Creation and Development of the Digital Learning Environment in Educational Institutions

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Abstract. The modern digital learning environment of educational institutions should be flexible and personalized, meet the needs, requirements and wishes of teachers, students and the educational institution. Education with the use of digital tools has become relevant today in the quarantine of COVID-19. The educational process takes place regardless of time and place. It requires quick and easy access to information and educational resources. The digital learning environment of the educational institutions provides these conditions. The components of the educational institutions should provide the main functions in the process of learning and education: learning, communication, cooperation, assessment and testing, planning and management, presentation and evaluation of tasks. The approach of creating and using the educational institutions involves the use of all its elements, namely: IT services, applications, systems, etc., which can be easily combined, updated, added, deleted, changed. This approach will create and develop the educational institutions that can be adapted to innovation in education and ICT.

1 INTRODUCTION

An urgent issue of modern education is the effective use of the potential of information and communication technologies. The Digital Agenda for Europe is one of the leading initiatives in the framework of the European Union's socio-economic development strategy "Europe 2020", adopted by the European Council in 2010. The introduction of e-learning (eLearning) is a leading direction of modernization of educational policy in European countries. The implementation of ICT should be reflected in the curricula, integrated into the content of education, included in the criteria for evaluating learning outcomes, the document states. Thus, the modern educational environment acquires the features of digital [1].

The processes of formation and development of the digital learning environment in educational institutions of Ukraine have been taking place in recent years. The organization of a new educational environment requires extensive use of ICT, multimedia teaching tools and resources, etc., as stated in the draft Concept of digital transformation of education and science for the period up to 2026(https://mon.gov.ua/), the concept of the New Ukrainian School (NUS). ICTs provide equal access to digital educational resources and environments [2]. The use of ICTs has become more acute during the COVD-19 pandemic. Today, learning is increasingly taking place in distance and mixed formats. The results of research (Results of an online survey of teachers' needs for raising the level of professionalism in digital and ICT use during quarantine (2020), Analytical report. The results of the online survey on the readiness and needs of teachers for the use of digital tools and ICT in the conditions of quarantine (2021)) conducted by scientists of the Institute Information Technologies and Learning Tools NAES of Ukraine, revealed gaps in teachers' mastery of ICT [3, 4]. International research states that every fifth student does not reach the basic level of ICT proficiency and only 39% of teachers in the EU consider themselves knowledgeable users of ICT [5, 6]. The Digital Education Action Plan 2021-2027 presented by the European Commission has identified two strategic priorities: promoting a highly efficient digital education ecosystem and raising the level of digital skills and competences for the digital age [7]. The digital learning environment should be part of the modern digital ecosystem.

The Ukrainian educational community, with the support of the Ministry of Education and Science of Ukraine, initiated the creation of the National Digital Education Platform. However, this platform is under development. Research on aspects of the development of the digital learning environment is an urgent problem for the modern education system of Ukraine.

The purpose of the article is to consider the main characteristics of the digital learning environment of educational institutions, to identify approaches to its creation and to identify the components of the digital learning environment. Summarizing the results of the study allowed formulating recommendations for educators conducting procedure for creating and using th digital learning environment of educational institutions.

2 LITERATURE REVIEW

The analysis of the research problem was based on the study of international and Ukrainian documents, resolutions, frameworks, analytical materials. They determine the strategic directions and general trends in the development of education in the context of digital transformations. The concept of "New Ukrainian School" [2], Digital Agenda for Europe [1], Digital Competence Framework for Educators (DigCompEdu) [8], the Digital Education Action Plan 2021-2027 [7] and others deserve special attention. The process of formation and development of the digital learning environment is a new phenomenon in education. This problem is of interest to researchers in the field of education. The research of many Ukrainian and foreign scientists is devoted to the problem of development and development of the digital environment in education. Considerable attention is paid to the digitalization of education and the development of

the educational environment, in particular in the works. V. Bykov, Y. Burov, V. Lugovy, V. Oliynyk, O. Spirin [9], O. Ovcharuk [10], S. Semerikov, M. Stryuk [11] and others. Some aspects of the creation and development of digital educational environments are considered in the works of domestic researchers S. Litvinova [12], M. Shishkina [13] (cloud-oriented environment), T. Vakalyuk [14], I. Ivanyuk [15], N. Soroko [16], (computer-oriented environment), O. Hrytsenchuk [17] (information and educational environment). Foreign researchers deal with current aspects of the problem of creating and developing an educational environment with the use of ICT in educational institutions, namely: S. Brand-Gruwel, S. Carretero, R. Vuorikari [18] (teaching and learning in the digital educational environment) I. Poldner [19] (virtual learning environments), P. Fisser and M. Phillips [20] (components of the environment), K. Veelo, L. van Elk [21] (personally oriented environment), J. Tondeur and J. van Braak [22] (approaches), J. Knight [23] and D. Clandfield [24] (digital educational hubs), A. van der Kaap and A. Visser [25] (development trends).

3 RESEARCH METHODS

The following methods were used to reveal the purpose of this study: analysis, synthesis, generalization, systematization of scientific sources and research, observation and analysis of effective pedagogical practices to identify theoretical and applied aspects of the problem of construction and development of the digital learning environment.

4 RESEARCH RESULTS

The theoretical basis for the construction and development of the digital learning environment, which determines the principles of its creation and development, is the work of scientists. Thus, V. Bykov believes that the learning environment is an artificially constructed system, the components of which create the necessary conditions for achieving the goals of the educational process. The structure of the learning environment determines its internal organization, relationship and interdependence between the elements that are, on the one hand, the attributes or aspects of consideration that determine its content and material content, and on the other hand - the learning environment resources included in the activities of participants educational process, while acquiring the characteristics of means of teaching and education [9].

Summarizing the experience of creating a single information space of in-service teacher training institutions, scientists V. Oliynyk and S. Kasyan identify the principles on which such a digital environment is built: multicomponent, integrity, distribution, adaptability. They provide the development of a digital educational environment for active creative activity of learners. [9, 26].

The the digital learning environment of the future should be flexible and personalized, meet the needs and wishes of students, teachers and educational institutions, be independent of time and place, has quick and easy access to information and necessary materials. The use of ICT infrastructure places high demands on archiving, security and manageability. The digital learning environment to support students and teachers in the learning process must include a coherent set of digital applications that require a new architecture for their integration.

The architecture of a user-centered the digital learning environment includes user interaction, process support, and data management. This makes it possible to use basic data in many programs and the learning process can be monitored transparently. In addition, applications must have individual settings for users. The digital learning environment offers the opportunity to personalize, create learning trajectories and collaborate in different formats and work at different levels. The Learning Management System (LMS), which is an example of a container application, provides functionality for communication, collaboration, testing, content component organization, and more. ILIAS, aTutor, Blackboard Learning System, Moodle are common among modern learning management systems.

Obviously, to create a single universal system that would meet the requirements and needs of all participants in the educational process is very difficult. Therefore, to develop the digital learning environment, Dutch researchers propose a modular approach, the so-called principle of LEGO blocks, which are components of the environment. Among the main functions to be provided by the components (blocks) of the environment: communication, collaboration, evaluation (testing), planning and management, presentation and evaluation of tasks. This approach to the creation and use of the digital learning environment involves a separate development of all its elements, namely: IT services, applications, systems, etc., which can be easily combined, updated, added, removed, replace. This will create and develop the digital learning environment that can be adapted to innovation in both education and ICT [21].

Thus, the conditions for building an effective the digital learning environment are: standards and conceptual frameworks; infrastructure with integrative properties of the environment; access to the digital environment. Let's consider them in more detail.

Standards and conceptual frameworks form a holistic set of individual requirements that define the norms and approaches to how a particular system works. With the use of standards, data exchange can be simplified and operations will be carried out in a secure and reliable manner. Adapting the conceptual framework is also an important part of the process of building and using the digital environment, as different states often use different terms for the same concepts in education.

The digital learning environment as a holistic concept. It should be recognized that existing tools and various applications are not yet sufficiently standardized and are not always compatible with each other, which complicates their practical application. For individual systems to function as one, it is necessary to ensure their integration. In the process of deploying the digital learning environment as an integrated infrastructure, Dutch scientists distinguish between visual integration, data integration and infrastructure integration (Fig.1.).
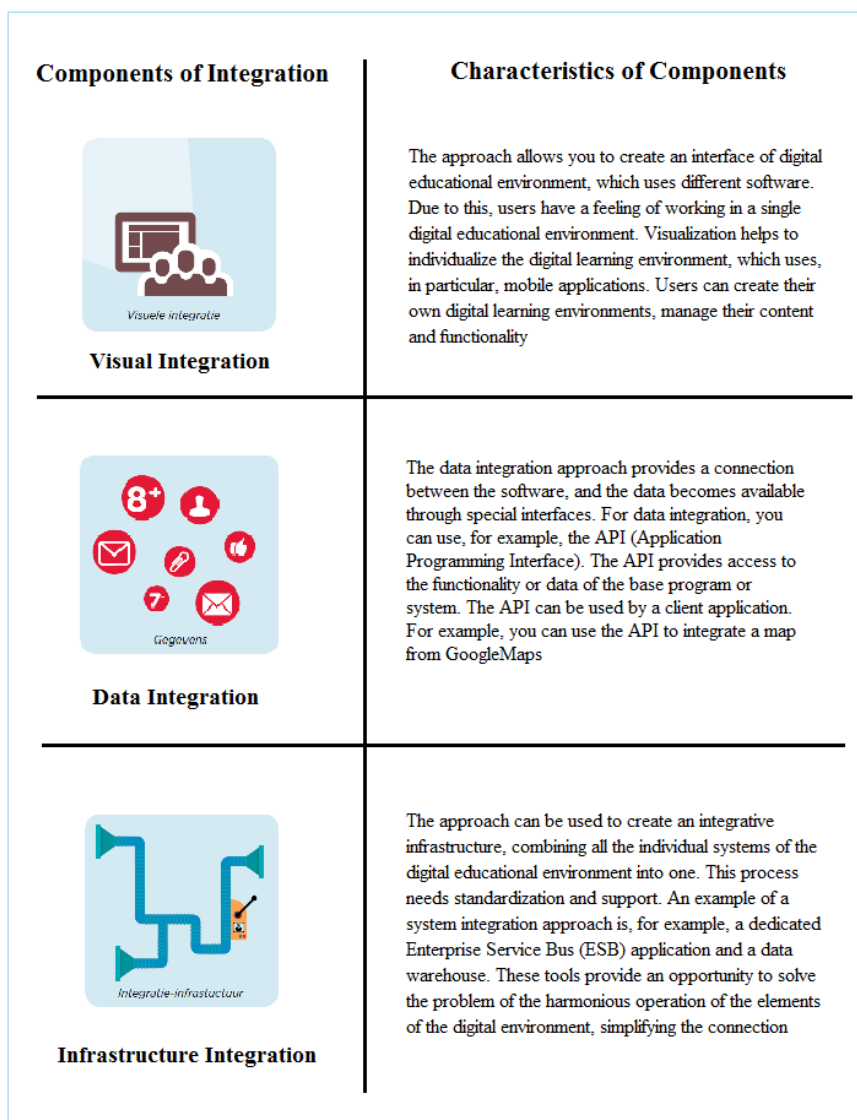
Components of Integration	Characteristics of Components
Visual Integration *Visuele integratie*	The approach allows you to create an interface of digital educational environment, which uses different software. Due to this, users have a feeling of working in a single digital educational environment. Visualization helps to individualize the digital learning environment, which uses, in particular, mobile applications. Users can create their own digital learning environments, manage their content and functionality
Data Integration *Gegevens*	The data integration approach provides a connection between the software, and the data becomes available through special interfaces. For data integration, you can use, for example, the API (Application Programming Interface). The API provides access to the functionality or data of the base program or system. The API can be used by a client application. For example, you can use the API to integrate a map from GoogleMaps
Infrastructure Integration *Integratie-infrastuctuur*	The approach can be used to create an integrative infrastructure, combining all the individual systems of the digital educational environment into one. This process needs standardization and support. An example of a system integration approach is, for example, a dedicated Enterprise Service Bus (ESB) application and a data warehouse. These tools provide an opportunity to solve the problem of the harmonious operation of the elements of the digital environment, simplifying the connection

Figure 1: An integrative approach to building a digital educational environment based on the principle of LEGO blocks (The Netherlands).

Access to the digital learning environment provides procedures that enable personalization, protection of information and systems and can be organized through identification, authentication and authorization. The organization of the access procedure is provided by defining the role played by the user personally or on the basis of belonging to a certain group of user.

The development of an integrated the digital learning environment is possible provided that basic systems, such as the Student Information System (SIS), are secure and reliable. Both the API standards (API) and the work on the architectural vision in the process of application integration are important. Basically, this is done by using the functionality of many programs.

The components of the digital learning environment perform functions such as communication, collaboration, testing, planning, submission and assessment of tasks (submission of students' works and their evaluation). These components can be changed, filling them with additional functions, to replace them with others that better meet the learning objectives. In this way, the digital learning environment can always adapt to the latest developments in the field of education and respond to technological innovations.

The stages of creating the digital learning environment should include measures that step by step implement the goals set by educational institutions.

Based on the work of scientists in the field of didactics and methodology, as well as domestic and international experience, we have developed a procedure for creating and using the digital learning environment.
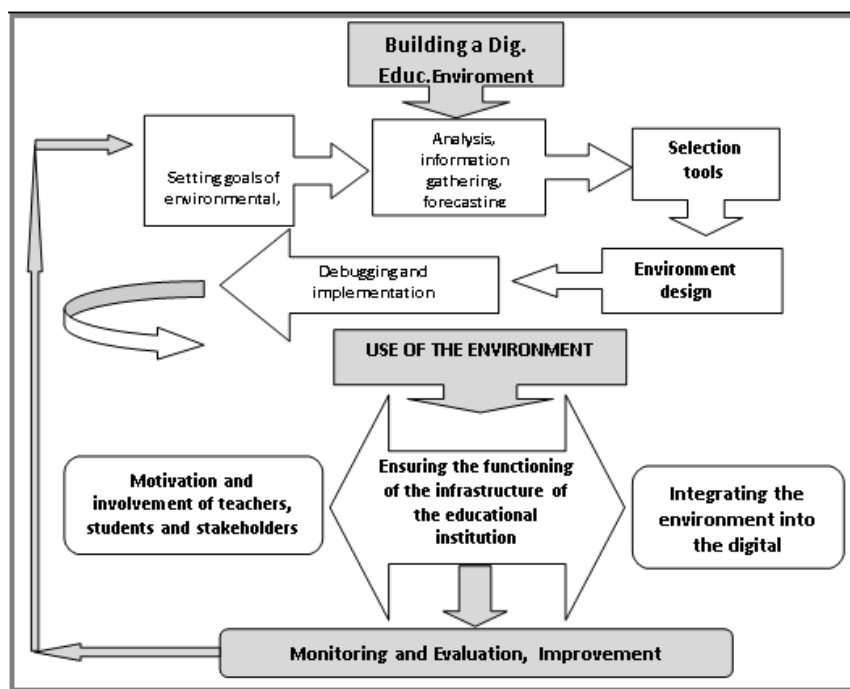

Figure2: The procedure for creating and using the digital learning environment.

The use of the digital learning environment from the standpoint of gradual creation and integration provides the formation and development of digital educational space with the direct participation of teachers, students and all

educational stakeholders. The block diagram shows the relationships between the main elements (stages) of this process (Fig. 2) [17].

Designing the digital learning environment includes the following stages: diagnosing the current situation, identifying problems and setting goals, analyzing and collecting information, selecting tools for the digital learning environment, designing an environment, setting up and implementing the digital learning environment, monitoring and evaluation, improvement. In addition, the following measures should be taken at these stages: motivate and involve teachers, head of educational institutions and stakeholders; ensure the functioning of the infrastructure of the institution where the digital learning environment is created; integrate the digital learning environment into the digital learning space.

Identifying problems and needs, setting goals includes defining the purpose and final results of the development and use of the digital learning environment. At the stage of determining the goal, the necessity and existence of the possibility of using the digital learning environment in the educational process is fixed.

There are certain conditions for initiating integration. The teacher manages the educational and information process within the discipline. Structured teaching materials become the basis for the formation of the digital learning environment, and the teacher uses them in the learning process.

Collection of information, analysis and forecasting include: collection of data on sources in your subject in Ukraine and abroad, teaching materials, projects, educational programs, networks of teachers and educators, etc.

Forecasting and planning involves defining goals, objectives and prospects for building the digital learning environment in stages.

The selection of the digital learning environment includes: definition of approaches and criteria for digital tools; definition and study of their features and properties of components, definition of the corresponding standards.

Environment design includes: the process of creating a project environment, its prototype (ßeta-version), development of terms of reference and determination of methods of its manufacture. At the same time, a system approach is used for design. It provides a description of the structure of the system, the type of communications, the definition of attributes, components, characteristics, analysis of environmental influences. Digital learning tools must also be chosen. Teachers and students choose these tools. They must meet the educational and professional needs and requirements of teachers and students, in particular as regards their effective and safe use.

Establishment and implementation of digital learning environment includes filling the educational environment with technological (software, information and organizational) resources. Important components are: appropriate computer equipment, the functioning of the Internet, Wi-Fi technology; software resources (virus and license security, software compatibility); academic component (scientific and methodological support, compliance with professional and educational standards, standard and working programs, elective programs, instructional and organizational documentation, digital didactic material, guidelines for the use of hardware and software products, etc.); social (ethical, culturological, normative-legal aspects); personal (ICT literacy, psychological readiness, availability of teachers and students to subject-subject interaction in the digital learning environment).

The process of monitoring, evaluating and improving digital learning environment involves tracking resource load statistics. The use of the digital educational tools demonstrates their relevance and necessity. It is important to monitor student progress and teacher development, identify problems, supplement and correct teaching materials, various types of assessment of the level of mastery of teachers and students' methods of using the digital educational environment.

5 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis of scientific and pedagogical works of foreign and domestic researchers, international documents of the Council of Europe, OECD and legislation, it is clarified that the digital educational environment is an effective tool in the educational process and in the process of professional self-improvement. Creating and maintaining a digital learning environment as part of the digital ecosystem is an important task of the education system.

The generalization of Ukrainian and foreign experience allowed to highlight the main features of the modern digital educational environment, including continuity and continuity, equal access to education, information security, mobility; interactivity, unity of purpose, content and focus on results; innovation and content with digital means, the ability to create their own digital resources and interaction of participants in the learning process in an unlimited open educational information space.

Summing up, we note that important aspects in the development of modern digital educational environment are: compliance with the principles of continuity and consistency, equal access to education, anti-discrimination, gender equality, information security, mobility; interactivity; involvement in the professional development of teachers and professional interaction of various actors and stakeholders; unity of purpose, content and focus on results; innovation and content with digital means; the ability to create their own digital resources and interaction of participants in the learning process in an unlimited open educational information space.

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