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THE ROLE OF VISUALIZATION OF EDUCATIONAL MATERIAL IN TEACHING STUDENTS WITH DIFFERENT TYPES OF COGNITIVE STYLE

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Abstract: The article examines the role of visualization of educational material in teaching students with different types of cognitive style. The aim of the study is to identify how the use of visualization, including diagrams, diagrams and infographics, affects the learning outcomes of students with a predominance of visual-spatial, verbal-logical and mixed cognitive style.

As part of the work, a training experiment was implemented in which two formats of presenting theoretical material were compared: traditional text and text with advanced visual support. Analysis of the data obtained shows that visualization helps to improve the academic performance of all groups of students, however, the most pronounced increase in results is observed among students with a visual-spatial style, somewhat less among students with a mixed style and relatively moderate among students with a verbal—logical style.

The article discusses the pedagogical implications of the identified patterns, the need for a differentiated approach to designing educational materials, taking into account the cognitive characteristics of students, as well as the limitations of research and the direction of further scientific research.

Keywords: visualization of educational material, cognitive style, students, visibility, digital educational technologies, individualization of learning

INTRODUCTION

The current stage of higher education development is characterized by the active introduction of digital technologies
and a gradual transition from a predominantly text-centric learning model to a multimodal presentation of educational information. Electronic courses, presentations, and interactive platforms increasingly use diagrams, logical and semantic models, diagrams, infographics, and other forms of visualization designed to facilitate understanding of complex concepts, systematize the material, and make the learning process more visual and accessible [4, 10].

However, the expansion of visualization practice is not always accompanied by a thorough consideration of the individual cognitive characteristics of students. At the practical level, visual aids are often perceived as a universally useful component that "by default" increases the effectiveness of learning. Meanwhile, psychological and pedagogical research emphasizes the significant role of cognitive style as a relatively stable individual characteristic that

The cognitive style associated with the dominance of visual-spatial or verbal-logical strategies influences which formats of presentation of educational material turn out to be the most comfortable and productive for the student. A student who is focused on a figurative, visual representation is inclined to rely on diagrams, drawings, spatial models. A student with a pronounced verbal-logical style prefers a detailed text, terminologically precise definitions and consistent logical reasoning. There is also a wide range of students with a mixed style who use both visual and verbal strategies quite flexibly [3].

Thus, the relevance of the study is determined by the contradiction between the intensive development of visualization tools in the educational process and the lack of understanding of how visualization affects the learning outcomes of students with different types of cognitive style. In the absence of reliance on empirical data, the teacher risks using visual means either formally or excessively, which can lead to both an overload of perception and a decrease in the quality of assimilation of the content.

In this paper, an attempt is made to experimentally evaluate the role of visualization of educational material in teaching students with different cognitive styles. The object of the study is the process of teaching students at the university, and the subject is the influence of the use of visualization of educational material on the results of the assimilation of theoretical material by students with different types of cognitive style. It is assumed that visualization generally increases the level of academic achievement, but the severity of this effect varies in groups of students with visual, verbal-logical and mixed styles. Of particular interest is the question of whether thoughtful visualization can perform a leveling function and reduce differences in academic performance due to cognitive characteristics.

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MATERIALS AND METHODS OF RESEARCH.

The methodological basis of the research is based on the provisions of cognitive psychology and educational psychology on the role of cognitive style in the educational process, as well as modern approaches to multimodal learning and cognitive load theory. The methods of psychodiagnostics, pedagogical experiment and quantitative and qualitative analysis of the results were used in the work.

A questionnaire aimed at identifying preferences when working with educational information was used to diagnose cognitive style. The questions allowed us to assess the extent to which students are guided by verbal and textual description, graphic and imaginative representations, as well as the combined use of both types of representation. According to the total indicators of those responding on the appropriate scales, groups with a predominance of visual-spatial, verbal-logical and mixed style were distinguished.

A training experiment was chosen as the main method of empirical research. Students were offered to study a fragment of the training course, including theoretical provisions, classifications and descriptions of processes. In the experimental version, this fragment was accompanied by purposefully constructed visual means. In the traditional version, the material was presented mainly in the form of solid text with minimal formatting.

After studying the material, testing was conducted, which included answer selection tasks, as well as open-ended questions to reproduce key concepts and explain the relationships between them. The maximum score for the test was 100. In addition, subjective assessments of the clarity and structure of the material, as well as subjectively perceived cognitive load, were recorded, but this article focuses on the analysis of quantitative test results.

Descriptive statistics methods were used to process the data. The average values and standard deviations of the indicators were calculated in groups with different cognitive styles and presentation formats.

Next, the results were compared and interpreted from the perspective of the stated issues.

RESULTS AND DISCUSSION

The study involved second-year undergraduate students in the humanities between the ages of nineteen and twenty-one. A total of sixty people participated in the study. Based on the results of the cognitive style questionnaire, all participants were divided into three equal groups. The first group included students with a predominance of visual-spatial style, the second — with a verbal-logical style, and the third — with a mixed cognitive profile.

Within each style group, the students were randomly divided into two subgroups. One subgroup worked with traditional text, the other with text supplemented with visualization in the form of diagrams, diagrams and logical—semantic models. Thus, there were ten people in each combination of the factors "type of cognitive style" and "presentation format".

General information about the sample is presented in table 1.

Table 1 – General characteristics of the sample

Indicator	Visual (n=20)	Verbal (n=20)	Mixed (n=20)	Total (N=60)
Average age (years)	19,8	20,1	19,9	19,9
Percentage of women (%)	60	65	55	60
Average score per session (on a 5-point scale)	4,1	4,0	4,2	4,1

The data in Table 1 indicate that groups of students with different cognitive styles are comparable in age, academic performance, and gender and age composition. This allows us to consider cognitive style as one of the main factors contributing to differences in subsequent results.

The experiment used a fragment of a training course related to psychological and pedagogical issues, including theoretical concepts, classifications and descriptions of mental processes. In the traditional version, the material was a coherent text with basic terms and definitions, divided into logical paragraphs and subheadings, without additional graphical tools.

In the visualized version, diagrams reflecting the structure of the phenomena under consideration, diagrams demonstrating the ratio of individual parameters, as well as comparison tables were added to the text, allowing compact representation of various approaches and classifications. The key concepts in the text were highlighted by means of formatting and color accents, enhancing the perception of semantic supports. At the same time, the volume and content of the text in the two versions were identical, the differences dwelt upon the form of the presentation [9].

The students got acquainted with the material in a ninety-minute classroom session. After completing their work with the text, they completed a test that included twenty tasks. Some of the tasks involved choosing the correct

answer from several suggested options, while others involved a brief written explanation of the concepts and the connections between them. The points received were converted to a scale from zero to one hundred.
The average values of the test scores by group are shown in Table 2.

Table 2 – Average test scores on a topic, depending on the cognitive style and presentation format of the material

Type of cognitive style	The format of the material	n	Average score (0–100)	SD
Visual	Traditional text	10	72	8
Visual	With visualization	10	84	7
Verbal	Traditional text	10	78	7
Verbal	With visualization	10	82	8
Mixed	Traditional text	10	75	6
Mixed	With visualization	10	83	7

Based on the data presented in Table 2, it can be concluded that the visualization of educational material has a positive effect on test results in all style groups. In each of them, the average score when working with the visualized text is higher than when studying the material in the traditional form.

The difference is especially noticeable in the group of students with visual-spatial style, where the average increase is twelve points. Students with a mixed style also have significant gains, while students with a verbal-logical style have less pronounced gains, but maintain a positive direction. These data confirm the assumption that visualization is especially important for students focused on figurative and spatial representation of information, but it is moderately useful for other categories of students.

For a more visual representation of the differences between the groups, a graph was constructed reflecting the average values of the test results (Figure 1).

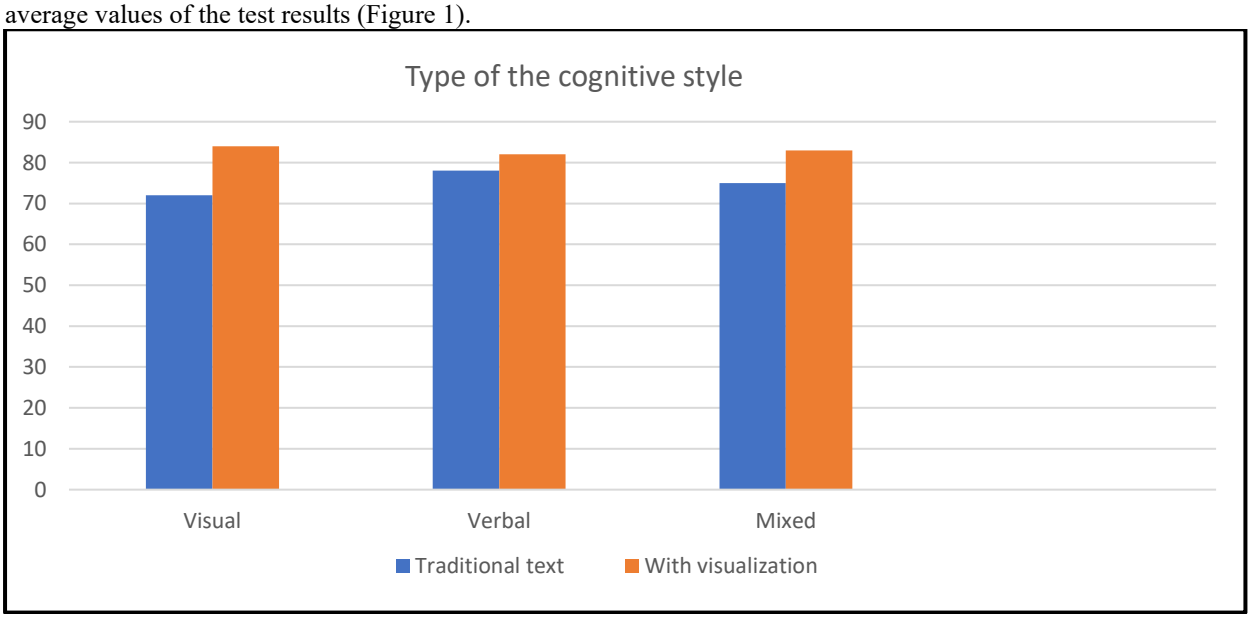

Figure 1 – Test results on a topic depending on the type of cognitive style and presentation format of the material

The graphical representation of the results shows that with traditional textual presentation, students with a verbal-logical style learn the material best, however, after the introduction of visualization, the average scores of all groups align and approach the range from eighty-two to eighty-four points. Visualization not only increases the average values, but also reduces the distance between groups with different cognitive styles, which suggests its leveling and compensatory effect.

A comparison of these tables and graphs allows us to assert that the visualization of educational material in the studied conditions is a factor that increases the effectiveness of mastering the theoretical content. The greatest gain is gained by students for whom the figurative and spatial representation of information is the leading one. At the same time, even in a group with a verbal-logical style focused primarily on text, visualization contributes to a slight increase in results, which indicates its supportive role. It is important to note that a well-thought-out modification of the form of presentation of the material makes it possible to reduce the dependence of educational achievements on individual cognitive characteristics, which is an important condition for inclusive and differentiated learning.

Additional observations based on students' self-reports show that the visualized material is more often described as more understandable, structured and "logical" due to the presence of diagrams and diagrams. In some cases, students with a pronounced verbal-logical style note that excessive graphics can distract attention from the

text, which emphasizes the need for careful selection of the volume and nature of visualization. This observation is consistent with the theory of cognitive load, which points to the importance of an optimal balance between the content and design of educational material.

The results obtained in the study make it possible not only to theoretically discuss the role of visualization in teaching students with different cognitive styles, but also to formulate practical recommendations for teachers designing training courses. It is important to assume that visualization is not a neutral addition to the text. It acts as an active tool for organizing material and managing cognitive load. Therefore, the choice of specific visual means should be correlated with how students perceive and process information.

First of all, it is advisable for the teacher to take into account that for students with a visual-spatial cognitive style, the visual design of the material actually becomes the leading channel for assimilation of the content. In this regard, it is useful for this category of students to use diagrams reflecting the structure of concepts and processes, visual models, mnemonic drawings and concept maps. The logical and semantic blocks placed in the infographic make it easier for such students to keep in mind the interrelationships of the elements of the topic and thereby reduce the likelihood of fragmentary, superficial memorization [2].

For students with a verbal-logical style, visualization performs a slightly different function. In their case, the leading role is played by a well-structured text, consistent presentation of arguments and terminological accuracy. Therefore, visual aids are appropriate here primarily as a tool for structuring and summarizing what has already been read. These can be compact diagrams summarizing the key sections of a lecture, comparison tables reflecting the differences between approaches and concepts, as well as drawings and diagrams that do not replace the explanation, but consolidate it. It is important to avoid excessive, decorative visualization, which can distract from the content and create the impression of information overload [11].

Students with a mixed cognitive style demonstrate the ability to productively use both textual and visual resources. For such an audience, it is advisable to combine detailed textual explanations with carefully thought-out visual supports. Alternating fragments of theoretical text with subsequent diagrams and diagrams is effective, which help not only consolidate information, but also translate it into a more compact and visible form. In this case, visualization serves as a means of integrating different channels of information processing and contributes to the formation of more flexible learning strategies [4].

The practical organization of the educational process, taking into account the cognitive style, also involves a well-thought-out distribution of types of visualization within the course. At the early stages of familiarization with new material, it is advisable to rely on simpler, generalized schemes and basic graphical models, without overloading them with details. At subsequent stages, these models can become more complex and complemented, helping students build more extensive connections. It is important that visual aids be associated with specific educational goals: the introduction of new concepts, the refinement of classifications, the demonstration of cause-and-effect relationships, the generalization and systematization of what has been learned [1].

It is useful to provide students with the opportunity to independently construct visual representations of the studied material. Creating their own diagrams, intelligence maps, and tables not only activates information processing, but also allows the teacher to better understand how students see the structure of the topic and which elements remain unclear to them. In this sense, visualization also acts as a feedback tool [5].

Modern digital educational platforms provide ample opportunities for integrating visualization into the learning process. Virtual whiteboards, interactive diagrams, tools for creating infographics and presentations can be used both in lectures and in students' independent work. At the same time, it is fundamentally important that the use of technological means does not replace the pedagogical task, but serves it. The visual series should be built around the key ideas of the topic and help to isolate them, rather than turn into a set of spectacular but meaningless illustrations [12].

The implementation of these approaches requires a certain methodological training from the teacher. It is advisable to include special modules in teacher training programs dedicated to the design of visualized educational materials, taking into account the cognitive styles of students. This will make the use of visualization not episodic and intuitive, but a systematic and meaningful element of the educational process [8].

The main practical recommendations resulting from the study are summarized in Table 3.

Table 3 – Practical recommendations on the use of visualization depending on cognitive style (summary of the results of the study)

Addressee (type of cognitive style)	Content of recommendations	Expected effect
Visual-spatial	The emphasis is on diagrams, diagrams, concept maps and spatial models, the inclusion of visual supports at the stage of explaining new material.	Deepening understanding of the topic structure, reducing knowledge fragmentation, increasing motivation and test results.

Verbal-logical	Using moderate visualization to structure the text, presenting the final diagrams and tables after a detailed verbal explanation.	Clarifying and consolidating already learned connections, increasing the transparency of the course logic without unnecessarily increasing the workload.
Mixed	A combination of text and visual supports, alternating theoretical fragments with diagrams and tables, involving students in independent visualization.	Development of flexible learning strategies, improvement of integration of different perception channels, steady growth of educational achievements.
All groups of students	The selection of visualizations in accordance with the educational goal, the gradual complication of graphical models, the use of digital tools and feedback.	Leveling differences between style groups, optimizing cognitive load, and improving overall learning effectiveness.

A meaningful interpretation of the data in Table 3 shows that the choice of specific visualization techniques should depend both on the prevailing cognitive style and on the tasks of a particular lesson fragment.

For students with a visual-spatial style, visual aids become the mainstay for the primary understanding and subsequent systematization of the material. For students with a verbal-logical style, they are especially effective at the stages of generalization and summarization, without replacing the main text channel.

For students with a mixed style, it is important to have a thoughtful combination of text and visual supports, accompanied by their inclusion in independent work on designing their own schemes and models. The generalizing recommendations for all groups emphasize the need for targeted rather than formal use of visualization, which is consistent with the leveling effect of visual aids identified in the study and their contribution to optimizing cognitive load.

CONCLUSION

The conducted research allows us to formulate a number of generalizing conclusions. Visualization of educational material within the framework of the considered experiment proved to be an effective means of improving student learning outcomes. When using diagrams, diagrams, and infographics, all categories of students show an increase in average test scores compared to traditional textual presentation of information.

However, the effectiveness of visualization depends on cognitive style. The most significant increase in results is observed among students with a visual-spatial style, for whom the figurative and spatial form of presentation of educational content turns out to be the most natural and productive. For students with a mixed style, visualization also provides a noticeable benefit, reflecting their ability to rely on both text and visual elements. For students with a verbal-logical style, visualization has a moderate but positive effect, complementing and structuring the text without replacing the main information processing channel for them.

The revealed patterns allow us to consider visualization as a tool that can not only enhance the strengths of students with a visual cognitive profile, but also reduce differences between students with different styles. This is its potential leveling function, which is important for the implementation of the principles of individualization and inclusivity in higher education. At the same time, visualization should not be decorative in nature, but requires meaningful pedagogical design based on the features of cognitive processing of information and on the idea of possible cognitive overload.

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