

Special Aspects of Using Modern Multimedia Technologies within the Educational Process

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Abstract—The use of modern multimedia technologies during the educational process is becoming more and more specific due to the multimedia penetration into different learning processes. This article aims to identify the special aspects of using multimedia technologies within the educational process in a distance learning environment. The research methodology is based on the stakeholders' theory, which identified the following participants in the educational process: education departments, the educational institutions' administration, students and pupils, and teachers. The content analysis method of the official websites of innovative educational platforms and services was used to study the specifics of multimedia applications. Results. The study identified the following special aspects of using multimedia technology within the educational process. Firstly, multimedia is actively integrated into platforms and services that are a virtual educational environment, ensuring the interests of all stakeholders. Secondly, multimedia performs not only traditional functions in learning, motivation, communication, and interactivity but also innovative functions (learning management, analytics, establishing social contacts, providing students' reflexion, communication, interaction, conducting surveys). Hence, it forms a full-fledged digital educational process in a virtual learning environment. Thirdly, multimedia technologies are actively used both in teaching students/pupils and also for the training and professional development of teachers and educators. The courses and training are offered to them via educational platforms. The other features of using multimedia include: performing many real-time education functions by technologies; providing personalization of the educational process, which is a foundation for developing an individual education route for each student and pupil.

Index Terms—Multimedia technologies, educational process, multimedia special aspects, virtual educational environment.

I. INTRODUCTION

Multimedia technology is a strategic tool in overcoming the problem of students' limited access to learning and quality education. In addition to solving the said technical problem, multimedia serves as a quick communication tool within a distance learning environment, a service for posting materials, and a tool for increasing materials acquisition through visualization. The pandemic has led to a significant

development in their use: the world's leading universities have developed large-scale learning spaces based on multimedia that ensure the effectiveness of distance learning activities. To improve the quality of education, distance learning developers offer teachers to combine the most effective multimedia for a specific area of activity. Such an educational practice stipulates the emergence of new and particular features of modern multimedia technologies used within the educational process.

Multimedia technology is a set of different ways of learning: texts, graphics, music, video, and animation in an interactive mode. The new learning environment creates additional opportunities for the development of students' creativity. It stimulates their curiosity and instills an interest in scientific activities. This approach significantly increases the interest in the study of the subject and involves the whole group in the cognitive process. Multimedia can be an effective and efficient means of intensifying the learning process; it enriches the learning process. Multimedia and hypermedia technologies integrate powerful distributed educational resources that can provide an environment for the formation and development of key competencies, which primarily include informational and communicative ones.

The purpose of the article was to form the main features of the use of multimedia in educational practice, in particular in the practice of using educational services and platforms.

This study will describe the current features of the use of multimedia as a component of educational services and platforms that have emerged in connection with the active development of distance learning during the pandemic. The article identifies the latest trends and tendencies in the use of multimedia in the context of stakeholder theory and their active involvement in educational practice through multimedia integrated into services and platforms. The study describes previously undefined trends in educational practice, in particular the trend towards expanding cooperation between stakeholders in the educational process through multimedia technologies.

II. LITERATURE REVIEW

Multimedia technologies (video and live lectures and seminars) are actively integrated into the practice of online and blended learning in colleges and universities. The term "multimedia" is described as a combination of sound, text, animation, video or art transmitted by a computer or other digital platform, and covers learning tools such as video or animation to complex learning tools such as virtual reality (VR), 3D, Augmented Reality (AR) [17]. "The various

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implementations of audiovisual media as the educational techniques and tools provide technology-enhanced learning” [11]. Academic researches investigate the special aspects of multimedia use in the following areas: effectiveness and outcomes of multimedia in education, learning [1]-[4]; multimedia perceptions among educators, pupils and students [5]; innovative learning forms through multimedia [6]; blended learning models, multimedia learning strategies [7], use principles [8]; multimedia integration barriers and effectiveness factors, advantages and disadvantages of use [9]-[11]; multimedia integration methodology, assessment and control of implementation effects [12]-[14]; cognitive theories of multimedia learning [15]-[17]. The main advantages of using electronic courses are: individualization of the learning process; increasing control possibilities with feedback and diagnostics; self-control and self-correction; self-training and coaching; improved illustrativeness; real processes modeling; increased learning motivation; systematic use of the problem-based approach in learning.

Li, Antonenko & Wang [5] analyzed 411 peer-reviewed articles from 1996 to 2016 to describe empirical research in multimedia learning. The results revealed that the main areas of study are the theoretical foundations of multimedia learning, perceptions of multimedia and principles of multimedia use, academic design and individual differences between students and pupils, motivation and meta-position, video and hypermedia as multimedia tools. Coherence, contiguity, and excessiveness are the most frequently discussed among the basic multimedia use principles in scientific literature. Mutlu-Bayraktar, Cosgun & Altan's [19] research on an analysis of 94 articles on cognitive load and multimedia learning from 2015–2019 notes that the research papers focus on multimedia design and presentation format and the principles of "Modality, seducing signaling" is most frequently mentioned in the publications. Alpizar Adesope & Wong [20] also study the concept of "signaling" based on a meta-analysis of 29 independent studies as a key principle for effective material learning. Kalyuga [21] investigates the "expertise reversal principle in multimedia learning" concerning the integration of learning information into working memory with knowledge structures in long-term memory.

Thus, the various aspects of multimedia technologies usage in educational activities, their effectiveness, models, teaching strategies, principles, advantages/disadvantages, factors, and barriers to implementation are studied in the scientific literature. At the same time, there were no studies devoted to the special aspects of multimedia application in the educational space in the distance education environment, which led to a significant leap in their use.

III. RESEARCH METHOD

This research used content analysis and comparative analysis methods to identify the special aspects of using multimedia technologies within the educational process. The stakeholders' theory was used to explain the role of platforms and services used in education to meet the needs of such players: education departments, heads, and management of

educational institutions, teachers, and students. Based on the content analysis, the special aspects of using multimedia were identified through the services, platforms, and the implementation of training courses.

In order to conduct content analysis in order to highlight the features of multimedia use, the following services and platforms for providing educational services were analyzed: Human School, Unified School, Moodle, Google Classroom, Prometheus, EdEra (Education Era), iLEARN, Learningapps, VUM online, EduHub .in.ua. These educational services and platforms were selected according to the following criteria: 1) the use of multimedia on the service, platform, integration of multimedia into the service, platform; 2) providing access to various stakeholders to the service, platform and the ability to create their own multimedia participants in the educational process (students, teachers, parents, administrations of educational institutions, education departments, etc.); 3) the prevalence of services and platforms.

IV. RESULTS

As a result of the complete transition to distance learning (due to the pandemic), multimedia use within the educational process acquires new features. Before the pandemic, technologies had the following functions: 1) served as digital tools for communication, assessment, control of students by teachers, a method of accelerating communication; 2) served as tools for the exchange of learning materials, experience, knowledge; 3) served as tools for knowledge transfer and information that provided increased motivation of pupils, students, learning and understanding of knowledge. For example, the use of the Internet, different videos, feature movies, multimedia programs prepared for the educational process, electronic textbooks, multimedia reference books, encyclopedias, and dictionaries allowed to create a communicative environment for learning, stimulate learning materials, create a more effective learning environment compared to traditional classes for pupils and students.

The main special aspects of multimedia in a pandemic environment are accelerated integration and combination to create an effective synchronous and asynchronous learning environment in education. Traditional ways of using multimedia are actively integrated into innovative platforms and services that have almost completely provided a digitalization of the educational process (using electronic textbooks, encyclopedias, etc.; creating illustrative materials; creating multimedia presentations; using video and audio materials in the classroom; using two-dimensional and three-dimensional (for dynamic illustration of educational material). Thanks to the ability of multimedia to integrate different kinds of information harmoniously, the virtual learning environment is developing more and more, which significantly expands the possibilities of participants in the educational process. Thus, if earlier multimedia were mainly effective ways of teaching, efficiency depended on teachers and their ability to use it, and, after the pandemic, multimedia became the tools of an educational institution to fulfill various tasks of different stakeholders (as a learning management system, as an analytics tool, as a school social network, as a reflexion tool, etc.).

The next feature of using multimedia is an effective combination of synchronous and asynchronous multimedia to work with multimedia technology depending on the type of classes (seminar, lecture, group, teamwork, discussion). Educational institutions allowed teachers to combine different media based on developed templates for certain types of classes. It ensured the absence of teachers' difficulties in the choice, the use of various tools, and, at the same time, personalization according to the teachers, pupils, and students' needs. Hence, multimedia tools are traditionally divided into two groups: 1) means of synchronous interaction (video conferences) and asynchronous interaction, online mode (webinars, e-learning materials); 2) multimedia technology itself (virtual objects, real video episodes, audio fragments, animated graphics, etc.).

The implementation of strategies for active learning, where most of the responsibility for the results is placed on the pupils and students, is also a special aspects of multimedia use in distance education. Teachers practically provided posting of learning materials, knowledge transfer, task formulation, evaluation, and control, while pupils and students had to manage their learning process and carry out the most effective search for solutions.

Despite some advantages of using multimedia within the new socio-economic reality, pupils and students of different educational fields faced some difficulties in multimedia technology learning:

- 1) First, the need for a sufficiently wide coverage of learning subjects, different curricula, and teachers with different skill levels in using and applying multimedia.
- 2) Secondly, the new technologies require both pupils, students, and teachers to have new specialized knowledge. Educators training together with pupils and students reduce the effectiveness of training and looks like an independent work, which is not a full-fledged educational process (there are no timed curricula, an unknown amount of material and, as a consequence, the curriculum looks somewhat, at best, and usually is absent at all).
- 3) Thirdly, if a professional in a given discipline is involved as a teacher, the teaching efficiency does not improve much because this person is usually not versed in didactics and pedagogy (because it requires special knowledge). That is why the simple involvement of a professional in a particular discipline even though it will introduce students to new technologies, will teach them ineffectively.

Thus, we can state that the process of teaching new technologies, in particular multimedia, within the education system contains serious difficulties, which reduce the learning efficiency and inhibit the formation of the necessary knowledge, skills, and qualities. To solve this problem, commercial structures are involved in the educational training system, which uses many different techniques for effective staff training, which in a short time achieve high results in training and re-training of their staff.

We should compare the main differences in the use of multimedia before and after the pandemic, as the full transition to online learning has significantly changed

perceptions and attitudes toward technology in education.

- 1) Before the pandemic, the multimedia learning process in educational institutions was characterized by certain difficulties related to the unpreparedness of educators, students, and pupils to teach the latest technologies at the right level. During the pandemic, all participants in the educational process needed to find the most effective multimedia combinations in the virtual space, and to learn quickly how to use them.
- 2) Before the pandemic, the attempt to involve professionals in teaching multimedia technologies usually failed because multimedia specialists did not have the necessary training in didactics and pedagogy. Throughout the pandemic, multimedia specialists became separate participants in the educational process and were assigned some functions to provide technical and technological multimedia management.
- 3) The problem of the lack of knowledge in didactics and pedagogy was solved during the pandemic by providing preliminary integration courses of didactics and pedagogy for specialists in multimedia technology. There was also mandatory training for specialists on the class regulations, in which the teacher brings the automatic skills of working with the student audience, based on modern scientific developments. During the pandemic, multimedia specialists and educators collaborate to ensure synergy in the use of technology in education. Multimedia specialists also become consultants who are brought in when any participant in the educational process has problems with multimedia use.

The use of multimedia in education is characterized by the use of services and platforms into which they are integrated. In particular, the best-known platforms into which multimedia is integrated for synchronous and asynchronous modes of communication are:

Human School [5] – convenient and modern tools for an educational institution (learning management system, analytics, school social network, reflexion), which is an educational platform for schools to implement the best innovations in education and provides a full educational process. The service provides communication, surveys, development of photo galleries, announcements of school events, and organization of afterschool programs created specifically for the needs of a modern school. Teachers within the platform can obtain in-depth analytics of the educational process and assess the dynamics of academic performance and student attendance in real-time (Fig. 1, Fig. 2). Tools for collecting and analyzing student reflexion permeate the system, enabling them to continuously identify the level of difficulty/utility of the material being presented and then develop an individualized educational trajectory for each student. The platform fully reflects the educational process – topics and lesson plans, assigned homework, test dates, and display of school events. Administration of the system provides creation and management of student flows by school year, graduation of classes, work with the school schedule, creation of courses, classes, adding users of the system.



Fig. 1. Analyzing the educational process of the Human School platform. Source: [5].

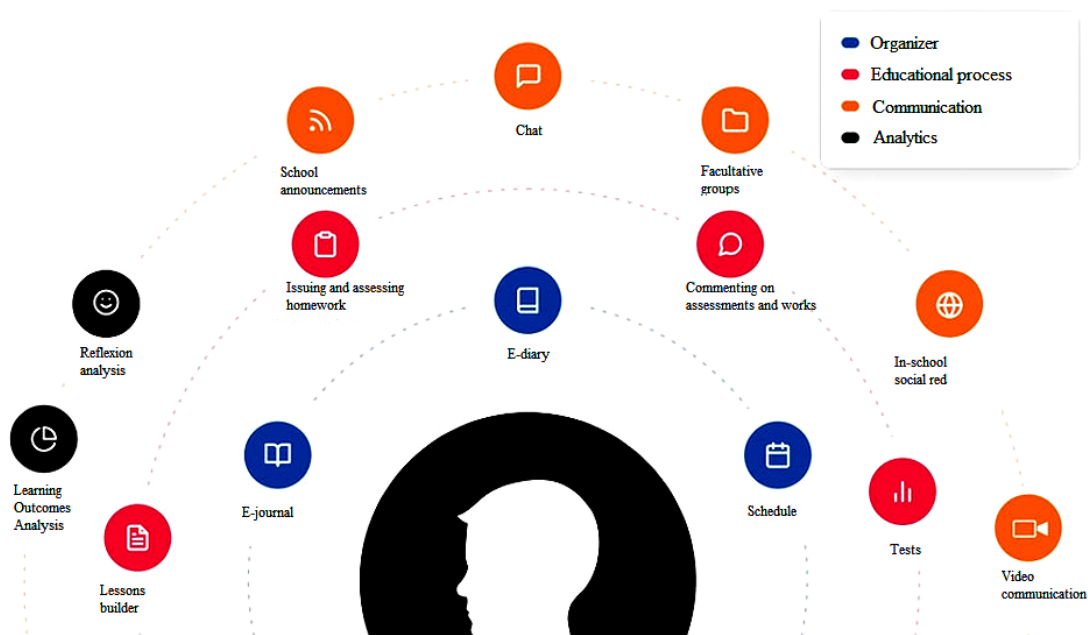


Fig. 2. Human School educational platform — Main opportunities. Source: [5].

The platform provides many benefits for different participants in the educational process and advanced tools in a single platform:

- 1) Education departments can inform educational institutions about digital technologies and provides the ability to control and coordinate the industry from a responsible contractor with experience in large-scale projects.
- 2) The heads of institutions create the space of an educational institution and provide a tool to control and monitor the school activities, as well as a single class, student, or teacher.
- 3) Teachers provide a complete learning process with feedback tools, disclosure of the student's educational trajectory, and creation of learning materials.
- 4) Students can use a unified educational profile, which preserves all the achievements and passed material even after graduation.

Novi znannya [44] – electronic class diaries and journals. A convenient distance learning system. An educational institution shall be connected to the "KURS. School" system.

Yedyna Shkola [44] – an information and communication system designed for educational institutions, students, and their parents, includes an electronic journal and diary with a

mobile application, and is recommended by the Ministry of Education of Ukraine.

Moodle [44] – a learning platform that will help to create effective online learning in your environment. Possibility to create courses, around 20 activities. There is a mobile application.

Google Classroom [44]. Free web service created by Google for educational institutions. There is a mobile application.

The next feature of using multimedia technologies in the educational space is their integration into training courses within the framework of educational services, in particular:

- 1) Prometheus [44] – Ukrainian public project of mass open online courses. The main goal of the project is to provide free online access to university-level courses to everyone, as well as the opportunity to publish and distribute such courses to leading professors, universities, and companies. The platform contains about 100 free online courses. Among them are UPE preparation courses, English, and Modern Teacher Education.
- 2) EdEra (Education Era) [44] – a Ukrainian educational project, which aims to make education in Ukraine high-quality, accessible, and available in a global educational context: public consultations; budget process; effective communications for education managers; Ukraine-EU association agreement; European human rights mechanism; Ukrainian language lifehacks. The project provides the creation of free online courses (now about 50) and educational content of a wide range using IT (history, math, human rights, English, biology)
- 3) iLEARN [44] – online courses on the main subjects of the UPE, webinars with the best tutors, tests, podcasts, materials for self-study
- 4) Learningapps [44]. Designer of interactive tasks, allowing you to easily and conveniently create electronic-interactive exercises that promote activity, independence, efficiency, the connection of theory with practice, a combination of collective and individual forms of learning, etc.
- 5) OUM online (Open University of Maidan) [44] more than 30 topics for free learning on the platform, including the following courses: public and power: effective mechanisms of influence, on the possibility of involving citizens in policy-making processes; anti-corruption in public procurement; financial justification of management decisions; personal effectiveness; change management; strategic thinking; leadership.
- 6) Educational Hub [44] – EduHub.in.ua – provides access to courses aimed at developing soft skills: people and project management; emotional intelligence; personal effectiveness; HR school, etc.
- 7) Portal “Dia. Digital Platform” [44] is a project of the President of Ukraine, embodied by the Ministry of Digital Transformation as part of its aim – to educate citizens in digital skills. The platform “Dia. Digital Education” launched a series “Quarantine: online services for teachers”.
- 8) GIOS [44] is an interactive online platform with lessons, assignments, and tests to help organize blended and online learning, approved by the Ministry of Education and Science of Ukraine. During the quarantine, GIOS offers free use of the platform for teachers and classes, the introduction of students to the system, and technical support. The GIOS online platform will help students learn math at home and effectively improve their results.
- 9) Shchodennik.ua [44] is an all-Ukrainian educational network for teachers, students, and parents. The project is supported by the Ministry of Education and Science of Ukraine, regional administrations, and education departments. The project aims to unite all teachers, pupils, and parents into a single community, modernize the learning process, and introduce modern computer technology in schools. You can register in the educational network when your school connects to the project. It is suitable for initiative parents or school administration representatives who want to introduce modern technologies into the educational process.
- 10) Osvitoria [44] is a nonprofit public union that helps transform and develop education in Ukraine, creates innovative schools and programs, helps teachers in learning, and provides access to high-quality education for needy children. The Nova Ukrainska shkola (NUSH) Coaching School is a partnership project with the Ministry of Education and Science of Ukraine, working with support from the International Foundation. The training center, Osvitoria Hub, provides training and courses for teachers. Osvitoria Media offers up-to-date news about education, etc.
- 11) Ilearn (Osvitoria) [44] is a project of GS Osvitoria. It is a free gamified platform with online training courses, tests, and webinars for anyone who wants to study and successfully pass the EIE (External Independent Evaluation).
- 12) MySchool.ua [44] is an online learning tool for pupils, parents, teachers, and managers of district education departments. The system brings together people involved in the school process via the school paperwork automation, an online library with multimedia materials for students, notes for teachers on all subjects, topics for all classes, and various SMS services. For school administrators, there is a school textbook account, an electronic test builder, and thematic social networks. Suitable for school management and teachers.

V. DISCUSSION

The use of multimedia technology in learning is becoming more and more common. For example, a growing number of university students are choosing to buy e-textbooks on their mobile devices instead of purchasing real textbooks without compromising their grades or cognitive learning [39]. Digital learning programs are building on new concepts such as virtual reality, augmented reality, and gamification [40], [40]. Instant messaging is increasingly being incorporated into educational settings, primarily as a communication tool [11]. Two main trends in multimedia use include their effective combination of educational platforms and services with courses that create a new virtual learning environment and transform the educational process.

Other studies consider platforms as digital tools in

education, the effectiveness of which is hardly confirmed. Hence, Tsai *et al.* [43] note that mobile multimedia platforms are multifunctional tools that can be used by individuals and corporations to share content and serve as an additional learning tool. However, the results of this research show that platforms are virtual educational platforms, combining multimedia technology and digital learning tools. At the same time, according to Vagg *et al.* [44], multimedia is considered a cost-effective and practical learning tool.

VI. CONCLUSION

The research reveals the following special aspects of using multimedia technology in the educational process. First, multimedia is actively integrated into the platforms and services, which are virtual educational environments, ensuring that the interests of all participants – stakeholders: education departments, managers and administrators, teachers, and students are taken into account. Secondly, multimedia performs not only traditional functions like motivation, communication, and interactivity but also innovative functions in learning. These platforms include learning management systems, analytical tools, a school social network, tools for student reflexion, communication, communication, polling, and some other technologies. As a consequence, it forms a complete digital educational process in a virtual learning environment. Thirdly, multimedia technologies are actively used both in teaching pupils/students and also for training and professional development of teachers within educational platforms, where courses and training for teachers and educators are offered. Fourthly, multimedia provides several educational real-time functions, in particular, for analyzing student reflexion (in-depth analysis of the educational process, assessment of the academic performance dynamics, and student attendance in real-time). Fifthly, multimedia provides personalization of the educational process through tools for analyzing students' reflexions and assessing the complexity/utility level of the material presented. Consequently, multimedia is the basis for the development of each student's educational trajectory. Thus, digital platforms and services and the integration of multimedia technologies and tools into learning platforms provide a complete digitalization of the educational process.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Oleksandr Priadko and Serhii Bordeniuk conceived of the presented idea. Oleksandr Lishafai and Natalia Lytvynenko verified the methods, performed the computations, and designed the figures. Tetiana Maslova and Zoriana Kryvoruchko verified and supervised the results and discussion of this work. The findings were discussed among the authors, who all contributed to the final manuscript and approved the final version.

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