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MODELING AND IMPLEMENTATION OF A DISTANCE LEARNING SYSTEM: STAGES, REQUIREMENTS, FUNCTIONALITY

Abstract. The article examines the essential aspects of organizing and implementing a distance learning system in the context of modern educational development. The study analyzes the principal stages of distance education deployment, ranging from initial planning to the full-scale operation of the system. A comprehensive specification of requirements for the system's functionality is outlined, including technical, functional, and organizational dimensions. The article defines the core user groups of the distance learning system, with a particular focus on identifying their roles and specific needs within the learning environment. Special emphasis is placed on the design of the user interface, which must ensure intuitiveness, accessibility, and adaptability to diverse user expectations. Additionally, the article addresses the requirements for the database structure intended to manage and store information related to users, courses, and learning outcomes. The core system modules are identified and described, including modules for registration, administration, educational content management, assessment, and data analytics. The proposed approach facilitates the development of an efficient and user-centered distance learning environment designed to meet the evolving demands of contemporary education.

Keywords: distance learning, computer technologies, modular software.

Introduction

In the modern context of the global use of computer technologies in every sphere of human activity, there arises a necessity for the implementation of both elements of e-learning and distance learning in general within educational institutions.

Distance learning is a combination of modern technologies that ensure the delivery of information interactively through the use of ICT (information and communication technologies) from those who teach (teachers, prominent figures in specific scientific fields, politicians) to those who learn (students or users).

The main goal of distance learning (DL) is to provide all citizens with the opportunity to acquire quality knowledge and the corresponding skills and abilities at their place of residence through the use of information and communication technologies and appropriate software [4].

An important factor in ensuring a sufficient quality level of DL during the organization of the educational process is the well-reasoned and balanced choice of specialized software for managing distance learning. The characteristic features of this form include flexibility, modularity, parallelism, cost-effectiveness, technological advancement, social equality, and a new role for the teacher.

Thus, it is possible to effectively allocate users' time and enable them to determine the quality of their own preparation. Distance education requires a high level of professional training for teachers. For the implementation of this form of learning into the educational process, it is necessary to determine the distance learning system.

Distance learning systems (Learning Management Systems) are applied software products for managing the educational process. Today, a wide range of distance learning systems is used in educational institutions in Ukraine. Almost all modern LMSs offered by developers meet the specified requirements, but not all of them are accessible to most educational institutions due to their high cost and complexity of use [8].

The absence of any standards and requirements for distance learning systems in the educational system compels the vast majority of educational institutions to make their choice among existing software based on the following main criteria:

- reliability in maintenance and security;
- compatibility;
- ease of use and administration;
- modularity;
- accessibility;
- cost of software, maintenance, and hardware.

Based on the above, the task was set to develop an accessible distance learning system that would meet the needs of any educational institution.

The aim of this article is to present a scheme of a distance learning course and to propose elements of a distance learning system.

Stages of Organizing and Implementing the Learning Process

The work of organizing and implementing the learning process is conventionally conducted in two stages:

0. Preparatory Stage.

At this stage, the instructor creates and populates the electronic course with logically-structured educational information, taking into account the specifics of the subject. The instructor also plans for student consultations and schedules the educational activities for all participants (Fig. 1).

1. The Main Stage.

This stage involves the organization of users' educational activities according to the plan, as well as adjustments to the educational material and the structure of the electronic course.

These stages are based on the working programs of academic disciplines, which define the subject, goals, and objectives of the academic discipline, as well as the

program of the academic discipline with a detailed course structure.

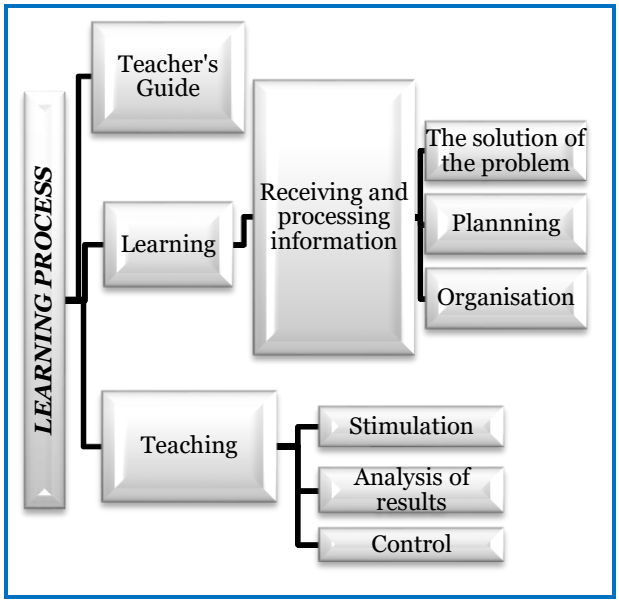

Fig. 1. The general schema of the learning process.

In the creation of a distance learning course at Poltava National Technical University named after Yuri Kondratyuk, a scheme was implemented as shown in Fig. 2.

The scheme was developed using the example of the discipline "Informatics," aimed at providing high-level computer training for future specialists. The course builds on the knowledge of computer technology acquired in school.

The main challenge in developing an electronic course is the unpreparedness of instructors to work with the software products used to create electronic versions of lectures and supplementary materials for the practical part of the course.

An important stage in the development and implementation of a distance learning course is the preparatory stage, which includes the development of the future course structure.

It is necessary to understand that, in modern conditions, there is still an issue with the level of computer science education among high school graduates, resulting in students at higher educational institutions having varying levels of preparation. Therefore, some initial topics overlap with the school curriculum. However, our goal is to provide more in-depth knowledge on these topics.

The subject matter was developed considering the updates in modern computer hardware and software (Fig. 3).

To implement a distance learning format in the educational institution, the creation of a modular software package was proposed. A work plan was developed to achieve this goal (Fig. 4).

2. Software Requirements Specification

The Software Requirements Specification (SRS) is a complete description of the behavior of the distance learning system to be developed.

Specification contents:
1. Purpose of creation.
2. User characteristics.
3. Product functions.
4. Assumptions and dependencies.
5. General limitations.
6. Operations.
7. Interface requirements.
8. Technological tools.
9. Memory constraints.
10. Maintenance.
11. Database requirements.
12. System architecture.

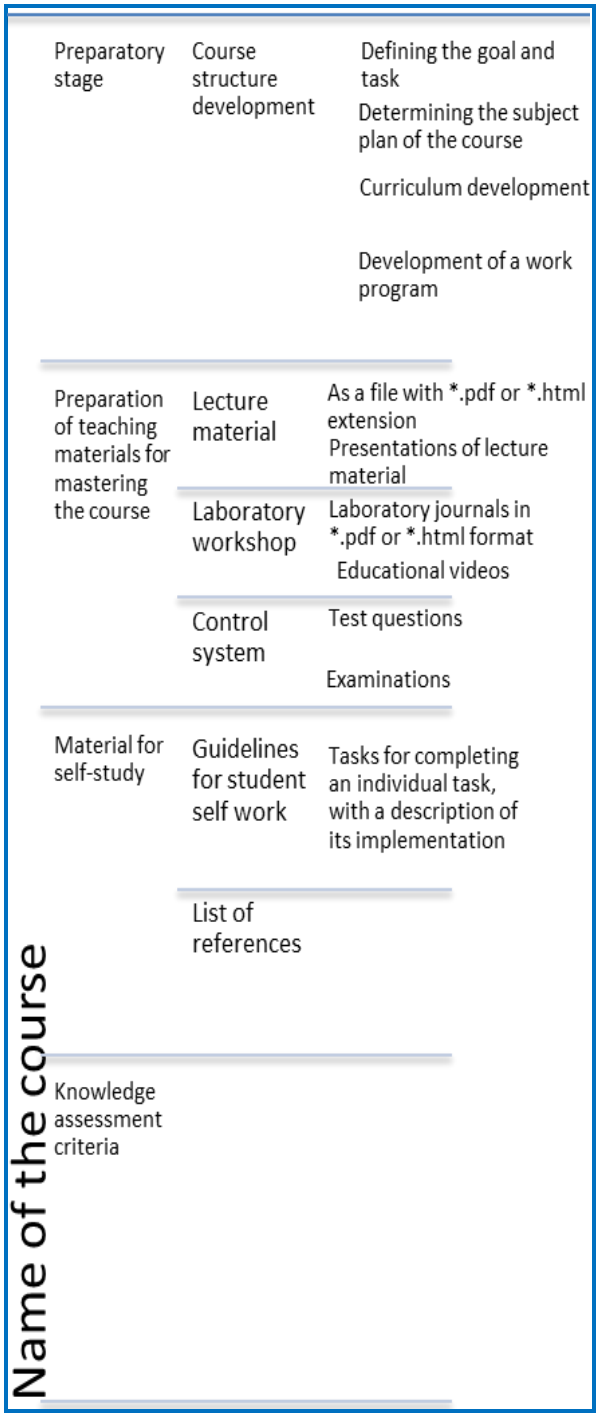

Fig. 2. Scheme of the educational process organization

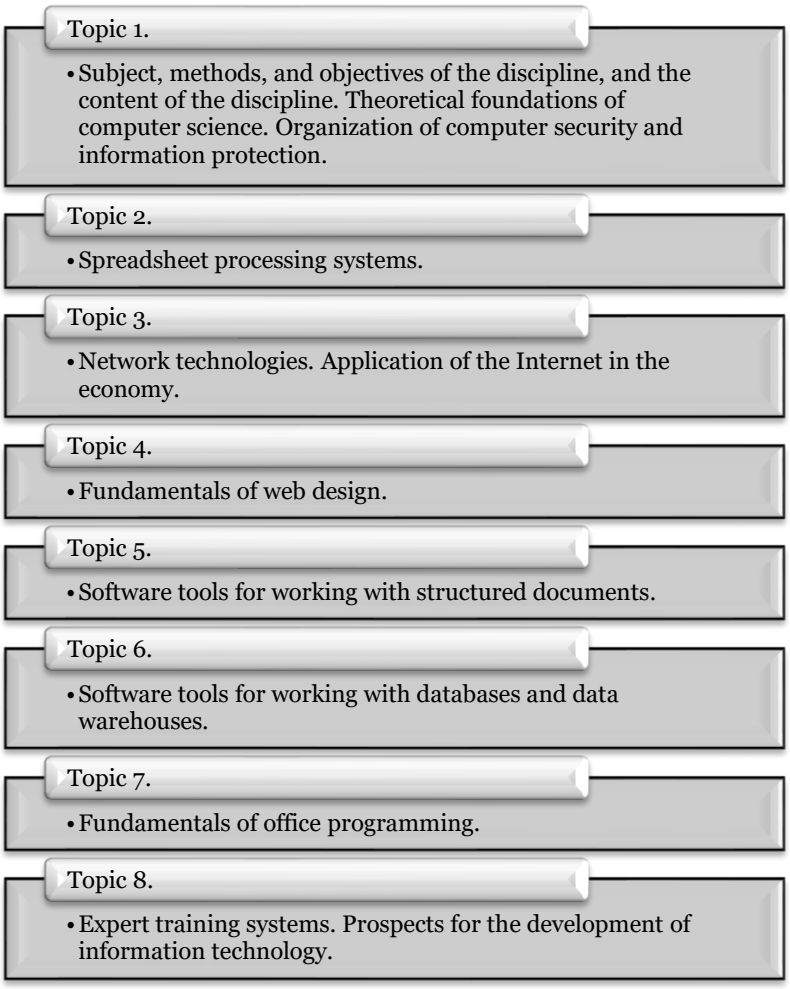

Fig. 3. Distance course topics

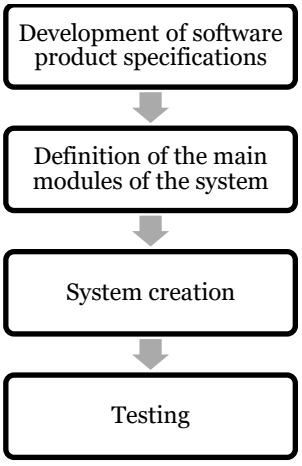

Fig. 4. Planning the implementation of a software development task

2.1. Purpose of creation

The implementation of the latest technologies in the educational process to ensure a distance learning format.

2.2. User characteristics

- Managers of various levels.
- Heads of regional management bodies.
- Individuals seeking a second education or retraining.
- Army officers facing downsizing.
- Individuals wishing to improve their qualifications in a specific field of knowledge.
- Citizens with limited mobility.
- Persons with disabilities.
- Citizens who wish to receive education at a convenient time and are located remotely from the educational institution.
- Highly capable students who already possess substantial knowledge and wish to complete an educational program in a shortened timeframe.
- Users who want to combine study with professional activities.
- Users wishing to complete special educational programs consisting of courses provided by various educational institutions, including those from different countries.
- Users geographically isolated from educational resources.
- Individuals who did not complete their education in their youth.

2.3. Product functions

- Accounting for learners, personalization, and access rights management to educational materials.
- Management of the learning process, including tracking learning and testing outcomes.
- Preparation of operational and analytical reports.

- Management and integration with electronic communication mechanisms.

- Integration with external information systems.

2.4. Assumptions and dependencies

- All users must have the technical and software capabilities necessary for quality learning (e.g., working with video, audio, multimedia).

- The presence of appropriate technical and software support, access to information, and the ability to use distance learning tools are required. The user must have a personal computer and internet access.

2.5. General limitations

- The system has limitations in knowledge verification.

- There is no direct face-to-face interaction between students and instructors. The presentation of material lacks emotional expression, making it difficult to create a creative atmosphere among students.

- High demands are placed on the organization of the learning process and its administration.

- A key challenge is the issue of user authentication during knowledge assessments.

- A set of individual psychological conditions is mandatory. The effectiveness of distance learning depends on the student's independence, awareness, and strict self-discipline.

- There is a lack of constant supervision over the learners.

- There is a noticeable lack of practical work.

2.6. Operations

- Authoring tools for developing educational content.

- Learning Management System (LMS).

- System for information exchange between participants in the educational process.

- Educational content delivery system (usually a website).

2.7. Interface requirements

- Since the quality of the user's interactive experience with the system (speed, convenience, low fatigue) is related to psychological characteristics such as short-term and medium-term memory, reaction time, and visual information perception capabilities, it is important to remember that the interface is the most crucial part of a Decision Support System (DSS) from both an advertising perspective and the direct user's perspective, who may work with it for several hours at a time.

- The interface influences the nature of decisions; it can accelerate decision-making time and improve or degrade their quality.

- The specific type of interface that can be created with the chosen tools and the fundamental possibilities offered by the tool system should be considered.

- The interface design was carried out based on the developed data flow diagram (Fig. 5).

Here is the English translation of the provided Russian technical text:

According to the international classification, the following interface requirements must be met:

- ✓ Alignment with user tasks.
- ✓ Ease of use.
- ✓ Manageability.
- ✓ Conformity to user expectations.
- ✓ Error tolerance.
- ✓ Adaptation/Personalization.
- ✓ Ease of learning.

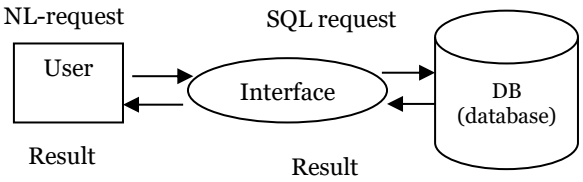

Fig 5. General diagram of data flows of a natural language (NL) interface

2.8. Technological Tools

- Internet technologies.

- World Wide Web: a system for organizing information on the Internet based on hypertext.

- FTP (File Transfer Protocol) for file transfers.

- E-mail.

- Synchronous, real-time online teleconferences.- Video conferencing in computer networks holds a special place.

- Given the needs for communication via global network channels and considering current trends in channel utilization methods, it is advisable to focus on the TCP/IP protocol stack. Accordingly, there are two main possibilities for implementing transport services: streaming mode, which is provided by the TCP protocol, and datagrams based on the UDP protocol [8].

2.9. Memory Constraints

- There are no memory resource limitations, reaction speed to system requests, etc.

2.10. Maintenance

- The software product is maintained by a team of specialists, including course instructors-designers and technology experts (television and video recording, computer graphics, network technologies, etc.).

2.11. Database Requirements

The main task of the database (DB) is to ensure the guaranteed preservation of large volumes of information and provide user access to it. Thus, the DB consists of two parts: stored information and a management system. In this project, the MySQL relational database management system was used. MySQL is an open-source database management system (DBMS).

MySQL server capabilities:

- Easy installation and use.

- Supports an unlimited number of users simultaneously working with the DB.

- The number of rows in tables can reach 50 million.

- High command execution speed.

- Simple and effective security system.

The main requirements for databases are:

- Structured: it should be organized according to a unified principle: by organizations, employees, industries.

- Ease of use.

- Maximum completeness of information.

2.12. Definition of Main System Modules

- Administration Module: includes role distribution, definition of restrictions, and general system settings.

- Learning Process Organization and Support Module: allows the introduction of materials for theoretical and practical training in any format into the system.

- Test Development and Support Module For technical universities, there is a need to implement both closed and open type test tasks. Therefore, when developing the testing module, the task of evaluating the assignment completion arose.

- Educational Materials Development and Presentation Module: should ensure the inclusion of theoretical material and methodological recommendations for completing the practical part in the course. In modern teaching conditions, the presentation of information changes, so it is necessary to provide students with video and multimedia materials. This means anticipating the inclusion of various formats and their compatibility with the system. Interactive Interaction Module for Course Users: lecturer-student, student-student, student-lecturer interactions. The most commonly used tools are forums and chats.

- User Activity Registry Module: should provide complete information about the work of students in the system and allow the output of reporting information.

3. Graphical Modeling of the Information System

During the preliminary analysis of the task, graphical modeling of the information system was performed using a Data Flow Diagram (DFD) (Figure 6).

This methodology of graphical structural analysis describes external sources and destinations of data relative to the system, logical functions, data flows, and data stores that are accessed.

Information sources (external entities) generate information flows (data flows), carrying information to subsystems or processes.

These, in turn, transform the information and generate new flows that carry information to other processes or subsystems, data stores, or external entities - information consumers [2].

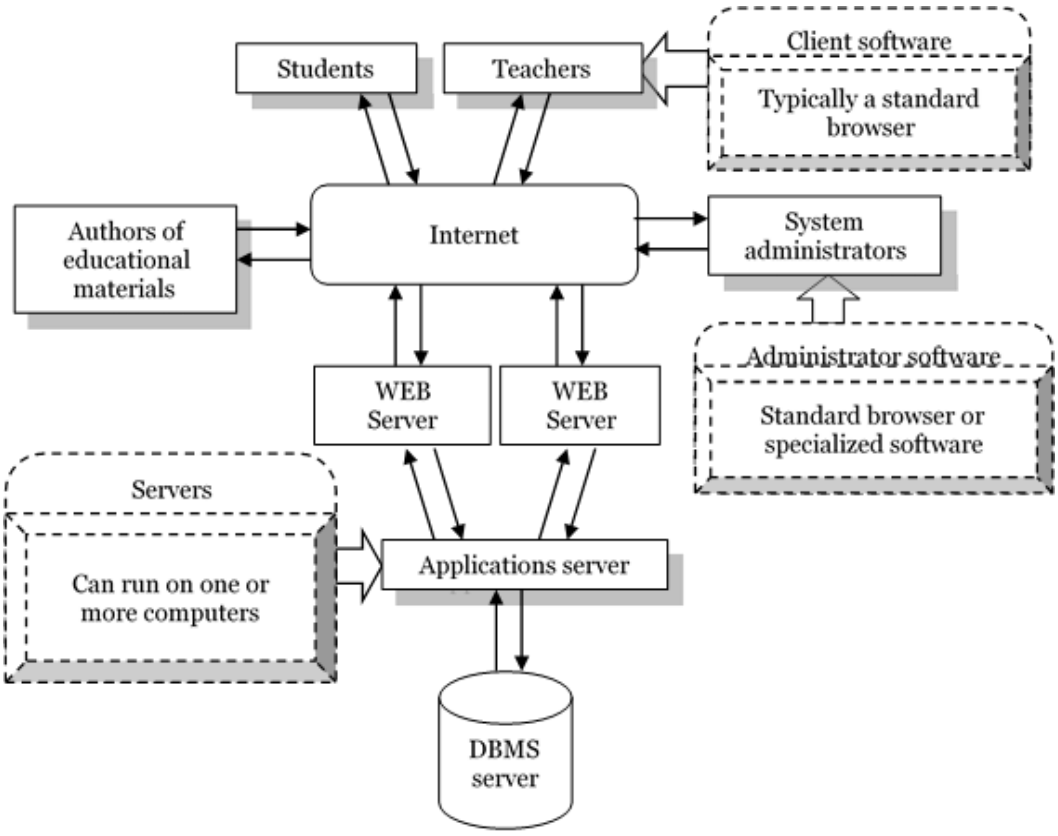

Fig 6. DFD Data Flow Diagram

Conclusions

The conducted analysis highlights that the effective organization and implementation of distance learning systems requires a comprehensive approach that integrates technical, functional, and organizational components. Clearly defined user roles, a user-friendly and adaptive interface, and a structured database for managing user, course, and learning outcome information are key factors for ensuring the system's efficiency and sustainability.

The identification and integration of essential system modules – including registration, administration, content management, assessment, and analytics − form the foundation for creating a flexible and scalable educational environment. The proposed approach not only addresses the current needs of learners and educators but also contributes to the development of a

modern, accessible, and high-quality distance learning ecosystem.

The results of this research may serve as a methodological basis for further improvement of distance education platforms and their integration into the broader educational process, facilitating the transition toward more personalized, data-driven, and technology-enhanced learning experiences.

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Моделювання та реалізація системи дистанційного навчання: етапи, вимоги, функціональність

Т. М. Деркач, А. О. Дмитренко, Л. А. Клочко

Анотація. У статті розглянуто ключові аспекти організації та реалізації системи дистанційного навчання на сучасному етапі. Проаналізовано основні етапи впровадження дистанційної освіти – від планування до експлуатації системи. Представлено специфікацію вимог до функціонування системи, зокрема технічні, функціональні та організаційні аспекти. Надано характеристику основних груп користувачів, із визначенням їхніх потреб і ролей у системі. Особливу увагу приділено вимогам до інтерфейсу користувача, що має забезпечувати інтуїтивність, доступність та адаптивність. Розглянуто вимоги до структури бази даних для зберігання інформації про користувачів, курси, результати навчання. Визначено основні модулі системи, включно з модулем реєстрації, адміністрування, навчального контенту, тестування та аналітики. Запропонований підхід сприяє створенню ефективного та зручного середовища для дистанційного навчання, що відповідає сучасним освітнім потребам.

Ключові слова: дистанционное обучение, компьютерные технологии, модульное программное обеспечение.