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Architecture and basic requirements for modern educational portals

This article is devoted to an overview of modern architecture and requirements for educational portals in terms of their functionality, ergonomics and efficiency of use, as well as the impact of modern technologies. It examines the key aspects of online educational portals as the basis of a high-quality learning web environment.

The place and importance of the educational portal in the modern learning environment

Most modern researchers consider the online education portal as a website that provides web-based learning participants with the opportunity to interact and collaborate with electronic learning materials, such as courses, presentations, podcasts, and tests, as well as a means for teachers to manage these materials [1, 2]. That is, in fact, it is possible to define an online educational portal as a multi-level digital platform that provides access to a variety of educational resources and services aimed at forming the knowledge and skills of users in a virtual environment.

As noted by N. T. Zadorozhna and T. G. Omelchenko in their work "Technological Bases for the Creation and Support of Portals", educational portals play an important role in modern schools, universities and other educational institutions. The authors define educational portals as software and hardware complexes that combine in various forms and volumes territorially distributed data on scientific and methodological information resources, modern teaching technologies, state educational standards and any other information that can maintain an individual level of education and interest in continuous improvement of this level [3].

Online learning portals integrate resources from various sources, providing students with access to the latest research and methodologies. Interactive elements enhance learning, and certificates earned can increase competitiveness. These portals contribute to the development of the educational environment by addressing modern needs and challenges like new assessment methods, maintaining motivation, and preparing participants for technology usage [4].

All of the above confirms the significant importance of the educational portal in the context of the functioning of the modern educational environment or educational space, the formation of which was considered, in particular, by Philip Bunyard and Gene Underwood in their work "Understanding the learning space" [5]. An important contribution to the consideration of this concept was made by the American scientist Malcolm Brown in his work "Learning Space Design Theory and Practice". Based on the characteristics of today's learners, he identified the design principles, technological configuration, and appropriate learning styles of the online learning space [6]. Brown's work is the first monograph to systematically introduce

the concept of the learning space and explain the basic trends in its design in the context of three aspects: student change, technology development, and understanding of the learning process.

Educational space is a multifaceted concept encompassing physical, digital, and socio-cultural aspects of learning. It provides the context for knowledge exchange, skill development, and the formation of the educational environment. A key component is the educational portal, which offers a range of online learning tools and resources. To effectively support modern learning, it's essential to define clear requirements and architectural principles for educational portals.

Basic principles of building the architecture of modern educational portals

Building an educational portal involves a complex process considering technical factors and pedagogical principles. The portal's architecture must support various components, ensure security and scalability, and integrate educational resources. Key aspects include user interaction, adaptive learning, and progress monitoring. Modern portals must meet high standards of quality, reliability, and security. Successful examples like Udemy and Coursera demonstrate how effective distance learning can be through well-designed educational portals. Achieving such results is possible due to a carefully developed training system using a modern approach to software architecture. New generations of online education platforms strive to be flexible and efficient, unlike outdated architectures. The possibilities of modern software and the development of multimedia technologies contribute to the ability to meet the maximum number of educational needs.

The issue of building the architecture of electronic learning systems is considered by various modern researchers, including E. A. Palamarchuk. He notes that at the heart of any electronic system of this type is the relationship between the user and the knowledge base. The simplest online learning systems provide the user with the opportunity to search in a certain database of materials, comprehend the information received and apply it [7]. However, complex structures such as educational portals provide a much wider range of educational opportunities. In his article, E. A. Palamarchuk gradually complicates the elementary educational system (figure 1), adding new elements to it, which can be implemented both with the help of modern technologies and with the addition of certain agents to the learning structure (for example, teachers, administrators, etc.).

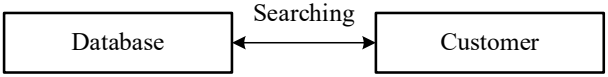

Figure 1. Elementary Educational System [7]

The issue of building a functional architecture of an educational portal is also considered in the article "Architecture of e-Learning". The authors of the work include such structural components as the user interface, which provides a direct opportunity for the user to interact with a certain e-learning system; user profile,

which can be customized by the user himself in accordance with his interests; elements of access to the knowledge base (information search, supply, filtering); notification system [8]. Modern online educational portals often include all of these elements: they provide a user-friendly interface that makes it easy to find the information you need, an adaptive user profile, an instant knowledge base, and a notification system that can be sent within the portal itself, to e-mail, or to a mobile device using a pre-installed application.

E. A. Palamarchuk provides a diagram of the general architecture of electronic learning systems based on web technologies (figure 2), which has become actively used, in particular, in such platforms as mentioned above (Coursera, Udemy) and other popular platforms for online learning (EdX, JetIQ). The main idea of such systems is to automate a number of educational functions, including navigation, provision of training materials, assessment, and processing of results [7].

Based on the above and the analysis of samples of modern educational portals, it is possible to conditionally divide the elements of the architecture of educational online portals into the main and fundamentally new (innovative) ones, which appear due to the influence of modern technologies.

The main components include a User Interface (UI), training content, a Learning Management System (LMS), communication tools, and a security system. These components should be present on online educational portals, regardless of their scale, as they provide the basic functionality of this type of web resources.

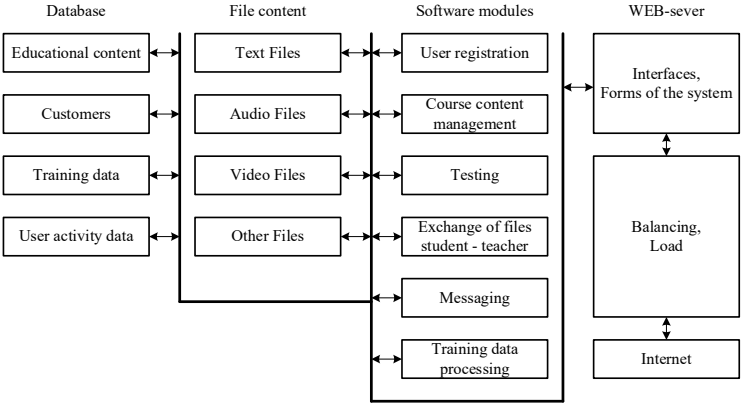

Figure 2. Architecture of e-learning systems based on web-technologies [7]

Modern educational portals are incorporating artificial intelligence, cloud technologies, AR/VR, and blockchain.

AI-powered assistants and personalized recommendations enhance the learning experience. Automated grading systems improve efficiency and objectivity. These technologies are transforming the way training is organized and users interact with educational portals. Also, an aspect of using artificial intelligence is the ability

to create educational materials and tasks for them with its help. However, any AI-generated content still needs to be reviewed. Cloud technologies enhance educational portals by providing scalability, accessibility, and real-time collaboration. AR/VR creates immersive learning experiences and enables virtual simulations. Blockchain ensures reliability, transparency, and data security in evaluation and certification processes.

Requirements for online educational portals and the general concept of architecture

Let's move on to considering the requirements of online educational portals. Of course, the list of requirements may vary depending on the purpose of the portal, the scale and characteristics of the user base to which it is focused. Therefore, we will offer the optimal range of conceptual requirements that meet the main criteria of today. One such aspect is to provide the ability to learn anywhere, anytime (Flexible Learning). This requirement stipulates that the educational portal must support a responsive design that allows users to access educational materials from any device – computer, tablet or smartphone. In addition, the portal should provide continuous access to resources, regardless of the time of day or the user's location. Another important requirement is the ability to manage users and authentication. Only authorized users can access the main content. Unauthorized users (guests) should be able to familiarize themselves with the content of the content (training materials and the list of tasks) [7].

Educational portals should offer reporting and analytics tools, communication features, and robust content management. They should allow for tracking student performance, course completion, and average scores. Additionally, portals should facilitate communication between students, teachers, and administrators through video conferencing, chats, and forum comments. Finally, they should provide tools f\or creating, managing, and organizing course content, including multimedia.

Educational portals must prioritize security measures to protect sensitive data. They should implement secure user authentication, data encryption, and access control. SSL/TLS certificates are essential for ensuring data confidentiality, integrity, and authenticity.

Based on the above, we can offer a new conceptual architecture of a modern educational portal, which includes additional requirements and innovative components.

1. User Interface (UI/UX). The main goal is to provide an intuitive and responsive interface that provides convenient access to all portal features. The interface should be: intuitive and easy to use for different categories of users (students, teachers, administrators); adaptive to provide the same user experience on different devices — computers, tablets, smartphones; multilingual to meet the needs of an international audience. interactive and multimedia and at the same time not overloaded with unnecessary elements.

2. Learning Content Management. Content should be modular, multimedia, and interactive: modularity (division into thematic blocks or modules) makes it easy to update and adapt materials; multimedia ensures the inclusion of

texts, video, audio and interactive elements; Interactivity fosters active student engagement through video lectures, simulations, quizzes, and hands-on assignments.

3. Learning Management System (LMS). LMS is the central element of the educational portal, which provides: adaptive learning through personalized learning paths that take into account student progress and outcomes; monitoring and evaluation using automated assessment systems, training analytics and reporting; learning analytics, which allows teachers and administrators to obtain detailed data on the effectiveness of curricula and individual student progress.

4. Communication tools. The platform should include a variety of means for communication and collaboration: forums and chats to discuss and support students and teachers; webinars and video conferences for online classes, consultations, and group projects; Email and messaging for quick and efficient information sharing.

5. Intelligent technologies. Using Artificial Intelligence and Machine Learning to Improve the Learning Process: intelligent assistants (chatbots) to support students in real time; personalized recommendations to provide individually tailored learning materials; automated grading systems for checking assignments and tests.

6. Cloud technologies. Cloud solutions provide flexibility, scalability, and availability of the portal: scalability and accessibility allow the portal to function stably, even under heavy load; Real-time collaboration allows students and faculty to work on collaborative projects and assignments; Storage and backup ensure reliable data storage and automatic backups.

7. Augmented and Virtual Reality (AR/VR). AR/VR technologies enhance learning experiences through immersive simulations: immersive learning aspects through interactive simulations that allow students to acquire practical skills; Virtual labs provide access to laboratory experiments and research in a virtual environment.

8. Blockchain technology. Blockchain provides security and transparency: data protection and certification through the secure storage of information about students' academic achievements; Digital identity management to protect personal data.

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