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# Data Visualization and Memory

**Usmonova Odinakhon Sobirovna**

Teacher of the Department of Methodology of Primary Education, Fergana State University, Doctor of Philosophy (PhD) in Pedagogical Sciences, Uzbekistan

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**ABSTRACT**

This article analyzes the impact of data visualization on human memory, its psychological and didactic foundations, as well as the mechanisms of its application in the educational process. The processes of receiving, processing, and storing information in long-term memory through visual images are explained on the basis of scientific theories. Furthermore, effective ways of using visualization technologies in primary education are presented.

**Keywords:** Visualization, memory, cognitive processes, dual coding, mnemonics, primary education, information processing.

## INTRODUCTION

Education in the 21st century is characterized by a sharp increase in the flow of information. The need for students to master a large volume of information in a short period requires new approaches in teaching methodology. From this perspective, data visualization technology is recognized as an effective tool for strengthening memory and retaining knowledge for a long time. Psychological research shows that the human brain perceives visual information faster and remembers it more effectively than textual information. Especially in primary school students, since figurative thinking predominates, information presented through visual materials is assimilated more firmly.

### Psychological Foundations of Visualization

Dual Coding Theory: According to the dual coding theory developed by Canadian psychologist Allan Paivio [8], the human brain processes information through two independent but interconnected systems – verbal (word-based) and nonverbal (imagery-based) channels. If information is presented simultaneously in text and image form, it is encoded twice, which increases the likelihood of its retention in memory. This theory provides the scientific basis for the use of pictures, diagrams, schemes, and infographics in the educational process.

Cognitive Load Theory: According to the cognitive load theory proposed by Australian scholar John Sweller [10], the capacity of working memory is limited. Complex and disorganized information overloads working memory. Visualization simplifies information, structures it, and reduces excessive cognitive load.

### Information Processing Model

In cognitive psychology, memory is considered in three stages:

1. Sensory memory
2. Short-term (working) memory
3. Long-term memory

Visual images leave a stronger trace in sensory memory and accelerate the transition from short-term memory to long-term memory.

The relationship between data visualization and memory has been widely studied in cognitive psychology and pedagogy. Research conducted in this field scientifically substantiates the effectiveness of visual information in the educational process. The classical model of memory proposed by Richard Atkinson and Richard Shiffrin divides memory into sensory, short-term, and long-term stages [1]. This model explains that visual information is initially recorded in sensory memory and later transferred to long-term memory through processing. One of the important concepts that theoretically substantiates the effectiveness of visualization is the dual coding theory developed by Allan Paivio. Paivio [8] emphasizes that the human brain processes information through verbal and nonverbal (imagery-based) channels. Research results have shown that imagery-based encoding has a higher retention rate than verbal encoding. Furthermore, the cognitive load theory developed by John Sweller substantiates that working memory has limited capacity. According to the author, visual tools optimize the learning process by structuring information and reducing excessive cognitive load. The author of multimedia learning theory, Richard E. Mayer [5], experimentally proved that the combination of text and images significantly increases learning effectiveness. Mayer and Moreno [6] recommended nine strategies to reduce cognitive load when designing multimedia materials. Issues related to memory structure and working memory model were extensively studied by Alan Baddeley [2]. His concept of the "episodic buffer" explains the mechanism of integrated processing of visual and verbal information.

In national pedagogy, the issue of visualization and pedagogical technologies also occupies an important place. In particular, R. Ishmuhamedov and A. Abduqodirov [4] emphasize that the use of innovative technologies in education develops students' independent thinking. The authors show that integrating visual tools with interactive methods yields effective results. O. Tolipov and M. Usmonboyeva [11] scientifically substantiated that systematic application of pedagogical technologies increases the effectiveness of the educational process. They highlight methodological aspects of using graphic organizers and schematic models in primary education. N. Muslimov [7] analyzed the significance of visual presentation tools in education quality and competency-based approaches from the perspective of professional pedagogy. B. Qodirov [9] substantiated the dominant role of figurative thinking in the process of intellectual development of personality, which explains the effectiveness of visual methods in primary school students. M. Davletshin [3] analyzed the interrelation of memory processes, attention, and thinking within general psychology and explained the psychological foundations of the principle of visuality.

**The Relationship Between Visualization and Memory**

Superiority of figurative memory: In primary school age children, figurative memory is more developed than logical memory. Colored images, animations, tables, and graphs attract students' attention and strengthen knowledge retention.

Mnemonic effect: Mnemonic techniques (mnemonic tables, associative images, symbol systems) facilitate memorization through visual encoding. For example, presenting historical dates in the form of a timeline helps memorize them more quickly.

Emotional impact: Visual materials enhance the emotional component. Emotionally rich information is retained more firmly in long-term memory.

**Didactic Possibilities of Visualization in the Educational Process**

Application in Primary Grades. Considering that research is being conducted in the field of primary education, the following tools are effective for younger students:mnemonic tables, mind maps, diagrams and clusters, colored cards, animated slides:

In Mathematics: For example, using circle diagrams or colored segments when explaining fractions facilitates students' understanding. Relating geometric shapes to real objects strengthens memory retention.

In Mother Tongue and Reading Lessons: Retelling the content of a text based on a scheme or image develops both logical and figurative memory simultaneously.

**Types of Visualization Tools**

1. Static visualization (tables, diagrams, schemes)

2. Dynamic visualization (animation, video)

3. Interactive visualization (digital platforms, presentations)

4. Graphic organizers (Venn diagram, conceptual map)

The advantage of visualization is that students assimilate information faster, activate attention, strengthen long-term memory, deepen understanding, and develop analytical thinking.

## CONCLUSION

In conclusion, data visualization is a powerful pedagogical tool that activates memory processes. Psychological theories – dual coding and cognitive load theories – scientifically substantiate the effectiveness of visual materials. Systematic use of visualization technologies in primary education contributes to faster knowledge acquisition, long-term retention, and the development of independent thinking. Therefore, integrating visual approaches into modern teaching methodology is one of the urgent issues.

## REFERENCES


1. Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. Psychology of Learning and Motivation, 2, 89–195.
2. Baddeley, A. (2000). The episodic buffer: A new component of working memory? Trends in Cognitive Sciences, 4(11), 417–423.
3. Davletshin, M. G. (2008). Umumiy psixologiya. Toshkent: TDPU.
4. Ishmuhamedov, R., & Abduqodirov, A. (2014). Ta'limda innovatsion texnologiyalar. Toshkent: Fan va texnologiya.
5. Mayer, R. E. (2009). Multimedia learning (2nd ed.). Cambridge University Press.
6. Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. Educational Psychologist, 38(1), 43–52.
7. Muslimov, N. A. (2015). Kasbiy ta'lim pedagogikasi. Toshkent: Noshir.
8. Paivio, A. (1986). Mental representations: A dual coding approach. Oxford University Press.
9. Qodirov, B. R. (2002). Shaxsning intellektual rivojlanishi. Toshkent: O'qituvchi.
10. Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12, 257–285.
11. Tolipov, O'., & Usmonboyeva, M. (2012). Pedagogik texnologiyalar va pedagogik mahorat. Toshkent: Iqtisod-Moliya.