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# Lms information system development concept and principles

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**Abstract**—A learning management system (LMS) is a system that includes the provision of educational services. Initially, this system was used only by educational centers and higher education institutions, but soon large companies began to use it. The current trend is towards distance learning, which is reflected in the increasing use of LMS. Thus, the development of this system allows companies to introduce a training platform for their employees. The main function of an LMS is to manage existing knowledge. Currently, the creation of LMS systems for improving the professional training of students and training quality personnel is not only the development of a software platform for e-learning, but also the creation of an effective environment for managing the e-learning process and acquiring knowledge and information. Therefore, creating comprehensive LMS systems using modern information technologies is very important today. Development of an electronic learning management system (LMS) is the most important step in the implementation of employees, pupils and students, course participants and training sessions. This article presents the modern concept and principles of LMS information system development.

**Keywords**—LMS, educational management systems, blended learning, concepts and principles, information system, educational process, e-learning.

## I. INTRODUCTION

The growing demand for LMS and other learning technologies reflects the tremendous changes that the world of work and society are experiencing. Today, identifying and retaining good talent is a critical factor for organizations to thrive. Traditional positions are starting to be disrupted by digital transformation, making skill sets that were once in demand gradually outdated. Transportation companies are incorporating data-driven automation procedures into their daily operations. As always, people who welcome change are robust and adaptive rather than those who fight it. Today, with the help of modern technology, traditional approaches to quality education and professional development are being reconsidered. LMS software

solutions are showing companies that learning is not a complicated, limited exercise by offering a continuous learning experience for their employees. HEIs can access software called a learning management system, or LMS, which gives them the resources they require for every facet of the learning process. Cloud integration with other critical HR and corporate management systems is supported by the finest LMS systems, which are built on AI and smart technologies [1,2]. The necessary learning resources are contained, distributed, and managed by the LMS.

The software implementation in the organization should be weighed against the short- and long-term benefits, including measurable increases in revenue and productivity. The advantages of implementing LMS systems in HEI are as follows [3,4,5]:

- Cost reduction and efficiency improvement. Typically, the initial costs of HEIs' LMS software are covered by savings in traditional training costs, travel and external expenses (for staff and faculty), and administrative and training consulting costs.
- Culture of continuous learning: tailored to each worker. A continuous learning process can be tracked, recommended, and delivered by an LMS with each new step or learning unit.
- Application of cloud technologies: LMS based on cloud technologies can be constantly updated with the latest design and development innovations. Integrating the cloud with ERP helps to facilitate the analysis of the HEI learning process and alignment with existing results.
- Ensuring compliance with regulatory requirements. The Learning Management System (LMS) offers an international and transparent perspective of the compliance status for certification and education, thanks to features like workflow monitoring, notifications, and electronic signature processes.

- Improving the skills and efficiency of employees. Modern LMSs use data and operational analytics to create actual training courses. LMS features help increase, manage and retain attendance. This leads to faster and more strategic upskilling and retraining of the talent pool.
- Increasing students' activity. An LMS can facilitate teaching and learning through a combination of different media and channels. This gives the user an opportunity to approach it individually and helps to increase the number of participants of training courses.

Types of educational management systems [6]:

- SaaS-based cloud-based learning management systems: Typically hosted by a software vendor. SaaS-based solutions provide easy scalability, updates to cloud technologies, and a wide range of features and integrations.
- Standalone LMSs: These are ideal for companies who wish to handle the setup and content distribution of LMS systems on their own. Although scalability, speed, and ease of integration are compromised, this system offers total control.
- Open Source LMSs: Because open source allows small organizations to incorporate ready-made, free open source code into their own systems, it's a perfect option for them.
- Rather than being a distinct "type" of LMS, mobile LMSs are LMSs that have dashboards and device-friendly components (the systems don't open and deploy on their own).
- business LMSs: Although these systems can be tailored for use in a business setting, enterprise users are becoming a more important consideration in the development of LMSs. Either self-hosted or cloud-based HEI LMS systems are available.
- Traditional LMS: Although they served as the foundation for many contemporary enterprise LMS systems, as previously said, they were not initially created with business objectives and goals in mind. An LMS of this kind may be self-hosted or cloud-based.

### STUDY OF LMS SYSTEMS

LMS is a software that allows the HEI to automate training courses, the student to register in the system and pass training courses, the teacher to create the content of training courses and monitor student learning. Through LMS systems, it is possible to provide education not only to citizens of the country in which the HEI is located, but also to citizens of other countries. The main characteristics of LMS systems are as follows [3,6]:

- conducting training individually;
- monitoring the results of the educational process, mastering and implementation of educational programs;
- providing individual training courses in accordance with the development of the learner's knowledge.

These characteristics allow HEI to effectively use both traditional and electronic learning opportunities. Information

systems such as Blackboard Learn, Moodle, Desire2Learn, and Sakai can be noted as the world's leading LMS systems. Western countries were the first to introduce LMS systems in the educational process. Therefore, we analyze the LMS systems implemented in higher education institutions of the USA, Canada, Great Britain and Australia.

According to Edutechnica, the world's leading HEIs are using the Blackboard Learn information system (22.8%). About 30 million users around the world receive education through Blackboard's products. In addition to the Blackboard Learn software product, this company has also developed other types of programs for the educational process. The Blackboard Mobile platform is software for mobile phones to collaborate online through the Blackboard Collaborate platform [7].

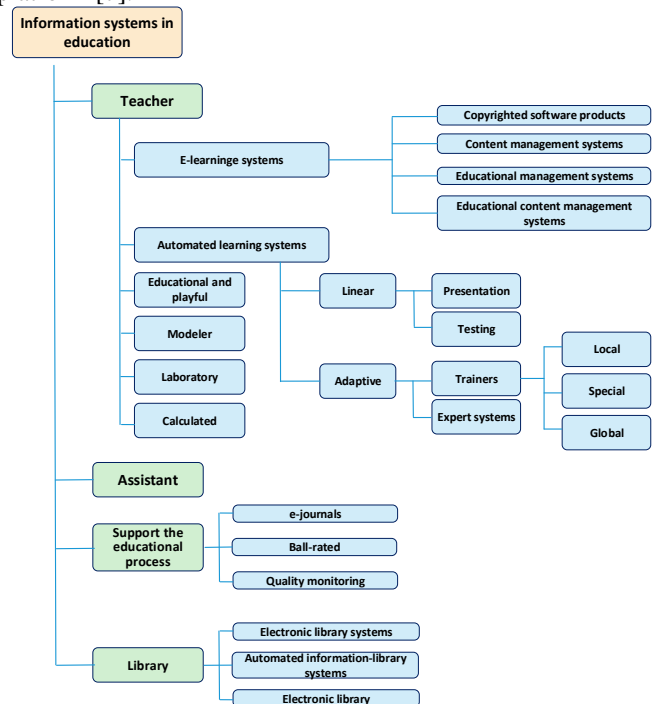


Fig 1. Information systems used in the educational sector

Today, the world's leading HEIs have introduced LMS information systems such as Blackboard, Canvas Desire2Learn, and Moodle into the educational process. Open source LMS systems similar to Moodle are used in HEIs with fewer students and less funding.

### Blended learning

Modern educational trends in the world are aimed at using mixed education in HEIs. In other words, training sessions in the educational process in HEIs are traditionally conducted in classrooms, as well as some types of training remotely [8,9]. Based on this approach, distance education is used in the educational process while preserving the achievements of traditional educational technologies. By using both educational technologies in the educational process, it serves to eliminate their weaknesses.

**Blended learning** is the successful blending of several instructional modalities and models while accounting for the unique qualities of students. Learning management system solutions deal with this issue. Open online course information systems include Coursera, Udacity, edX, and Udemy.

The top HEIs in the world provide free online courses on the Coursera platform. 106 HEIs will take part as collaborators in the endeavor.



Stanford, Pennsylvania, Princeton, London, and Manchester universities have also contributed to this project. The majority of the training programs are in English and are made up of a series of video lectures. While the educational process is free, obtaining a certificate requires payment of a certain sum.

The majority of the instructional courses on the platform **Udacity**, which was created in collaboration with Google, AT&T, Facebook, Salesforce, and Cloudera, are in the information technology industry. All of the training materials are written in English and have Chinese, Spanish, French, and Portuguese subtitles.

**edX** was developed in partnership with Harvard and the University of Massachusetts. The edX information system allows for classroom instruction in addition to monthly courses.

**Udemy** is a mobile-first platform that offers mostly paid courses.

**Academic Earth** includes MIT (235 courses and over 1000 lectures), Yale University (43 courses and over 1000 lectures), Stanford University (161 courses and More than 1700 lectures), Harvard University (17 courses and more than 195 lectures) are posted.

Courses can be created and accessed through the **Blackboard CourseSites** platform. The platform is specially designed for teachers of higher education institutions. Unlike **CourseSites**, the **Open Education platform** is designed for HEIs. At the beginning of 2023, 57 free educational courses for 37 HEIs were developed on the Open Education platform. In the Russian Federation, the creation of online courses has also been started. An example of this is the **Universarium** portal. This portal represents an open e-learning system and offers users the opportunity to take training courses for free. In 2023, 152 educational courses developed by professors and teachers of MGU, REU, IRYa universities, which are considered the leading HEIs of the Russian Federation, will be placed on this platform.

241 educational courses developed by the teachers of 10 leading HEIs of Russia are posted on the **Uniweb** portal.

The **INTUIT** project, developed in Russia, is considered an open university and offers the use of various educational programs and an electronic certificate based on final inspections. **INTUIT** information system can be used online and offline and provides various educational services:

- higher education and second specialty;
- professional retraining;
- training.

The creation of training programs by higher education institution instructors on the aforementioned educational platform is the cause of the institutions' improved reputation, as well as their ascent to the top of global rankings, increased enrollment from international students, and improved educational standards.

The growth of the world economy and the development of new information technologies require the training of highly qualified specialists. This problem can be solved by applying educational management systems to the educational process. Today, the e-learning industry is developing. According to Orbis Research, this market will reach \$275 billion by 2023 (\$165 billion in 2015). Forbes predicts growth to \$325 billion in 2025 (\$107 billion in 2015). This impressive growth is due

to several key advantages of e-learning over traditional learning [10,11,12]:

- Easy to use. Any device (computer, laptop, tablet, or phone) can access online courses through the Internet, enabling users to learn anything at any time, from any location.
- Economic efficiency. Because everything happens online, there is no need for physical locations, a sizable bureaucracy, teaching staff, or other conventional overhead costs. This makes online education more affordable.
- Flexibility of the educational process. Customized courses of any complexity, expertise, and audience can be created thanks to e-learning. One-size-fits-all is over. Furthermore, individuals can study at their own pace because online courses, in contrast to those offered at colleges and universities, are not restricted by a set time or schedule.
- Extensive coverage. Anyone with an Internet connection can access online schooling. This represents half of all people on Earth.

Furthermore, anyone can enter this industry; the key is to provide consumers with excellent instructional content and maintain user interest. Thus, you can build an e-learning site similar to Udemy or Coursera using the ideas and guidelines discussed in this post.

At the moment, Uzbekistan's utilization of LMS systems lags behind that of the top HEIs worldwide. Certain aspects of the LMS's functioning, such as attendance, class scheduling, and scholarship, are handled by automated business processes in many of our local HEIs. Our republic's HEIs are guaranteed to be organized in a way that makes education both contemporary and efficient by implementing LMS systems.

In organizing the educational process based on new modern technologies, the quality of education is achieved by visualizing educational materials, increasing the types of interactive communication between the student and the teacher, and constantly monitoring the educational process. LMS systems expand the capabilities of tools for working with students:

- use of chat, video conference, webinar, virtual audiences;
- ensures discussions and joint activities on projects.

Additionally, direct communication between the teacher and the student is possible at any moment via the LMS. The effectiveness of education is increased when students can provide feedback to the teacher and when the teacher is neither location- or time-bound. Thus, learners' ongoing utilization of high-quality educational services contributes to HEIs' growing reputation.

## II. PRINCIPLES OF LMS INFORMATION SYSTEM DEVELOPMENT

The organization of the educational process through LMS is based on three concepts: modularity, individuality, encapsulation (Fig. 2) [13,14,15].

### A. Concept of modularity

Utilizing the smallest items, referred to as "curriculum modules" or CM for short, at every level of the educational process—from planning to documenting outcomes—is implied by structuring the process around modules. Conflicts over resources are settled and the learning process is planned using CM.

Curriculum modules, or CMs, are the fundamental accounting unit. Within the system, every CM is distinct and stands alone from the others.

CM allows you to conditionally bind the following parameters:

- The minimal amount of a student's impact on the educational system;
- Support for methods (material, uniform, etc.);
- Materials and technological resources.

No CM can be larger than the maximum planned tact of the learning process (for example, a semester) and it must be independently evaluated and conditionally defined.

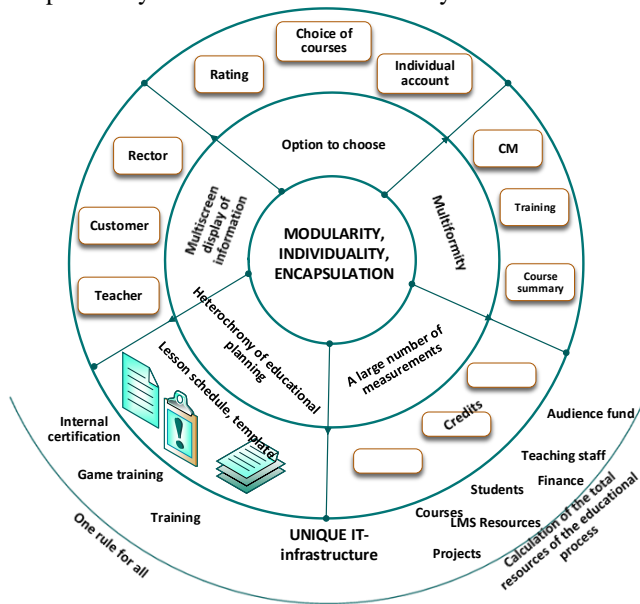


Fig 2. Principles of LMS

### B. The concept of individuality

Because the educational process is structured in an individualistic manner, planning and recording are done uniquely for every student, audience, etc., utilizing the unique content of each object. It is feasible to arrange studies based on customized study plans that are thought to be unique for every student thanks to the notion of uniqueness.

### C. The concept of encapsulation

The specifics of the HEI's internal business process organization, which are not deemed important by external control agencies, are covered in the encapsulation of the educational process. Therefore, the organization is not required to rebuild the recording processes in response to a change in the requirements of the external control bodies for the filed report.

### D. The priority principle of educational activity

According to this approach, the learning process is the primary HEI process, with other processes serving to support its implementation (Fig. 3). The requirements and guiding principles of the primary process serve as the foundation for

the organization and hierarchy of supporting processes within HEI. Furthermore, modifications to supportive processes shouldn't result in adjustments to the guidelines and practices of the primary educational process.

### E. The principle of management through active entities

The management of active entities is one of the tenets of management systems. According to the idea, multiple active bodies oversee the management of HEIs' educational programs.

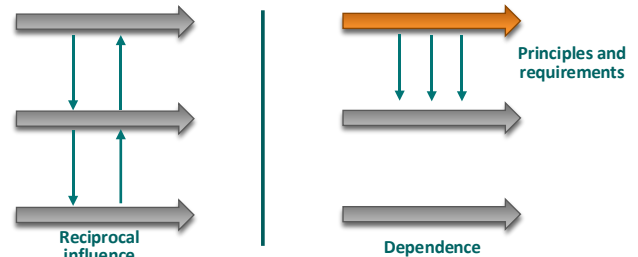


Fig 3. The priority principle of educational activity

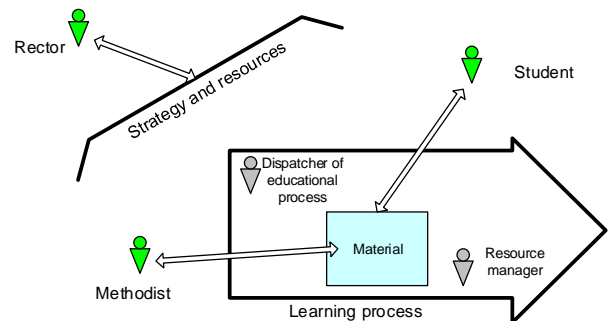


Fig 4. The principle of implementation of LMS through entities

LMS as active subjects: "methodologist" who supplies the system with instructional materials and methodical materials at every stage of the educational process; "student" who, within the parameters of the educational program, determines the educational trajectory; "rector" or "director" who decides the strategy of higher educational institutions, sets priority directions of development and resource limitations.

In LMS, "administrators" and "dispatchers" are considered to be inactive subjects. For instance, the "dispatcher of resources" and "dispatcher of educational process" follow tight directives rather than exercising any decision-making authority within the confines of the management system. For business tasks that machine algorithms cannot replace with human labor, inactive entities are required.

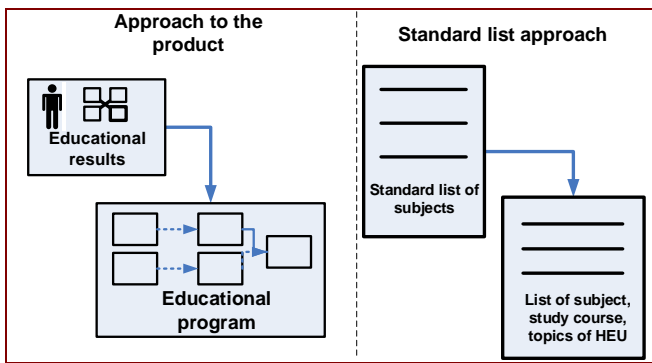
### F. The principle of approachability to the product

Unlike conventional (traditional) education, this principle is taken into account for the entire educational program, including the mastering of all academic disciplines and courses (Figure 4). A collection of previously established competencies (concepts, knowledge, and skills) is referred to as an outcome. This idea compels everyone in authority to approach their task in a unique way in order to arrange the instructional materials and produce the intended outcome. In this instance, the educational program's business procedures help to accomplish the desired outcome for the learning process.

Interconnection between the blocks of educational materials and the sequence of their implementation can be formed. The sequence of implementation of the training course in accordance with the expected result is developed by the person in charge of the educational program.

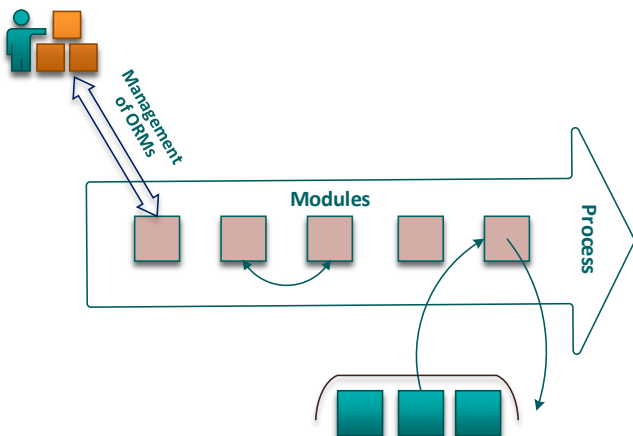
*G. The principle of modularity*

Based on this principle, the organization of the educational process on the basis of a module implies the use of the smallest (minimum) objects, which are called "curriculum modules" (CM) at all stages, from its planning to the recording of results.



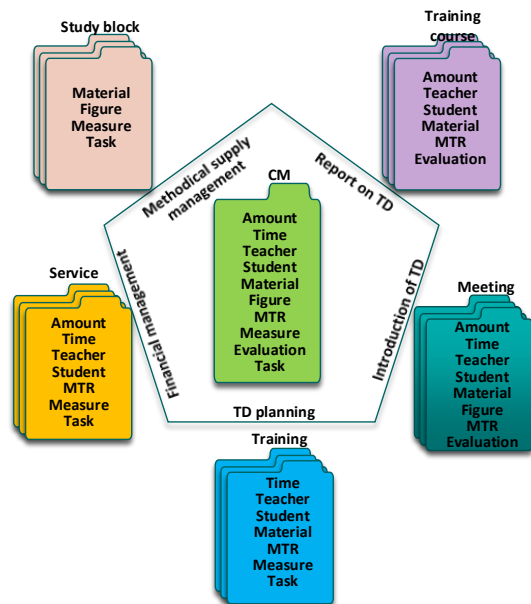
**Fig 5.** The principle of approachability to the product

The fundamental minimal items required for management process information are assigned within the LMS architecture. These items are typically implemented as CM in the management system. The primary accounting unit (CM) is distinct from other units in each CM information system. Resource conflicts are resolved and the learning process is planned using CM.



**Fig 6.** Curriculum modules

An example of the implementation of this principle is the separation of the module of the learning process (plan).



**Fig 7.** The principle of modularity

CM allows you to conditionally bind the following parameters:

- professor-teacher;
- student;
- methodological support (uniform, material, etc.);
- material and technical resources;
- time;
- funds.

CM can arise as a hierarchically integrated structure of different items inside a single process. When organizing the educational process, the following parameters are expressed as educational activities: CM (time (implementation period), professor-teacher, student(s), educational materials, MTR, measurements (various evaluation criteria), and purpose of application (specialty corresponding to the criteria competence).

Within the financial management process, the following terms are used: MTR (which represents a service with parameters like MTRs necessary for the implementation of the service), measurement (measures of the service), professor-teacher (funds spent on a teacher for the implementation of this service), student (funds spent on one student), and purpose of use (financial gain).

The material (minimum portion of methodical material), form (methodical material transfer form), measurement (critical measurement and calculation formula of this block), and purpose of application (within the educational program represents a "learning block" with parameters such as the function of the block) are all considered in the process of managing methodical supply (CM).

When using CMs in the educational process, a "meeting" is defined by CM-funds (meeting cost and its calculation algorithm), time (meeting date, time, and duration), professor(s), student(s) (students participating in the meeting), form (method of material transfer), MTR (MTRs required for the meeting), and evaluation (the assessments provided to the learners during the meeting).

In LMS, other generalized objects such as CM are also used in various business processes.

The principle of systematic organization of work

Functions that must be performed in the system are not implemented in a hierarchical manner of users (responsibilities). Functions in the system are distributed

through logical blocks (Fig 8). Each function serves to shape the final result.

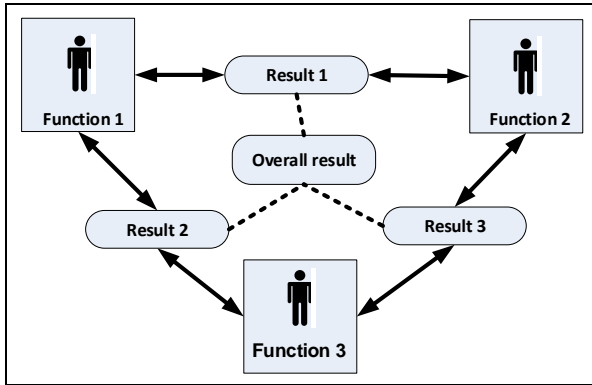


Fig 8. The principle of systematic organization of work

#### H. The principle of changes in the implementation process

This principle means that it is necessary to make changes in the processes started quickly without stopping the processes and without hindering the current activities.

#### I. The principle of transparency of the educational process

Vocational education process should be transparent. Although the concept of "transparency" is widely used, in most cases it serves a narrow range of individuals (organizational management). In this LMS, "transparency" is provided for all participants to make a decision.

If an employee lacks complete and transparent information about a process, they may make incorrect decisions. Different users within a given process demand access to comprehensive information that is unique to them and intriguing. For instance, in a single process, the dispatcher for the educational process needs information about the lesson plan, and the financial vice-rector wants information about the flow of cash.

Also, transparency of processes simplifies the process of managing non-active entities.

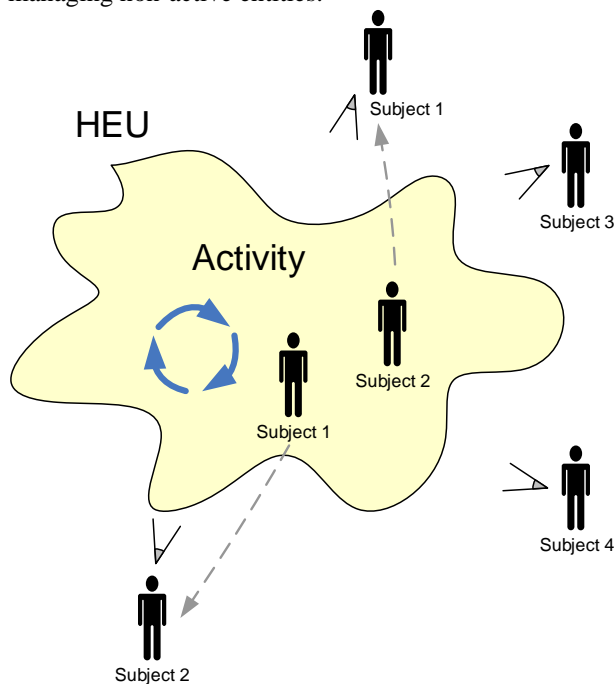


Fig 9. The principle of transparency of the educational process

#### J. LMS features

An LMS should have three user roles:

- administrator - manages the site and solves technical problems;
- instructor (instructor) - creates training courses and conducts training;
- student - studies courses and receives a certificate confirming the completion of the course.

To do this, the LMS must provide the following functions:

Table 1. LMS User Features

Administrator	Student	Instructor
Mobile Compatibility	Search Engine	Instructor and AnalyticsDashboard
Admin panel	List of courses by categories	Create a training course
Manage Payments	Course Summary	Customize Course Information
PCI-DSS compatible gateways	View course structure	Courseprivacy settings
Manage course categories	View instructor information	Take online quizzes
Control the search engine	Leave feedback on the course	Price management: retailprice and discount
Multilingual support	Communication with administrator and teacher	Communication with students and administrator
Commission Management	Asynchronous Learning:Full Course or Module	Only View course reviews and ratings
User management	Student panel and analysis	Ability to issue certificates, diplomas
Instructor Management	Quizzes	
Manage Course Categories	LearningProgress Reports	
Complaint management system	View offers on the platform	
Manage reviews and ratings	Abilityto apply for a refund	

### III. CONCLUSION

Today, communication and information acquisition is increasingly done through the Internet and gadgets. E-learning is learning using modern multimedia and communication technologies. In information societies, there are no other non-electronic forms of education left: after all, if modern technologies participate in at least some aspects of the educational process - even e-mail, mobile phones or social networks - it is already very ineffective in electronic form. Today, e-learning has achieved the greatest development in the world's leading countries of education, such as the United States, Great Britain, Germany, Australia, and others. In these countries, the principle of forming a continuous education system has been fully implemented. Many universities in Uzbekistan integrate e-learning and distant learning technology in their curricula, which contributes to the development of new models of education that emphasize the use of electronic content. This article examined the information systems in use worldwide in the context of education, highlighting their strengths, weaknesses, and accomplishments. The concepts of modularity, individuality, and LMS encapsulation were described, and the principles of learning process management systems (LMS), which are extensively utilized in the educational process, were created. The structure and model of LMS were also evaluated.

The LMS information system, developed on the basis of

the concepts and principles presented in the article, will change the traditional approaches to education, making learning convenient and knowledge sharing simple and effective.

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