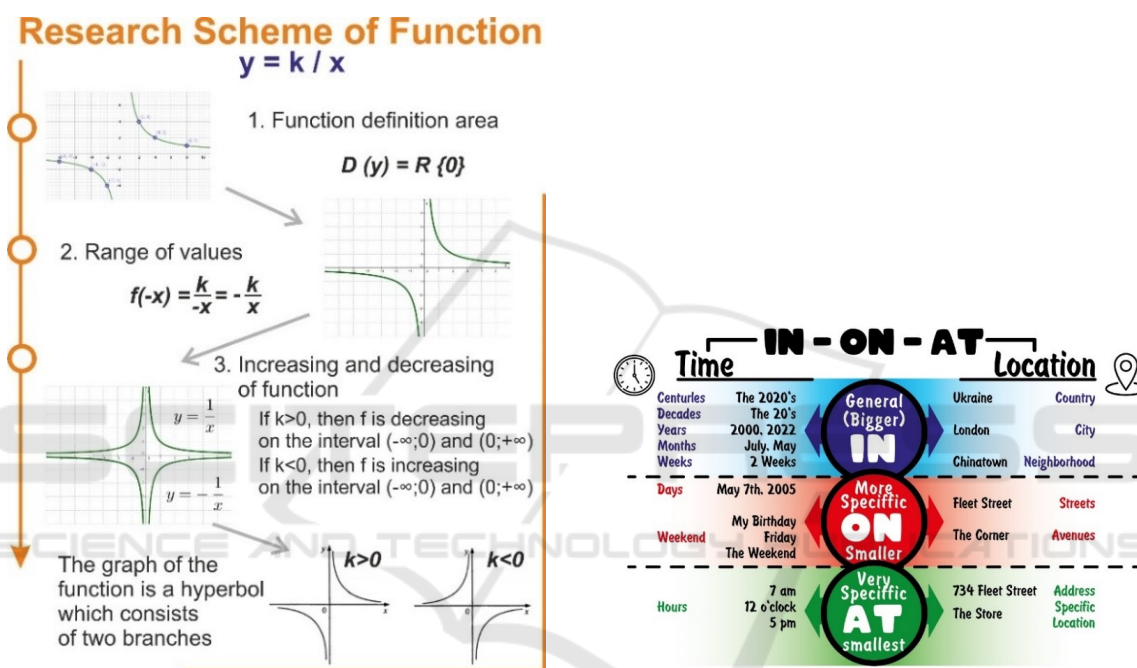


Figure 10: Video scribe “Degrees of adverb comparison”.



(a) “Function Research”.

(b) “Prepositions of Time and Location”.

Figure 11: Infographics.

respondents whose total score decreased (“-”), did not change (“0”) and increased (“+”).

In accordance with the objectives of the experiment, a null hypothesis was formulated: the organization of training does not promote the development of skills of teachers of different subjects to create and use mnemonic didactic materials. Then an alternative hypothesis: the organization of training promotes the development of such skills.

The constructed hypotheses defined a one-sided sign test for testing dependent samples. According to the decision-making rule (Grabar and Krasnjanskaja, 1977) we have: value $T_{exp} = 16$ (number of “+” in the sample), $n = 20$ (number of respondents, which have changes in results), acceptance interval of null hypothesis: [6, 14] at the significance level 0.05.

Since T_{exp} is not included in the acceptance interval of hypothesis H_0 , we reject the null hypothesis and accept the alternative one, concluding that the training promotes the development of teachers’ skills of different subjects to create and use mnemonic didactic materials. Since the value of T_{exp} went beyond the interval on the right, we concluded that the positive dynamics of the number of teachers who have developed the ability to create and use mnemonic didactic materials.

Additionally, we studied the ability to create authorial examples of mnemonic techniques and the ability to reproduce them in digital form. It should be noted that natural sciences and mathematics teachers, as a rule, had no problems with the technical implementation of the plan in contrast to humanities teach-

Table 2: Detailing the content of the training on the development of mnemonic techniques.

The number of hours	Contents	Training methods	Learning tools	Expected learning outcomes
0,25	Memory. Mechanical and meaningful memorization	Verbal methods (story, conversation)	Presentation	An idea of the mechanisms of human memory, knowledge of the types of memorization of educational information; development of teacher professional competence
0,75	Educational mnemonics as a technology for the effective assimilation of information. Mnemonics and their corresponding mnemonic techniques	Verbal methods (story, conversation), visual methods (demonstration, display), Interactive methods (brainstorming)	Presentation	Knowledge of the methods and techniques of mnemonics: Link Method (techniques: Sequential Associations, Key Letters Method), Transformation Method (Analogy technique), Amplification method (techniques: modality, character, personification, hyperbole, comedian, fiction, stereo, color accent, visualization, interpretation, emotional accent); development of teacher professional competence
0,5	Specialized software for supporting mnemonic techniques	Visual methods (demonstration, display)	Presentation, Specialized software: 1) office software products with Smart-objects; 2) mind mapping programs; 3) services for creating scribing presentations; 4) programs for creating infographics	The concept of specialized software groups for supporting mnemonic techniques, knowledge of specialized software (including freeware) and its computer tools for supporting mnemonic techniques; development of teacher professional competence
1,5	Development of copyright materials for mnemonic support	Interactive methods (brainstorming, case-method)	MS Power Point, X-Mind, Free-Mind, Powtoon Easel.ly	Knowledge of specialized software examples, knowledge of software tools (MS Power Point, X-Mind, Free-Mind, Powtoon, Easel.ly), the ability to use specialized software tools to accompany mnemonic techniques; ability to analyze created products; development of teacher professional competence

ers, who rather presented ideas of mnemonic techniques, but spent more time implementing the technical part of creating mnemonic didactic materials.

5 CONCLUSIONS

In the process of analyzing the scientific literature, it was found that the level of development of mnemonic processes that ensure the memorization, storage and

reproduction of information in the brain, depends on the success of learning. In order to introduce effective ways to memorize a variety of information, mnemonics is considered as a way of perceiving new information through the formation of associative connections using special methods and techniques.

The method of "Binding" consists of techniques: Storytelling, Rhyme, Sequential Associations, Gluing, Synthesis, Key Letters, Logical Questions. The method of "Transformation" consists of techniques:

Table 3: Results of evaluation of respondents.

Respondent	The first assessment	The second assessment	Respondent	The first assessment	The second assessment	Respondent	The first assessment	The second assessment
1	2	4	11	3	4	21	2	3
2	4	4	12	2	3	22	1	4
3	3	3	13	2	2	23	4	5
4	3	3	14	3	2	24	1	3
5	3	3	15	3	3	25	1	2
6	1	2	16	3	3	26	4	5
7	2	3	17	3	3	27	3	4
8	2	2	18	4	5	28	3	2
9	4	3	19	2	3	29	3	4
10	3	3	20	3	4	30	3	2

Table 4: Comparison results.

Dynamics of points	Number of respondents
Negative, "–"	4
Without changes, "0"	10
Positive, "+"	16
Number of changes, $n = "–" + "+"$	20

Analogy, Transformation, Icons, Stenographer, Phonetic Association, Neologism, Digital Image, Alphanumeric Code, Individual Association, Regularity. The method of "Amplification" consists of techniques: Modality, Sign, Personification, Hyperbole, Comedian, Fable, Stereo, Color Accent, Visualization, Interpretation, Emotional Accent.

As a result of the teacher's survey, a positive attitude to the use of mnemonics was revealed, the most popular of mnemonic techniques were Visualization, Color Accent, Analogy, Storytelling, Rhyme and Interpretation.

The classification of software used to create mnemonic didactic materials is given: a package of office software with Smart-objects; mind mapping software; services for creating video scribing presentations; software for creating infographics.

The training on mastering mnemonic methods of presenting educational material was developed. According to the results of the training, its positive influence on the development of skills to create and use mnemonic didactic materials by teachers of various subjects was confirmed. At the same time, it was noted that natural sciences and mathematics teachers had no problems with the technical implementation

of the plan in contrast to humanities teachers, who rather presented ideas of mnemonic techniques, but spent more time implementing the technical part of creating mnemonic didactic materials.

The effectiveness of the training was confirmed by the sign test.

Prospects for further research are seen in the developed methodological support for the training of pre-service teachers to use the techniques of mnemonics in professional activities.

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