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The power of digitalization in education: improving learning with interactive multimedia content

Сила цифровізації в освіті: покращення навчання за допомогою інтерактивного мультимедійного вмісту

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Abstract

The article highlights the advantages of creating multimedia content in education based on digitization. Programs for creating multimedia content in education on the basis of digitalization of multimedia were analyzed and the stages of working with them were considered, which were grouped by main categories. The most important characteristics of interactive multimedia are revealed. The importance of media competence and media literacy of the teacher and student has been proven. The necessity of creating multimedia content of a cloud-oriented educational environment in our time is shown. To achieve the goal of the research, an experiment was conducted, the purpose of which is to identify more effective multimedia technologies for providing multimedia content

Анотація

У статті виокремлено переваги створення мультимедійного контенту в освіті на засадах цифровізації. Проаналізовано програми для створення мультимедійного контенту в освіті на засадах цифровізації мультимедіа та розглянуто етапи роботи з ними, які згруповано за основними категоріями. Виявлено найважливіші характеристики інтерактивного мультимедіа. Доведено важливість медіакомпетентності та медіаграмотності викладача та студента. Показано необхідність створення мультимедійного контенту хмароорієнтованого навчального середовища у наш час. Для досягнення мети дослідження проведено експеримент мета якого виділити більш ефективні мультимедіа технології для забезпечення мультимедійного контенту на

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on the basis of digitization in the field of education, where an experimental approach is the most appropriate. As a result of an experimental study of the influence of multimedia content on the quality of assimilation of educational content by students of different age categories based on digitalization, the combination of multimedia tools in various combinations made it possible to reveal the characteristic features of the multimedia phenomenon in the modern world.

Keywords: multimedia content, education, digitalization, cloud-based educational environment, media literacy.

Introduction

The most successful and developed countries, in our time of rapid changes, global informatization of society, and competition of specialists, direct their state policy in the direction of modernization of educational activities, namely, training of specialists capable of competing in the modern labor market, specialists of a new generation, capable in non-standard situations act and adapt to today's conditions.

The entire education system was radically affected by new information technologies, affecting the content of the educational field, methods, and forms of education, which in the "teacher-student" paradigm led to new requirements, namely, the possibility of effective use of technical and new ICT tools in education and professional activity, their strong potential today (Vanivska et al., 2018).

A person receives video, text, and graphic information throughout his life. One of the possible ways to solve the task of obtaining high-quality education is the digitalization of the educational process of higher education institutions, since it serves as a starting point for the implementation of innovations, is a center for the design of the latest technologies, contributes to socio-economic growth and generally ensures the development of any spheres of human life. Activity.

Based on the harmonization of education, in particular, the educational systems of European countries, the creation of a single European digital educational space is a complex and large-scale task today. Based on the European vector of development, the main directions of digitalization of education are: to create a digital learning environment – introduction and development of computer innovative, computer-oriented, and multimedia training tools and

zasadaх цифровізації у сфері навчання де найбільш доцільним є експериментальний підхід. В результаті експериментального дослідження впливу мультимедійного контенту на якість засвоєння змісту освіти учнями різних вікових категорій на основі цифровізації, поєднання мультимедійних засобів у різноманітних комбінаціях дозволили виявити характерні риси мультимедійного явища в сучасному світі.

Ключові слова: мультимедійний контент, освіта, цифровізація, хмароорієнтоване освітнє середовище, медіаграмотність.

equipment; for general access to educational institutions – creation of educational digital platforms and resources with support for multimedia and interactive content; development of a remote form of education using multimedia and cognitive technologies; organization of free access of education seekers to the Internet (Nesterenko, 2022).

Despite the information age as a new stage in the development of civilization, the subject of digitization of education cannot be considered sufficiently studied. There are a number of problems in the economy, politics and culture that require additional research efforts and intelligence. The information age actively and profoundly affects the educational process, it needs significant transformations, bringing it into line with the new requirements of the time.

A theoretical analysis of the practical experience of using digital technologies in the process of training students of higher education indicates the existence of contradictions between:

- the socially determined task of digitalization of education and science and the insufficient level of readiness of a significant part of higher education institutions of Ukraine for their implementation;
- the task of higher education institutions regarding the training of scientific personnel in the context of integration into the global scientific space and the insufficient level of development of the provisions of the theory and practice of digitalization of the process of training specialists under educational and scientific programs;
- the intensive development and spread of digital means of supporting scientific communication and the lack of students'

ability to carry out digital scientific communication.

Overcoming these contradictions requires the solution of a socially significant research problem, which consists in the need to develop and substantiate the theoretical and methodological foundations of the implementation and application of digital learning with the aim of forming an information-competent specialist.

In the article, we described the main aspects of digitization in education in order to improve learning with the help of interactive multimedia content: advantages of creating multimedia content in education based on digitization; programs for creating multimedia content in education based on digitalization of multimedia; the most important characteristics of interactive multimedia; media competence and media literacy of the teacher and student; creation of multimedia content in a cloud-oriented educational environment.

Literature Review

Several authors, summarizing modern innovative processes in professional education, single out innovative, promising directions of digitalization of the educational sector, in particular: implementation of digital learning management systems, mixed digital learning systems; creation of appropriate digital platforms of information infrastructure with support for multimedia and interactive content, etc. Among such authors are N. Lazarenko, R. Hurevych, S. Kizim (2021).

In his research, V. Bykov (2017) notes that "the software and hardware basis of the digital transformation of society will be laid by the convergence of the most modern nano-, bio-, information, and cognitive technologies – NBIC Technologies, basic technologies of the knowledge society, and user- the technological basis is a global network of data processing centers built based on a cloud-oriented virtualized ICT infrastructure and personal electronic communicators." The scientist understands a personal electronic communicator as "a portable, compact, convenient and safe to use by a mobile user wireless electronic digital device that combines the functions of smartphones, pocket personal computers, and controllers, as well as means of radio frequency identification and GPS positioning".

In the process of distance learning, O. Vanivska, O. Malinovska, R. Presner (2018) considered the

possibilities of modern information and communication technologies and showed ways to improve distance higher education; discussed the role of a teacher and a student of higher education in the distance learning system based on the use of a multimedia approach, a wide range of ICT, which allows organizing a full-fledged educational interaction in the "teacher-student" paradigm. With this approach, the use of multimedia learning is the basis of modern ICT, and the basis of multimedia learning is multimedia content, one of the main and effective components of multimedia content is audio and video content.

T. Bondarenko (2022) considered video editors, programs for viewing videos, programs that allow you to convert files from one video format to another, and screen recording programs – the most popular and often used when editing, viewing, or transforming multimedia content. The analysis is given and the possibilities of software tools are described.

The analysis of the scientific works of O. Dushchenko (2021) made it possible to determine the most modern technologies – digital technologies, to characterize key concepts, to propose ways of using technologies (cloud environment, large volumes of data, robotics, quantum technologies, the Internet of Things, artificial intelligence, etc.) and gadgets, the Internet, modern personal computers, reveal the content of digitization, characterize the current state of digital transformation, show ways of using digital technologies; outline the directions of digitalization of education, show the advantages and highlight the existing problems of the digital transformation of education.

In the form of a list of skills, abilities, and knowledge that are used in assessing the level of digital competence of higher education students, I. Borodkin and H. Borodkin (2018) created a model of digital competence for students, which includes: information management (information storage, search, reproduction, review, and evaluation), cooperation supported by digital technologies, communication in digital environments (distribution of content and information, communication using digital means, civic activity on the Internet, digital identity administration, network etiquette), digital content for creativity (copyright, programming, creation of new knowledge, protection of intellectual property), security (protection of personal data, equipment, environment, health), problem-solving (finding ways and clarifying needs for their solution, solving technical

problems, creative use of technologies and innovations, self-assessment of digital competence).

L. Ivanova and D. Dzhabrailov (2022) carried out an analysis of the use of multimedia technologies in the educational process, conducted an experimental study on the influence of multimedia means of presenting educational content on the quality of assimilation of educational material; a diagnostic program was developed to conduct research. an experimental study was conducted among college students; experimental research made it possible to build a model of the interaction of participants in the educational process and to provide recommendations on the use of "methodology for creating high-quality educational content for certain categories of education seekers".

So, scientists have shown ways to improve distance higher education; discussed the role of the teacher and student of higher education in the system of distance learning based on the use of a multimedia approach; provided an analysis and described the possibilities of software tools, proposed ways of using technologies (cloud environment, large volumes of data, robotics, quantum technologies, Internet of Things, artificial intelligence, etc.) and gadgets, the Internet, modern personal computers; revealed the content of digitization, characterized the current state of digital transformation, showed ways of using digital technologies; to outline the directions of digitization of education; singled out innovative, promising directions of digitization of the educational sector, in particular: implementation of digital learning management systems, mixed digital learning systems; creation of appropriate digital platforms of information infrastructure with support for multimedia and interactive content; built a model of the interaction of participants in the educational process and provided recommendations on the use of "methodology for creating high-quality educational content for certain categories of education seekers". However, the process of creating multimedia content in education based on digitization is not fully disclosed.

The purpose of the article: creation of multimedia content in education on the basis of digitalization and research on the impact on the quality of assimilation of educational content by students of different age categories of multimedia content on the basis of digitalization, combining multimedia tools in various combinations, with the aim of highlighting the

characteristic features of the multimedia phenomenon in modern education.

Methodology

To achieve the set goal, the following research methods were used: theoretical – to clarify the conceptual apparatus of the research – generalization and systematization of scientific sources, theoretical, scientific analysis of psychological-pedagogical, philosophical, methodical literature; definition and substantiation of the conditions for creating multimedia content in education based on digitization; analysis of regulatory documentation and modern practice of higher education institutions; formation of researched quality of multimedia content in education based on digitization; empirical: in order to determine the state of formation and dynamics of multimedia content creation in education on the basis of digitalization, a diagnostic toolkit was used in accordance with the defined structural components; pedagogical experiment – to check the effectiveness of the developed conditions for creating multimedia content in education based on digitization and the developed methodology for their implementation; methods of mathematical statistics were used to determine the statistical significance of the research results.

To fulfill the purpose of the research, it is necessary to experiment, the purpose of which is to identify more effective multimedia technologies for providing multimedia content in education based on digitalization in the field of education.

The most expedient, in our opinion, is the experimental approach, because it enabled the effectiveness of multimedia systems in educational content based on digitization in the "frontal" comparison of data acquisition. We proceeded from the reasoning that the more control questions and the more respondents there are to compare the degree of knowledge obtained, the "cleaner" the obtained data will be.

Testing was conducted several times to obtain more accurate results: the first testing was conducted after passing the material, and the second testing was conducted sometime later. Re-testing made it possible to eliminate the error in the field of knowledge of the applicants, and re-testing also helped to identify the features of multimedia in the respondents' memory. The obtained data provided the basis for identifying a more detailed impact of multimedia based on

digitization on the respondents' memory and for conducting further experiments.

After getting acquainted with the multimedia content based on digitalization, a diagnosis was made regarding the assimilation of the educational content by the participants of each experimental group. To confirm the results of the experimental study, a repeated diagnosis was carried out after a certain period. The results of the study of the impact on the quality of the assimilation of educational content by students of different age categories of multimedia content based on digitalization, combining multimedia tools in various combinations, made it possible to highlight the characteristic features of the multimedia phenomenon in modern education.

Research relies heavily on the accuracy and reliability of the data. In research work, the quality of data collection and analysis not only adds weight to the research, but also contributes to the formation of sound conclusions, which is the key to academic success.

The following digital data collection tools were useful in the study:

- Google Forms - a simple tool for creating surveys that allows you to collect data from respondents, create different types of questions and collect answers in spreadsheets.
- SurveyMonkey - a modern survey tool that offers a wide range of customization options and analytical tools for analyzing the collected data.
- JSTOR, Google Scholar, and other academic search engines to provide access to scholarly articles, books, and other academic resources that may be useful for literature review and theoretical data collection.
- Zotero or Mendeley - bibliography management programs that help organize research materials, store references, and format bibliographies and citations according to different citation styles.
- Microsoft Excel or Google Sheets - spreadsheets are useful for organizing and analyzing collected data when working with quantitative data.
- SPSS, R or Python for more advanced data analysis, for statistical analysis and processing of volumes of data.

When determining the sample of subjects, the general specificity of the subject of the study was taken into account. The total volume of the sample is 62 subjects. When forming the sample,

the criteria of meaningfulness, representativeness, and equivalence were taken into account. The sample was formed by random selection using the technical procedure for calculating the selection step.

The reliability and validity of the obtained results, the objectivity of their assessment was ensured by the methodological soundness of the initial positions and the qualitative mechanism for evaluating the quality under study, the use of a complex of complementary research methods, and the involvement of a group of respondents from a higher educational institution in the analysis of its results.

To assess the homogeneity of experimental and control data, statistical processing was performed using MS Excel and SPSS (Statistical Package for Social Science).

Results and Discussion

Advantages of creating multimedia content in education based on digitization.

The study of the derivatives of the concept of "digitalization" and the concept itself proves that it appeared recently in the scientific environment and is connected with the large-scale penetration of information and communication technologies into the everyday life of modern society. Digital technologies allow the manipulation of data at high speed, including during transmission over continuous analog or digital communication channels (coding, analog-to-digital conversion, demodulation, and signal modulation) (Havrilova & Topolnyk, 2017). Since the modern information society requires fundamentally new approaches to obtain quality education, the scientific and technical progress, its rapid pace, makes it possible to take into account the implementation of a new and permanent digital revolution in the field of education. It is worth looking for ways and means of training highly qualified specialists, and new ways of educational space, in this context, which are capable of development, contribute to the introduction and spread of digital education, and possess the basics of digital literacy. Within the walls of a higher school, this task can be achieved through a qualitatively adjusted educational process.

The creation of multimedia content in education based on digitization makes it possible at the current stage of development of science, education, and technology to consider a

multimedia product as a form of educational content that occupies an important place.

To support and ensure that the content developers create an innovative educational process and update the educational material in the best quality, and that the students learn it effectively and innovatively, software tools for the development of multimedia products, video materials, composition, special effects, sound series, and coloristic solutions are aimed, their installation (Budnyk et al., 2022).

Among the advantages of creating multimedia content in education based on digitization is the possibility for individual users to reproduce it repeatedly at home. In the process of using the video, the user is allowed to adjust the playback of information fragments, control the demonstration of the video series, and stop it under certain conditions. Thus, already at the stage of self-training, we get the opportunity to provide an individual approach to learning, since students determine the most difficult sections for learning on their own, and this stimulates them to further in-depth study of the subject area (Bondarenko, 2022).

The emergence of multimedia tools and systems made a revolutionary leap in the creation of multimedia content in education based on digitization in our everyday lives and firmly took its positions in the field of science, education, and professional activity.

A few dozen years ago, multimedia tools were not used in the educational process, only static texts on paper media were used. Now, in the educational process, multimedia content in education based on digitalization plays a huge role, which cannot be overestimated in the era of rapid development of digitalization. This cannot be neglected, it must be taken into account in the educational context. With such an approach, the question of media competence and media literacy of the specialist who selects multimedia content and uses it – this or that informational content as needed for his course is at the fore, as well as the media literacy of students who for educational purposes are taken into account. use this media content (Mussoi et al., 2014).

The level of media culture is taken into account here, which refers to the ability to communicate and express oneself with the help of media, use information and communication technology, critically interpret information and consciously perceive it, separate reality from its virtual simulation, that is, understand the reality

constructed by media sources, effectively interact with the media space, as well as the ability to be a transmitter and carrier of media culture preferences, tastes, standards, to create new elements of media culture: videos, presentations, interactive maps, smart maps, slide shows, animations, illustrations, etc. (Peláez & Solano, 2023).

Readiness in the educational process to master modern computer technologies of higher education students and teachers (at a higher level than the level of a "simple user") is the most important thing in this case. Therefore, the media literacy of students of higher education and teachers, and their readiness for innovative educational activities is a qualitative main characteristic of a student of higher education, as a future highly qualified specialist and teacher of a higher school (Vanivska et al., 2018).

Programs for creating multimedia content in education based on digitalization of multimedia.

Programs for creating multimedia content in education based on the digitalization of multimedia and work with them can be conventionally divided into the following main categories:

1. Programs with which you can watch videos.

We can single out the most effective of them for the educational space:

- Windows Media Player – a free file player for Windows: audio and video.
- BSPlayer – a media player for Windows that plays files in many multimedia formats, works with subtitles, differs in functionality, can independently download subtitles in the desired language, displays two pairs of subtitles on the screen at the same time, can automatically adjust the display of subtitles when the subtitles and video are out of sync;
- KMPlayer – player of video files and sound files for macOS and Microsoft Windows, there is also a mobile version for Android;
- Light Alloy – for playing video and audio files, this is free software. The program is optimized for minimal system loading and quick launch and has a small size.

2. Editor programs, video editors – you can use them to edit videos. Video editors differ among themselves in terms of interface, requirements for computer specifications, functionality settings, etc. For working with

video, the software includes a set of tools and functions that allow you to overlay music, apply special effects, and adjust frames (Zaluzhna & Nefiodova, 2020). Among the video editors, we will single out the most effective in the educational space:

- Pinnacle Studio is a video editor used for computer editing, which allows you to edit, process, create, and improve video files. Provides support for video in Ultra HD (4K) format and multi-channel sound, works with 3D content, authors Blu-ray discs, creates special titles and effects – provides a set of tools, provides a keying function, extended libraries of transitions, etc.;
- Adobe Premiere Pro – a professional non-linear video editing program from Adobe Systems;
- Sony Vegas Pro – a professional video editor for video processing and non-linear editing;
- Corel Video Studio is one of the most popular programs today, it is used for editing Microsoft videos and is a necessary Windows software package.

There are many functions in its arsenal for video editing: cropping, cropping, instant video correction, rotation, correction of the fish-eye effect and distortion in videos shot with a wide-angle camera, muting, video stabilization, direct upload to Vimeo sites and YouTube, audio mixing, etc.

3. *Screen recording programs – programs that help record user actions from the screen.* Among the digital tools for visualizing educational information, you can distinguish special software that allows you to record user actions from the screen. These programs include:
 - Bandicam – software that works on the principle of capturing an image from the monitor screen;
 - Camtasia is a versatile and powerful application used for video reviews, recording professional screencasts, educational presentations, or product demonstrations. The program, for further editing of the video document, has a significant set of tools and can record sounds and actions in any part of the Windows system;
 - UVScreenCamera – a functional and simple program for recording the monitor screen with sound. You can quickly create educational and demonstration videos, and presentations with the help of software;

- Screen Recorder is a Chrome extension for recording the screen that can be used for video instructions, recording video lessons, demonstrations;
- Screen recording in Google Chrome provides complete autonomy and creates an intuitive interface.

4. *Programs that allow you to convert files from one video format to another.*

There are many ways to record, encode, and play video. For video conversion, the software allows you to convert the video file format in such a way that the file can be opened in a certain media player or the file size is reduced. The user can edit the codec and bitrate, resolution, and video conversion format.

The selection of the converter depends on the task: the files of which format should be received and the files of which formats should be converted.

The most effective programs in the educational space that can help convert files from one video format to another include:

- VideoProc Converter is a software complex equipped with a large number of convenient tools, including a video editor, media converter, video downloader, screen recorder;
- WinX HD Video Converter Deluxe is a software, with a large set of tools, universal support for publishing on the network, for appropriate (including HD) devices, for converting video files into various formats;
- MediaCoder – video and audio transcoder for Windows, which transcodes media files into various audio/video formats;
- VSDC Free Video Converter is a video converter with a large set of additional functions, which is universal and works flawlessly on all Windows systems.

It provides several options for video editing, and not only allows you to get high-quality conversion (Bondarenko, 2022).

The most important characteristics of interactive multimedia.

The most important characteristic of multimedia interactivity is the interaction between the machine and the user, where each of them plays an active role.

The advantages of interactive multimedia are that it is easy for the user to combine, manipulate, and control different types of media, such as computer graphics, text, animation, audio, and video materials (Correa Cruz et al., 2017).

Interactive multimedia combines the following information technologies: television, storage, data, telephone, computer, and others. The most effective interactive multimedia programs in the educational space include educational and educational programs, electronic encyclopedias, video games, and guides. The participant of the interactive educational multimedia program or the user changes his role – he becomes an active participant. Interactive multimedia systems will become the next generation of electronic information systems. Another name for interactive multimedia is Hybrid art – the art movement of the modern world, in which people of an artistic direction work with new technologies and advanced fields of science such as information visualization, artificial intelligence, physical sciences, robotics, biology, experimental interface technologies, etc.

In Tokyo, Japan, the Museum of Digital Art – the first in the world that amazes the imagination – has opened. It was created by hundreds of scientists and artists. The exhibits of the Museum of Digital Art interact with each other and with the viewer, "flowing" into each other. The works of digital art scientists combine carefully thought-out virtual spaces of various environments, and projection sounds, where imagination and fairy-tale fantasy border on reality.

The term hypermedia is sometimes used as a synonym for multimedia, but the definitions of these concepts are somewhat different.

Hypermedia refers to a technology that is used to combine programs on a network and various multimedia files. This practice is based on the concept of linking different text documents in the network using hyperlinks. Hypermedia links related content, which can consist of text, images, video, and animation, and takes this concept a step further (Brovchenko & Tymenko, 2023).

Media competence and media literacy of the teacher and student.

Easier and faster reproduction of lexical-semantic connections in the human mind is provided by the use of multimedia content.

Here we can talk about the nominative-definitive function in educational multimedia content.

The video shows the peculiarities of the behavior of students of higher education, which is characteristic of their culture, helps to remember and understand the semantics of words thanks to a certain situation with the help of associative-semantic connections. Thus, the video provides an opportunity to demonstrate extra lingual components, which in education have an important informational load and the sound side of speech. The number of associative connections increases due to the specifics of the video image, and wider opportunities are opened for understanding the shown video or simple video text, which can be presented using animation, illustration, color selection, and underlining to establish certain associative-semantic connections with one or another video series.

The sound information displayed on the screen significantly expands the audiovisual information system in general and the concept of informativeness, in particular. If a person receives information using the organs of hearing and vision, then this information is perceived more effectively compared to information that comes to the student of education with the help of only vision or only hearing. Regardless of the age of the participants in the educational process, multimedia content is remembered much better. Therefore, the use of multimedia content in the educational process, compared to the standard study of academic disciplines, plays a key role (Anderson & Rivera-Vargas, 2020).

In the foreground, with this approach to education, there is the issue of media competence and media literacy of the teacher, who, as needed, selects and uses certain multimedia content, informative content for his course, as well as the media literacy of students of higher education who use this media content for educational purposes. First of all, we mean the level of media culture, which refers to the ability to communicate with the help of media, to express oneself, to use information and communication technology, to critically interpret and consciously perceive information, to separate reality from its virtual simulation, that is, to understand the reality constructed by media sources, as well as the ability to be transmitter and carrier of media culture preferences, tastes, standards, create new elements of media culture, effectively interact with the media space: slideshows, presentations, smart maps, videos, interactive maps, animations, illustrations, etc.

Of great importance in such an approach in education is the willingness to master modern computer technologies on both sides of the educational process at a high level, higher than the level of a "simple user") – both on the part of the student and on the part of the teacher. Therefore, the media literacy of a student of higher education and a teacher, their readiness for innovative educational activities is a qualitative main characteristic of a modern student and teacher, and as a result of the educational innovation process, it is a future highly qualified specialist (Vanivska et al., 2018).

Creation of multimedia content in a cloud-oriented educational environment.

Figurative thinking is an important issue in innovative education, in which scientists and practitioners plan to create virtual reality programs including in the field of artificial intelligence.

A multimedia image embodies in its essence the interpretation of three tasks facing computer graphics:

- the creation of multimedia models of knowledge presentation should make it possible to make images of models as images of multimedia pictures, as objects for logical thinking that are operated by figurative thinking itself;
- visualization of human knowledge, for which it is impossible to find ways to transition to the formulation of some hypothesis about mechanisms and processes from multimedia images-pictures, which are hidden behind the dynamics of the image-picture, text, or audio description;
- the use of Internet resources, which is the main source of providing a higher education student from any field of activity with diverse information, has become widely used in education. Therefore, developers of Web pages need to use a wide range of possibilities of multimedia systems. One of the main criteria for creating a high-quality website with multimedia content is the use of appropriate graphic capabilities to create the most understandable display of information provided by the website and good design (Shuliak et al., 2022).

The modern educational environment and its constant development involve the transition to the use of software of cloud-based platforms, the

provision of services, etc. (Merzlykin & Semerikov, 2015).

Due to its flexibility and versatility, HTML5 is one of the main tools used by specialists to create educational electronic courses. Such multimedia content in education based on digitalization provides interactivity – the possibility of direct interaction with the user's software resource. Blended learning combines the classic classroom system with e-learning while using a multimedia content management system in education based on digitization. Blended approaches to learning provide an opportunity for a cloud-based learning environment to be an effective option for obtaining an education.

In the practice of the higher education institution and the research of scientists, the tools that teachers need to use to create multimedia content in education based on digitization, in particular, multimedia content of educational electronic courses based on HTML5, remain undefined.

In the e-learning environment, the software is called the term "Authoring Tools", which is intended for saving the resulting product in formats: Flash, HTML, SCORM, etc., designing electronic courses, and educational materials.

With the help of existing multimedia content management systems in education, it is possible to easily reproduce created materials based on digitization. H5P was developed in Norway by the Joubel company, and further development was dictated by the need to move away from the Flash format, which modern browsers do not support.

About 20 types of standalone HTML5 multimedia content compatible with the full range of touch-enabled devices and web browsers for tablets and phones are provided by H5P. Web pages may have embedded content that can be used for training. H5P makes it possible to create HTML5 content that is cross-browser and cross-platform for higher education students with an initial level of computer use.

H5P is a tool for creating HTML5 open educational resources based on digitization with such content as Chart, Collages, columns, Accordeon, audio, course Presentation, drag Text Fill in the Blanks, Summary, dialog Cards, find the Hotspot, image Hotspots, flashcards Guess the Answer, Interactive Video, Mark the Words, Single Choice, Memory Game, Multiple Choice, Appear.in, Twitter and Facebook User Feed, etc. The tool is open-source and freely distributed.

Based on digitalization, to use the tool, you have to:

- register on the H5P.org website;
- create your own multimedia content (for example, MOODLE), which can be placed using a tag in the content management system. In addition, H5P provides the ability to export and import H5P files in the h5p format, which is open, for efficient reuse of content;
- install the MOODLE plugin. Thus, in the content management system, when creating an activity, the option to select the H5P tool will appear. User evaluation results are available through the MOODLE evaluation log.

Therefore, H5P is a means of creating educational content for assessing students' knowledge and studying educational material with many possibilities. For one or another educational subject, instead of text fragments, the teacher can use multimedia electronic content, which is represented by objects that can be manipulated (Vorozhbyt, 2019).

Modern multimedia content in education is developed based on digitization with the help of multimedia technologies, which allows combining methods of processing different types of data into one computer system. The use of multimedia technologies in the educational process, perceived by the subjects of education, significantly increases the flow of educational information. Since not all information is assimilated, part of it does not find its place in those logical structures of a fragment or the entire educational content, the formation of which for an individual is the main goal of the educational process. Ensuring the educational process, and its planning, which involves the active use of visual images presented using multimedia technologies, should be based on the teacher's understanding of the concept of "information" (Ivanova & Jabrailov, 2022).

Experimental study.

To fulfill the purpose of the research, an experiment was conducted, the purpose of which is to identify more effective multimedia technologies for providing multimedia content in education based on digitization in the field of education.

Multimedia tools, which are based on digitization are a component of multimedia content in

education, and multimedia educational resources can include:

- digital information: texts, diagrams, graphics;
- visual information: video, animation, image;
- audio information: music, speech, other sounds.

To conduct the experiment, a topic for training was selected – educational content for students of the same age category and level of training; prepared multimedia content based on digitization using multimedia learning tools: video lectures, presentations, audio lectures, etc., and also, for comparison, separately developed a test ordinary lecture.

Education respondents were divided into subgroups, each of the subgroups studied the topic in its own type of multimedia. A separate subgroup studied the topic of the lecture in the classical form. The participants of the groups, after familiarizing themselves with the educational content, launched the test program to check the level of knowledge of the respondents.

In the lecture material, to make the system of determining the effectiveness of education by students more effective, the same marker theses were added for each type of teaching. The more the respondents chose exactly marker theses during the test, the higher the level of attention to the presented material was considered.

The most expedient, in our opinion, is the experimental approach, because it enabled the effectiveness of multimedia systems in educational content based on digitization in the "frontal" comparison of data acquisition. We proceeded from the reasoning that the more control questions and the more respondents there are to compare the degree of knowledge obtained, the "cleaner" the obtained data will be.

Testing was conducted several times to obtain more accurate results: the first testing was conducted after passing the material, and the second testing was conducted sometime later. The purpose of such repeated testing is to determine whether there is an effect or impact on the long-term or short-term memory of a person in the types of multimedia and whether there is a difference in the long-term perspective of training specialists.

Re-testing made it possible to eliminate the error in the field of knowledge of the applicants, and re-testing also helped to identify the features of

multimedia in the respondents' memory. The obtained data provided the basis for identifying a more detailed impact of multimedia based on digitization on the respondents' memory and for conducting further experiments.

This approach to the experimental methodology allowed us to conduct a more in-depth study, such as:

- synergy of the learning topic and multimedia;
- synergy of multimedia with each other;
- the relationship between the age of the student and multimedia/learning topics based on digitalization.

We developed software to conduct an experimental study, namely:

- testing;
- justification of the stages related to the formation of multimedia content based on digitalization;
- a set of software modules for studying the effectiveness of multimedia educational content based on digitalization for education seekers;
- development of a model of interaction of experimental research participants with software;
- formation of analytical results of the experiment.

Each of the program modules contained a set of fragments of educational multimedia content based on digitization and was presented using testing and various multimedia tools for better learning. The results of the experimental study were processed by the analytical module.

The diagnostic software made it possible to use the developed templates of sets of fragments of educational multimedia content based on digitalization and to create their own multimedia tools in various combinations.

The template module of educational content fragments contained templates for creating educational multimedia content based on digitalization, in which the structure of educational multimedia content from educational blocks is formed based on digitalization to place the material being studied in the appropriate form: graphics, text, video, sound, games, hypertext, etc.

The module for creating fragments of educational multimedia content based on digitization made it possible to fill the educational content with educational materials by the selected template with the use of multimedia technologies, which gave higher education students access to educational content with further access to the diagnostic module, which allowed for the created fragments of initial content to create diagnostic tests and evaluate the level of assimilation of educational material by students of education.

The analytical module of multimedia content based on digitalization carried out analytics on the compliance of the level of assimilation of educational content created using various means of multimedia content based on digitalization.

A control group of respondents was divided into five experimental groups (EG). Each EG received a fragment of the educational content. The fragment was created using various multimedia technologies based on digitization (graphics, presentation, game, video) and a traditional textual fragment.

After getting acquainted with the multimedia content based on digitalization, a diagnosis was made regarding the assimilation of the educational content by the participants of each experimental group. To confirm the results of the experimental study, a repeated diagnosis was carried out after a certain period. The results of diagnostics regarding the quality of assimilation of multimedia content by students of education based on digitalization are presented in Figure 1.

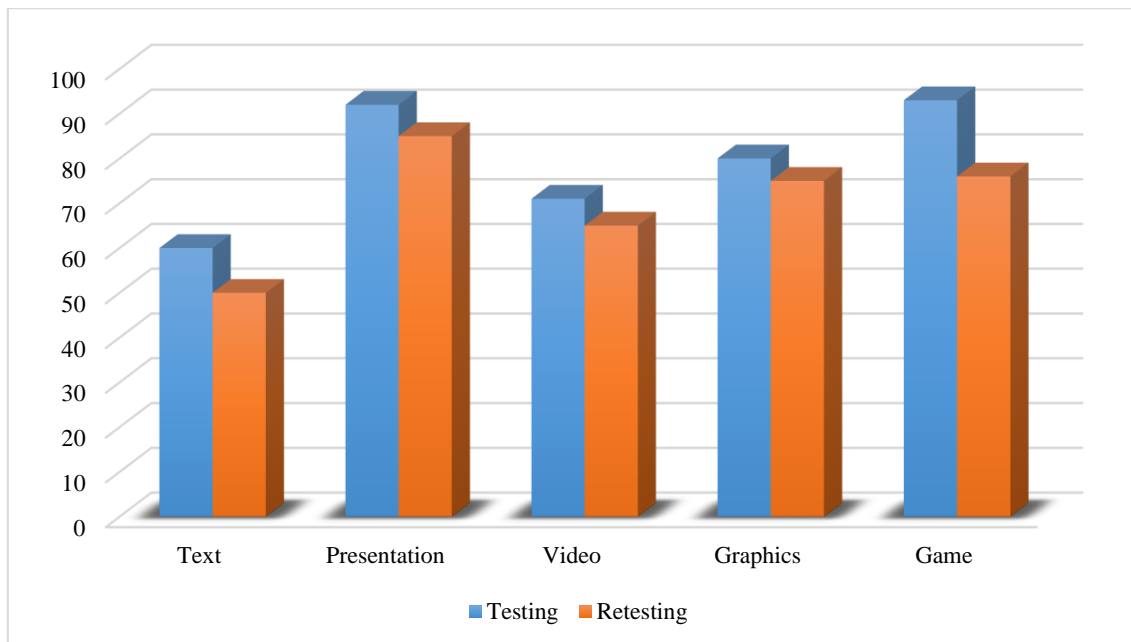


Fig. 1. Results of an experimental study.

The results of the study of the influence of multimedia content on the quality of assimilation of educational content by students of different age categories based on digitalization, combining multimedia tools in various combinations, made it possible to identify the characteristic features of the multimedia phenomenon in modern education:

- the reality of the reality that is depicted: expressiveness, the display of phenomena in dynamics and development, the wealth of pictorial techniques, emotional saturation;
- information saturation: interactive mode of working with information, the possibility of combining information that is presented in different forms (sound, text, graphics, animation, video), and convenience of processing different types of information.

The use of multimedia technologies in the educational process of a higher education institution significantly increases the flow of educational information, which is constantly perceived by a student of higher education (Ivanova & Jabrailov, 2022).

The results of the research made it possible to identify the characteristic features of the multimedia phenomenon in modern education: the reality of the reality that is depicted: expressiveness, the display of phenomena in dynamics and development, the richness of pictorial techniques, emotional saturation; information saturation: interactive mode of working with information, the possibility of

combining information presented in different forms (sound, text, graphics, animation, video), convenience of processing different types of information.

It has been proven that H5P is the main tool for creating HTML5 open educational resources based on digitization with such content as: Chart, Collage, column, Accordeon, audio, course Presentation, drag Text Fill in the Blanks, Summary, dialog Cards, find the Hotspot, image Hotspots, flashcards Guess the Answer, Interactive Video, Mark the Words, Single Choice, Memory Game, Multiple Choice, Appear.in, Twitter and Facebook User Feed and more. The tool is open source and freely distributed. Due to its flexibility and versatility, HTML5 is one of the main tools used by specialists to create educational electronic courses. Such multimedia content in education on the basis of digitalization provides interactivity - the possibility of direct interaction with the user's software resource. In the e-learning environment, the software is called the term "Authoring Tools", which is intended for saving the resulting product in formats: Flash, HTML, SCORM, etc., designing electronic courses, educational materials.

Conclusions

The advantages of creating multimedia content in education based on digitization are highlighted. Programs for creating multimedia content in education based on digitalization of multimedia were analyzed and the stages of

working with them were considered, which were grouped by main categories.

The most important characteristics of interactive multimedia are revealed. The importance of media competence and media literacy of the teacher and student has been proven. The necessity of creating multimedia content in a cloud-oriented educational environment in our time and taking into account imaginative thinking in innovative education, which scientists and practitioners in the plan of creating virtual reality programs are considered to be in the field of artificial intelligence, is shown.

To achieve the goal of the research, an experiment was conducted, the purpose of which was to identify more effective multimedia technologies for providing multimedia content in education based on digitization in the field of education.

The results of the study made it possible to identify the characteristic features of the multimedia phenomenon in modern education. H5P has been proven to be the premier tool for creating HTML5 open educational resources. The tool is open source and freely distributed. Due to its flexibility and versatility, HTML5 is one of the main tools used by specialists to create educational electronic courses. Such multimedia content in education on the basis of digitization provides interactivity.

The most expedient, in our opinion, is the experimental approach, because it enabled the effectiveness of multimedia systems in educational content based on digitization in the "frontal" comparison of data acquisition. We proceeded from the reasoning that the more control questions and the more respondents there are to compare the degree of knowledge obtained, the "cleaner" the obtained data will be.

Testing was conducted several times to obtain more accurate results: the first testing was conducted after passing the material, and the second testing was conducted sometime later. Re-testing made it possible to eliminate the error in the field of knowledge of the applicants, and re-testing also helped to identify the features of multimedia in the respondents' memory. The obtained data provided the basis for identifying a more detailed impact of multimedia based on digitization on the respondents' memory and for conducting further experiments.

After getting acquainted with the multimedia content based on digitalization, a diagnosis was made regarding the assimilation of the educational content by the participants of each experimental group. To confirm the results of the experimental study, a repeated diagnosis was carried out after a certain period. The results of the study of the impact on the quality of the assimilation of educational content by students of different age categories of multimedia content based on digitalization, combining multimedia tools in various combinations, made it possible to highlight the characteristic features of the multimedia phenomenon in modern education.

Further research is needed to justify ways of using virtual reality programs in education.

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