

GENERAL AND SUBJECT DIDACTICS

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Psychological and didactic fundamentals of modern educational technologies of visualization

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Abstract

The relevance of the studied issues is that the introduction of modern technologies of visualization of educational information in the educational environment of higher school is a tool for ensuring the quality of professional training. Accordingly, there is a need to determine the psychological and didactic fundamentals of this process in order to use them as efficiently as possible.

The purpose of the given study is to determine the psychological and didactic fundamentals of modern educational technologies of visualization and to formulate practical recommendations for their implementation in the educational process of higher school.

Based on the outlined features of the cognitive activity of modern generation (the ability to quickly switch between different semantic fragments, high speed of information processing, preference for perceiving information in a figurative form, inability to perceive linear information, etc.), the most significant cognitive needs of modern students are characterized. Prospective technologies for visualizing educational information (mind maps, scribing, video scribing, etc.) and methodical features of their use in the process of professional training are characterized. The tasks of modern visualization tools are defined (tool for improving the educational process, concentrated presentation of educational material, provision of the correspondence of educational material corresponds to the psychophysiological characteristics of students and rational organization of educational and cognitive activities of students). The author's experience in the use of modern visualization technologies, which are based on the application of modern software products, in the process of professional training of future specialists has been presented.

Keywords: visualization; psychological and didactic fundamentals of the educational process; modern visualization technologies; professional training; educational environment

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Психолого-дидактичні основи сучасних освітніх технологій візуалізації


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Анотація

Актуальність досліджуваної проблематики полягає у тому, що впровадження сучасних технологій візуалізації навчальної інформації в освітнє середовище вищої школи є засобом забезпечення якості професійної підготовки. Відповідно існує необхідність визначення психолого-дидактичних основ цього процесу з метою максимально ефективного їх використання. Метою роботи є визначення психолого-дидактичних основ сучасних освітніх технологій візуалізації та формулювання практичних рекомендацій щодо їх впровадження в освітній процес вищої школи. На підставі окреслених особливостей когнітивної діяльності сучасного покоління (здатність швидко перемикається між розрізненими смисловими фрагментами, висока швидкість обробки інформації, перевага до сприйняття інформації в образному вигляді, нездатність до сприйняття лінійної інформації тощо), схарактеризовані найбільш значимі пізнавальні потреби сучасного студентства. Схарактеризовані перспективні технології візуалізації навчальної інформації (ментальні карти, скрайбінг, відеоскрайбінг тощо) та методичні особливості їх використання в процесі професійної підготовки. Визначені завдання сучасних засобів візуалізації (інструмент вдосконалення навчального процесу, концентроване подання навчального матеріалу, забезпечення відповідності подання навчального матеріалу психофізіологічним особливостям студентів та раціональна організація навчально-пізнавальної діяльності студентів). Представлено авторський досвід використання сучасних технологій візуалізації, які засновані на використанні сучасних програмних продуктів, в процесі професійної підготовки майбутніх фахівців.

Ключові слова: візуалізація, психолого-дидактичні основи освітнього процесу, сучасні технології візуалізації, професійна підготовка; освітнє середовище

Problem setting. In the system of higher education, the need for drastic changes has come. The transition from a traditional to an innovative model of higher education is not only desirable, but also forced. The main task of the teacher at the moment is the application of methods and technologies that allow students to develop critical thinking, creativity, and successfully adapt to the requirements of the time and changes in the legislation of a certain field. In addition, taking into account the rapid development of information technologies, the future graduate must not only form a sufficient level of knowledge and skills, but also the ability for continuous professional improvement throughout life. In the modern environment of higher school, a number of factors can be identified that prevent

the updating of the educational process: insufficient implementation of pedagogical technologies in the teaching process, low level of educational and cognitive activity of students, associated with the lack of motivation to study, which leads to problems concerning mastering and uptalking the information.

It is known from the theory of psychology that we perceive 90% of information owing to sight. In addition, the perception of a significant amount of information in the form of a text or a monologue is unproductive, because after a short period of time attention is scattered and the meaning of what was heard is lost. It is most effective to present educational material evenly distributing it by channels of perception (visual, auditory and kinesthetic). Considering this, we think that one of the effective ways

to ensure the cognitive activity of future specialists and improve the quality of higher education is the introduction of modern information visualization technologies into the educational process. However, in order to provide the efficiency of their usage, we consider it expedient to characterize the psychological and didactic fundamentals of modern educational visualization technologies.

Analysis of recent research and publications. Theoretical and methodical principles of educational information visualization were reflected in the works of A. Verbytskyi, A. Gritchenko, V. Davydov, M. Martyniuk, M. Shute and others. G. Gardner, N. Manko, K. Frumkin, based on the theory of cognition and psychological fundamentals of educational activity, emphasized the heuristic potential of visualization. In recent years, innovative technologies of visualization of educational information have also been under the special attention of scientists. Thus, N. Zhytenyova considered the peculiarities of visualization of educational information using cloud technology services [1]. According to the scientist, this approach has a number of advantages compared to other means of visualization: the ability to work without being tied to a place, using any computer with an Internet connection; insurance against work failures in case of machine breakdown; the ability to quickly create, adapt and replicate educational services during the educational process; the possibility of joint work on the same document; ensuring high scalability, reliability, security, resource allocation; the possibility of feedback; ease of administration [1, p. 81].

The problem of intensification of the educational process using visualization tools at the current stage of higher education development was studied by O. Filonenko and N. Baidak [4]. Scientists have established that with the help of methodically expedient use of visualization in the distance learning process, it is possible to solve a number of pedagogical tasks: ensure the intensification of learning; activate educational and cognitive activities; develop critical and visual thinking; form a visual representation of knowledge and educational actions; increase visual literacy and form visual culture, etc.

The issue of visualization of educational information is also of interest to foreign scientists. Thus, N. Michinov and J. Hutain [17] investigated ways of increasing students' motivation during a lecture by using visualization technologies and creating a personalized display of information. To confirm the proposed theory, the scientists conducted a pedagogical experiment and obtained positive results. Y. Zhang, K. Xu, Y. Pan, Z. Pi and J. Yang [20] analyzed the effects of visual aids on the learning outcomes of college students.

Characteristic features of visualization in the conditions of digitization of the educational space are reflected in the publication [11]. This study determined the potential impact of practical experience on students' knowledge, skills and values regarding new technologies, characterized the theoretical application of next-generation visualization technologies and their impact on the further professional activities of graduates. The study of the peculiarities of the perception of educational

information by students and the development of appropriate ways to provide the efficiency of education are reflected in the publication [10]. The study deepens the understanding of the importance and influence of constructively oriented teaching on the educational process of students. The creation of effective online courses using modern visualization tools is discussed in the publication [19]. The results showed that developing online courses with the introduction of innovative visualization tools, as well as including strategic planning for pedagogical interaction points, can maximize the potential for student engagement and their subsequent effective learning.

Objective of the article is to determine the psychological and didactic fundamentals of modern educational technologies of visualization and to formulate practical recommendations for their implementation in the educational process of a higher school.

Taking into account the outlined goal, the following tasks of the research are defined:

- 1) conduct a theoretical analysis of the sources of the subject of the research;
- 2) characterize the psychological and didactic fundamentals of modern information visualization technologies;
- 3) on the basis of the conducted research, establish the conditions for the effective use of modern information visualization technologies in the process of training future specialists.

Presentation of the main material. Modern educational environment of a higher school tends to replace the explanatory and illustrative pedagogy that prevailed before, to a constructively new direction in the theory of learning, which involves the active interaction of students and the educational environment. As a result of such changes, the educational environment should turn into a comfortable and developing one. Given that the cognitive activity of the future specialist is based on theories, concepts, ideas, laws that they must understand, master and learn to use in their professional activities, for the effective organization of this process, it is necessary to create conditions for active interaction between the educational environment and students, in particular using modern visual aids. It is worth noting that despite the generally recognized didactic potential of visualization technologies, their use in the educational process of a higher school is spontaneous in nature, limited both in terms of scope and didactic goals. However, visualization should be aimed not only at adding brightness and expressiveness to the presentation of educational material, but also at affecting the emotions of students, awakening their interest in learning, involving them in independent work, etc.

In scientific studies of the previous century, it was recognized that visualization helps to generalize and remember the material, and also contributes to its longer retention in memory. At that time, diagrams, posters, projectors, etc. were used in practice. At the current stage, visualization reaches a new level, taking into account the capabilities of modern computer technology. And if earlier

in the educational system visualization performed the auxiliary role in learning, now its use involves a significant revision of methodological approaches.

The expediency of using the visualization of educational information is dictated, first of all, by the need to present it in the form most appropriate to the new needs of the modern generation of students. Psychologists and culturologists, characterizing this generation, talk about a new culture of information perception, about "screen people", about a new type of thinking – the so-called "clip" thinking, which is formed as a reaction to the rapid growth of information flows, mainly in visual form, to a high fragmentation, great variety and complete heterogeneity of incoming information [12, c. 311]. Characteristic features of such thinking are the ability to quickly switch between separate semantic fragments, high speed of information processing, preference for the perception of information in a figurative form, but at the same time the inability to perceive linear, homogeneous information, including long texts from the manuals.

However, the analysis of own experience, which is partially reflected in the publications [13; 7; 15; 14] of teaching in higher education establishments, showed the lack of visual literacy (the ability to analyze, critically think and assimilate information created and presented using visual aids). The need to develop the ability to effectively use and analyze visual information is necessary for life in the modern information society, but like any other skill, it requires study and development.

Reformation of the education system promotes to master, use and optimize the innovative technologies. Creating an educational environment with a subject-oriented and educational-informative direction makes it possible to use innovative multimedia products (applications, e-books, Internet services, etc.). This direction of educational activity will become the basis for the development of a high-quality innovative product for teaching not only in the conditions of distance learning, improving the efficiency of memorization, improving the quality of students' knowledge, as well as the objectivity of the assessment.

Every day we create in our mind's cognitive models, mental maps, schemes of the environment in which we exist. These actions allow us to perceive certain events and plan our own steps, determine a strategy of behavior aimed at achieving the set goal [9, c. 312]. Our conscious thinking and decision-making process are based on such models. Any external reality or event has certain reflection within the model created in the inner world of the individual. Intellectual (mental) maps have a similar principle of action in the educational environment.

Intellectual maps (mind maps) are structural and logical graphic representation of a problematic issue with an extensive system of thoughts and ideas necessary to solve a specific situation.

The methodology was developed by the English psychologist and intelligence consultant T. Buzen [6].

Mind mapping is the process of creating a mental map, in the center of which is a basic concept, from which tasks, ideas, shortcomings, conditions for

implementation, etc. branch out. Mind mapping is an effective way of processing information. This is evidenced by the popularity of mind maps around the world - about 250 million users of the most popular services for their creation (Xmind.net, Miro.com, Bubbl.us, Mindmeister.com, Mindomo.com, Coggle.it). The peculiarity of mental maps is that they can be used in any field of activity.

Mind maps are a tool for structuring and systematizing information in graphic expression. Mind mapping is the process of creating a branching scheme of thoughts that resemble the branches of a tree. The more thoughts, the more branches on the tree. It can be used effectively both in lectures and in seminar classes. To improve the effectiveness of training, it is advisable to use it during group work in combination with the "brainstorming" method. Intellectual maps have a number of characteristic features that positively affect the process of assimilating new knowledge:

1. Visibility. The projection of mind mapping technology on the canvas allows you to see the whole problem in a complex way and find several options for solving the problem.

2. Attractive appearance. Mental maps visually reflect the essence of a problematic issue and, like any graphic image, are better perceived for processing.

The use of colorful images, colors and associations affect visual perception, which, in combination with auditory, facilitates memorization. There are many applications and services for creating mind maps, most of which are free. However, you can create a mind map by hand on a piece of paper or a presentation board. The most popular applications for creating mind maps are Freemind, Xmind, MindMeister and iMindMap. These are free or partially paid programs that have a certain number of templates, layouts and drawings. In general, such applications "excellently" cope with the set tasks. The service for creating mental maps from Google – coggle.it – needs special attention. On the basis of this platform, it is convenient to create mind maps of any level of complexity, there is the possibility of group work, which is necessary during an interactive lecture, practical or seminar class, as well as in the conditions of distance learning. The created cards are automatically saved in the user's profile. To invite participants, the service sends a link with the invitation, it is possible to save the map in image or pdf format. An example of a mental map is shown in Fig. 1. Features of the use of these technologies are given in publications [2; 3].

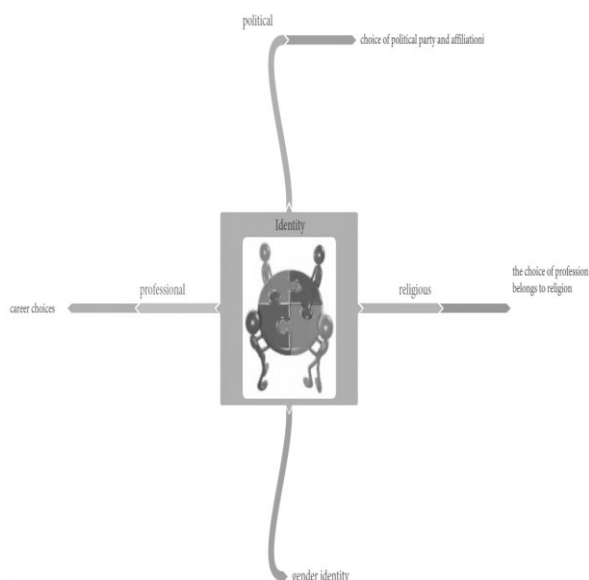


Fig. 1. An example of a mental map

In order to understand how to combine different elements of the surrounding reality into coherent mental constructs, it is necessary to turn to psychology, which claims that the system of mental images reflects not only a person's perception of the external world, but also his attitude towards it. S. Rubinstein [18], connecting the image with the thinking process, defines it as an imaginary picture of what is currently inaccessible to direct perception. As one goes about one's ordinary life, he determines each situation by imagining which of the schemas existing in his memory it fits into. We can safely say that a person creates a second, more specific, type of scheme of each individual event and its correspondence to a more general model that exists in our minds [16, c. 273].

Therefore, for the effective use of mental maps during training, we should act according to the same principle: the information for building mental maps should be organized not linearly, but associatively, with the establishment of those ties that our imagination tells us. The second important fact is that our brain remembers key words and images. Such a visual scheme with established relationships between keywords allows not only to remember them, but also to reproduce them if necessary. Placing information from the center to the periphery is psychologically justified, the most general and significant information is placed in the center and immediately attracts attention, and therefore is easier to remember. From the center, you can move in rays or rings diverging in any direction. The organization of such a scheme, as a rule, reflects the peculiarities of the organization of ideas and concepts in the brain. And the third important element when creating mental maps is emotions. The reproduction of any information in a person's mind is not only in the format of reproduction of an image or text, in parallel we reproduce the emotions that we felt at the same time.

Therefore, emotions are a kind of trigger that allows you to make such a learning tool as effective as possible [1, c. 169].

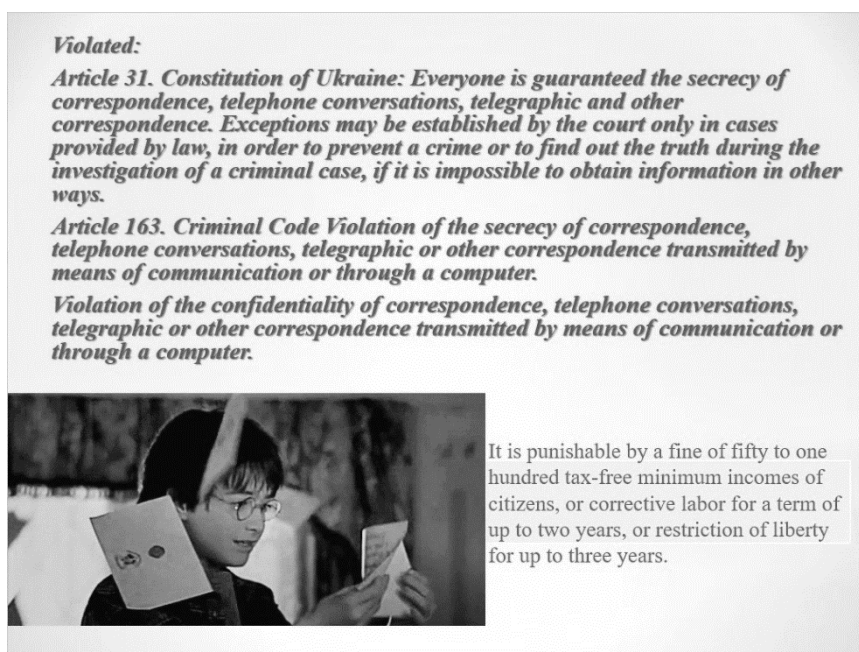
When solving professional tasks, such schemes help to see the whole picture and connections between different links, to imagine different aspects of the problem, their relative importance, to quickly assess the situation and make the most effective decision. It is difficult to overestimate the potential of mental maps, they can be used when planning a written work or any activity – a map helps to collect all relevant information in one place, organize this information depending on importance into a map convenient for this specific activity, which will later be easily applied to practice. Similarly, you can plan a performance and presentation. In this case, the advantages are the convenience of remembering the scheme, reproducing it in front of the inner gaze and relying on it during an oral presentation or answering an exam.

Another promising visual technology is scribing – it is an innovative teaching technology that consists in creating visual connections at the same time as explaining theoretical material. Thus, it is possible to illustrate educational material in real time, which makes it possible to focus students' attention on studying a specific topic. As mentioned above, for better memorization, you need to engage different senses at the same time. Therefore, for better learning efficiency, the use of scribing is a necessary component, because it includes listening and visualization.

Video scribing should be considered separately. Video scribing is a type of scribing that reproduces information in dynamics, which is based on illustrations, drawings, diagrams that form a video sequence. The advantages of video scribing are obvious – the video clip can be used many times, this type of scribing arouses great interest of students, and it is also an informative way of presenting information. To create scribing presentations, it is sufficient to have a felt-tip pen, paper and stickers. But nowadays, computer scribing is gaining more and more popularity – creating presentations based on computer programs or applications. The most popular program for working with real-time presentations is Microsoft PowerPoint. The application is easy to use, contains standard layouts and designs, suitable for creating a simple scribing presentation. Google presentations have similar characteristics – a service for creating presentations that are automatically saved on the Google Drive of your account. It is convenient to make adjustments to existing presentations and broadcast them from any gadget. There are a number of partially free services and programs for creating video scribing. The most popular of them are GoAnimate, PowToon, Wideo, Moovly and others. These applications have a collection of standard scenes and pictures, you can add text and audio files. The VideoScribe application deserves special attention – it is

easy to use, equipped with the necessary tools and ready-made templates. An example of scribing is shown in

Fig. 2.



Scribing technologies can be used not only by the teacher during lectures, but also by students as an individual work on a problematic issue or during research work in groups. This type of work forms general and professional competences of students and prepares them for professional activities.

In addition, for the effective use of modern visualization technologies, there are a number of useful and easy-to-use tools, for example: PicCollage application (for creating collages on Windows, Android and iOS platforms), Powtoon (software for creating animated videos and presentations), Explain Everything (a platform for creation of videos and interactive presentations), Canva (an application for creating presentations, posters, collages, website design), etc.

Taking into account the above mentioned, we believe that the methodologically appropriate use of modern visualization tools performs the following tasks:

- is an effective tool for improving the educational process, in particular due to the compact presentation of educational material, which creates an opportunity to increase the information saturation of education;
- is a concentrated presentation of educational material while preserving its semantic completeness;
- provides compliance of presentation of educational material with psychophysiological characteristics of students;
- is rational organization of educational and cognitive activity of students due to its algorithmizing.

The use of modern visual technologies requires certain preparatory activities of the teacher, which can be conventionally divided into two stages: modeling and designing. In the modeling process, the general idea (model) of the future visualization of a certain object or theory is developed. At the same time, it is important that modeling is aimed not just at the creation of certain schemes, but at the imagination and further construction of a holistic pedagogical process, the key element of which is the introduction of visualization into the educational process. At the design stage, the development and detailing of the general idea of creating a new pedagogical object takes place, the main ways of achieving the results of the educational process are outlined [8]. For example, a particular image can form the basis of an entire session, creating an occasion for intense discussion, thoughtful explanation, and careful exploration.

From the standpoint of the initiated research, modern visualization technologies are considered as

- an effective way to activate the educational and cognitive activity of students and a means for mastering educational information;
- a methodological tool that provides students with a set of tools for solving future professional tasks;
- a tool that stimulates the development of creativity, critical thinking, increases work productivity, inspires creative solutions;

- a process that allows you to identify existing problems, establish relationships between them and see the picture as a whole.

Conclusions. Thus, modern educational technologies of visualization of educational information are an effective tool in the process of training specialists in higher education, as they allow not only to provide the effective mastering of a certain system of knowledge and skills, but also to develop creative skills, generate new ideas and concepts, etc. In the article, an attempt was made to summarize the acquired experience regarding the use of visualization technology in the process of professional training of future specialists. As a methodological basis for the use of innovative

visualization technologies, a system of principles isolated from the key principles and principles of pedagogy and psychology, grouped on the basis of the unity of personal and activity approaches, is used. Modern visualization technologies make it possible to build close relationships between educational information to be mastered and the consciousness of students: any external information can be recorded in the form of images, models, descriptions. In this case, it is not just a copy placed in the mind of the subject, but a complete system, which is formed by building a number of additional elements and connections between them, determined by knowledge, experience, features of the psyche and mental processes and personality properties.

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