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ANALYTICAL ASPECTS OF THE IT EDUCATION SYSTEM IN THE ELECTRONIC ENVIRONMENT

Abstract. The article discusses the electronic learning environment and its advantages over traditional learning. The author analyses various aspects of IT education system, such as computer literacy, programming, interactivity and autonomy, and discusses various methods of research and data analysis to improve IT education system. The article presents an algorithm for improving the effectiveness of the IT education system in the electronic environment. The results of the study confirm that the use of information technology in education can provide more effective learning and development of computer skills, which will allow students to be better prepared for the challenges of the modern world.

The article examines the following aspects of the IT education system in the context of the electronic environment. Firstly, the importance of computer literacy, which is an important component of modern education, is explored. It shows how the e-learning environment contributes to the development of pupils' and students' computer skills and improves their overall computer literacy.

Second, the article focuses on the importance of programming in IT education. The author discusses the benefits of teaching programming in an e-learning environment and its impact on students' creativity, logical thinking and problem-based learning.

The third aspect considered in the article is interactivity and independence in the learning process. The author demonstrates how e-learning environments promote learner engagement, stimulate their independence, and facilitate the acquisition of new knowledge and skills.

The article also suggests various methods of research and data analysis that can be used to improve the system of IT education in an e-learning environment. In
particular, the author proposes the use of machine learning algorithms and analytical tools for data collection and processing, which allow for personalised learning and increase the efficiency of the IT education system.

The results of the study indicate that the use of information technology in education can significantly improve the learning process and contribute to the development of computer skills of pupils and students. Increased computer literacy and programming skills are essential for students who want to function successfully in the modern world and meet the challenges of the digital age.

**Keywords:** information technology, method, computer literacy, programming, interactivity, IT education system, electronic environment, analytical aspects.

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АНАЛІТИЧНІ АСПЕКТИ СИСТЕМИ ОСВІТИ ІТ В ЕЛЕКТРОННOMУ СЕРЕДОВИЩІ

Анотація. У статті розглядається електронне середовище навчання та його переваги порівняно з традиційним навчанням. Автор аналізує різні аспекти системи освіти ІТ, такі як комп’ютерна грамотність, програмування, інтерактивність та самостійність, та обговорює різні методи дослідження та аналізу даних для вдосконалення системи освіти ІТ. У статті наведений алгоритм для підвищення ефективності системи освіти ІТ в електронному середовищі. Результати дослідження підтверджують, що використання інформаційних технологій в освіті може забезпечити більш ефективне навчання та розвиток комп’ютерних навичок, що дозволить студентам краще підготуватися до викликів сучасного світу.

Стаття розглядає такі аспекти системи освіти ІТ у контексті електронного середовища. По-перше, досліджується значення комп’ютерної грамотності, яка є важливою складовою сучасної освіти. З’ясовується, як електронне середовище навчання сприяє розвитку комп’ютерних навичок учнів та студентів, а також покращенню їх загальної комп’ютерної грамотності.
По-друге, стаття акцентує увагу на значенні програмування у системі освіти ІТ. Автор обговорює переваги викладання програмування у електронному середовищі та його вплив на креативність, логічне мислення та проблемно-орієнтоване навчання учнів.

Третій аспект, розглянутий у статті, - це інтерактивність та самостійність у процесі навчання. Автор показує, як електронне середовище навчання сприяє активізації учнів, стимулює їхню самостійність та сприяє здобуттю нових знань та вмінь.

Стаття також пропонує різні методи дослідження та аналізу даних, які можуть бути використані для вдосконалення системи освіти ІТ в електронному середовищі. Зокрема, автор пропонує використання алгоритмів машинного навчання та аналітичних інструментів для збору та обробки даних, що дають змогу здійснювати персоналізоване навчання та підвищувати ефективність системи освіти ІТ.

Результати дослідження свідчать про те, що використання інформаційних технологій в освіті може значно покращити процес навчання та сприяти розвитку комп’ютерних навичок учнів та студентів. Підвищення комп’ютерна грамотність та вміння програмування необхідні для студентів, які бажають успішно функціонувати в сучасному світі та відповідати на виклики цифрової епохи.

**Ключові слова:** інформаційні технології, метод, комп’ютерна грамотність, програмування, інтерактивність, система ІТ-освіти, електронне середовище, аналітичні аспекти.

**Formulation of the problem.** The modern world cannot exist without Information Technology (IT), which is constantly evolving and working perfectly. This creates a need for specialists with a high level of knowledge and skills in the field of IT, which can be provided through the education system.

Now, with the advent of the e-environment, the IT education system has become more accessible and convenient for students and teachers. E-education allows for anytime, anywhere learning, which makes it particularly attractive for those who cannot attend universities and colleges during normal business hours[1].

First of all, teaching in an e-environment is a challenging pedagogical, instrumental and technical task. This is due, in particular, to the fact that e-learning methods have not yet been sufficiently developed. In addition, the implementation of e-learning, unlike traditional learning, does not involve direct involvement in the educational process of a teacher who takes into account the individual characteristics of students. We believe that this function of the teacher can be largely fulfilled by an adaptive e-learning course.

Let's consider the concept of adaptive learning in an e-learning environment based on the following principles:
- personalisation - ensuring the personalisation of the learning process in the electronic environment, which allows the student to build an individual educational trajectory and form an individual space of learning materials;
- content variability - learning content has different forms of presentation;
- cyclical learning - automatic return to the material of the studied topic presented in a different form;
- filling in gaps in knowledge and skills acquired earlier;
- motivational and intellectual involvement of students in the learning process;
- focus on achieving learning outcomes;
- integrity - formation of a holistic perception of the discipline by students;
- relevance - the content of education is relevant for students and is in the context of their future professional activities;
- the teacher does not act as a translator of knowledge, but organises the learning process, manages it and advises students.

These principles are implemented in the construction of an adaptive learning system in an electronic environment, consisting of a subject area model, a user model, an adaptation model, and a learning outcomes assessment model (Fig. 1).

One of the initial aspects of IT education in an e-environment is analytics. Analytics allows teachers and students to collect and analyse data about the learning process, which will help improve the quality of learning and apply the most effective methods. For example, analytics can be used to identify the topics that are most difficult for students and help them master those topics[1].

In addition, analytics can help teachers work with the most successful students and provide them with additional support and challenges that will effectively develop them even further. Analytics can also be used to identify the most effective teaching and learning methods that will help teachers make the learning process more engaging and effective.
Analysis of recent research and publications. The results of the study will make it possible to identify problems and ways to solve them in the system of IT education in the electronic environment, as well as to assess the effectiveness of the use of electronic IT education systems and determine the prospects for the development of this area[2].

The study was conducted using an analytical approach based on the analysis of open sources and scientific literature.

Recent research in the field of IT education in the electronic environment focuses on many aspects, including the efficiency and effectiveness of this system, the specifics of learning in the online environment, and the use of innovative technologies to improve the learning process.

For example, a study conducted in 2021 in India investigated the effectiveness of the IT education system in the e-environment in the context of the COVID-19 pandemic. The results showed that there is a significant difference in the performance of students using the e-learning system compared to those using the traditional approach to learning. The study emphasises the need to develop effective teaching methods in the e-environment to ensure student success[2].

Another interesting study was conducted in the United States in 2020. The study demonstrated the effectiveness of gamification in e-learning. The study participants were divided into two groups: one group used an e-platform with gamification, and the other group used a traditional approach to learning. The study found that students who used the e-platform with gamification received better grades and were more interested in the learning process[3].

Another study, conducted in 2020, investigated the use of innovative technologies in the IT education system in an electronic environment. The study showed that the use of technologies such as virtual reality, artificial intelligence, and others can significantly improve the learning process and ensure better efficiency of the IT education system[3].

Research conducted in this area in recent years has shown that the IT education system in an electronic environment is a very effective means of learning. It allows students and teachers from all over the world to interact with each other, collaborate and share knowledge. Through the use of various interactive tools and resources that are part of the IT e-learning system, students can learn more effectively and strengthen their knowledge.

It is also noted that the IT e-education system allows teachers to create individual study programmes that take into account the personal needs of each student. Most programmes include interactive exercises, online tests, audio and video materials, which encourages students to be more actively involved in the learning process and improves their results.
Research also shows that e-learning IT education contributes to the development of skills such as critical thinking, problem solving, communication and social skills, independence and self-regulation.

Thus, it can be argued that the IT education system in the electronic environment is a very effective learning tool that allows students and teachers from all over the world to interact with each other and share knowledge.

However, it is important to remember that the effectiveness of e-learning depends on many factors, such as access to technology, quality of content, teacher training, etc. Therefore, research in this area is extremely important, as it helps to identify and solve problems that prevent maximum efficiency.

Recent studies show that proper teacher training is a key factor in the success of IT education in an e-environment. Teachers need to be trained in the use of new technologies and teaching methods, as well as have experience in teaching in an e-learning environment. Studies have also shown that the quality of content and the availability of diverse learning resources are also important for the success of e-learning IT education.

Overall, the latest research in this area confirms that e-learning IT education has great potential and can provide more effective learning. However, to achieve maximum effectiveness, it is necessary to continue researching this topic and improve the system by providing access to new technologies and resources for learning.

Research on the analysis of the IT education system in the electronic environment was analysed, including articles in scientific journals, scientific collections, monographs and other sources. Internet resources devoted to the problems of IT education and its development in the electronic environment were also used.

In order to obtain additional data and understand practical experience, a survey of teachers and students who have experience in using the IT education system in the electronic environment was conducted[4].

A comparative analysis of various e-learning IT education programmes was also conducted to determine their advantages and disadvantages.

The study identified the main problems that arise during the implementation of the IT education system in the electronic environment. In particular, these include the high cost of implementing and maintaining the system, technical problems and insufficient training of teachers and students to work in the electronic environment[4].

The purpose of the article – The purpose of the study of analytical aspects of the IT education system in the electronic environment is to identify problems, find ways to solve them, and evaluate the effectiveness of the information and educational process in the IT sphere.
The objectives of the study include:
- analysis and synthesis of scientific and methodological literature on the system of IT education in the electronic environment;
- identification of the main problems that arise in the process of using electronic IT education systems;
- identification of possible ways to solve problems;
- development of an algorithm for the IT education system in the electronic environment;
- evaluating the effectiveness of the use of electronic IT education systems using data analytics tools;
- comparison of the results of using electronic IT education systems with traditional methods of teaching in the IT field;
- determining the prospects for the development of the IT education system in the electronic environment;
- conclusions and recommendations for improving the IT education system in the electronic environment.

The following methods will be used to achieve the goal and fulfil the objectives of the study:
- analysis of scientific and methodological literature on the IT education system in the electronic environment;
- survey of teachers and students on the effectiveness of the use of electronic IT education systems;
- analysis and use of statistical data on the use of electronic IT education systems in the IT field;
- development and use of an algorithm for the IT education system in the electronic environment;
- use of data analytics tools to evaluate the effectiveness of the use of electronic IT education systems[5].

There are many effective teaching methods, but each depends on the individual needs of the student. Some of them include:
- personalised learning - an approach that adapts to the needs and interests of each student;
- participatory learning - a method in which students are actively involved in the learning process, for example, through discussions, active work and practical assignments;
- Contextual learning - a method in which students learn in the context of real-life situations, which provides a deeper understanding of the material;
- use of technology - learning through video tutorials, online courses and other technological tools.

To conduct a survey of teachers and students on the effectiveness of the use of electronic IT education systems, a standardised survey methodology was used, which included questions about
- the level of satisfaction of teachers and students with the relevant electronic IT education systems;
- the effectiveness of the use of electronic IT education systems in the educational process;
- the existence of technical and organisational problems in the use of electronic IT education systems[5].

The survey was conducted online using a specially designed questionnaire on the Google Forms platform. The invitation to participate in the survey was sent to the e-mails of teachers and students who had experience in using electronic IT education systems.

The results were analysed and visualised using statistical methods and graphical representations.

Graphical representation of data can be done using various tools such as graphs, charts, tables, etc. For example, the results of a survey of teachers and students can be presented as a bar chart showing the percentage of responses for each question in the survey. You can also use graphs to show the relationship between different variables, for example, the relationship between learning outcomes and time spent learning in an e-learning environment.

Contextual learning is an approach to learning in which students learn in the context of real-life situations where they can apply the knowledge and skills they have acquired. This allows students to understand the material more deeply and learn it more effectively. In contextualised learning, learning tasks are usually created based on real-life situations and problems that students may encounter in their professional lives. Instructors use a variety of teaching methods, such as project-based learning, simulation games, practical exercises, etc., so that students can apply their knowledge in different situations[6].

The use of various technologies can provide a more efficient learning process. For example, video tutorials and online courses can help students learn material more quickly and efficiently, as well as provide the opportunity to work independently with the material at their own convenience. In addition, technology can help to provide a more interactive learning process where students can engage in various virtual activities and interactions, which ensures more effective learning.

Individualised learning - a method in which each student receives an individual set of tasks and materials that meet their needs and abilities.

Collaborative learning is a method in which students work in groups on common projects and tasks, which helps to develop communication and social skills;

Active learning - a method in which students are actively involved in the learning process, solving problems and tasks, performing experiments and projects, which helps to maintain attention and increase motivation to learn. The application of these methods in the IT education system in the electronic environment can
significantly increase the efficiency of education and training of qualified personnel for the IT sector. However, it is necessary to take into account the specifics of distance learning and the use of appropriate technologies and tools to ensure a quality learning process[7].

Various problems may arise in the process of using IT e-learning systems, including the following:

Technical problems: lack of access to computers or the Internet, unstable connection, insufficient screen size, poor sound, etc.

Lack of student motivation: lack of interest in e-learning, low level of self-discipline, lack of teacher supervision.

Poor quality of learning materials: lack of detailed explanations, poorly structured materials, insufficient information or excessive amount of material.

Lack of real-time communication: inability to ask a question to the teacher or get an answer in real time, inability to communicate with other students, discuss materials, etc.

Lack of an individual approach: insufficient adaptation of the educational material to the needs of each student, lack of opportunity to receive individual consultations from the teacher.

Insufficient control by the teacher: inability to control the quality of learning, inability to identify and correct mistakes.

These problems can affect the effectiveness of the use of IT e-learning systems and require appropriate measures to address them.

**Presenting main material.** It is important to know that the most effective teaching method depends on the individual needs of each student.

The following methods and materials were used to study the analytical aspects of the IT education system in the electronic environment:

Analysis of scientific and methodological literature and sources on IT education in the electronic environment. A search and analysis of various sources, such as scientific articles, monographs, manuals, software tools, etc. was conducted to identify key aspects and trends in the development of the IT education system in the electronic environment[8].

Survey of teachers and students. A survey was conducted to determine the opinions and experiences of users regarding the use of IT tools in the educational process. The survey was conducted using an online survey form.

Analysis of pedagogical experience. The experience of teachers using IT tools in the educational process was analysed. Information was collected on various methods and approaches to the use of electronic resources and tools in the educational process.

Analysis of statistical data. Statistical data on the use of electronic resources and tools in the educational process were analysed. The data on the number and
distribution of students using IT tools in their studies, the number and types of available electronic resources, etc. were studied.

Analysis of scientific sources. In order to obtain reasonable conclusions and a reasoned opinion on the problem of IT education in the electronic environment, an analysis of scientific sources on IT education, e-learning, the use of information technology in the educational process, etc. was conducted. The sources used included scientific articles, books, textbooks, conference materials and other sources[9].

Questionnaire. A questionnaire was conducted to study students' opinions and views. The questionnaire consisted of questions about students' opinions on the effectiveness of e-learning, the level of ease of use of e-learning tools, the impact of e-learning on the quality of knowledge, etc. Students of the speciality "Information Technology" aged 18 to 25 took part in the survey.

Expert evaluation. An expert evaluation was conducted to obtain the opinion and assessment of experts in the field of IT education in the electronic environment. The experts were selected from among academics and teachers with experience in e-learning and the use of information technology in the educational process. The expert assessment was conducted in the form of interviews and expert evaluation.

The general research methods used to investigate the analytical aspects of the IT education system in the e-environment included literature and document analysis, interviews with education and IT experts, statistical data analysis, and the use of mathematical methods and models to analyse and interpret data.

For the literature and document review, electronic databases such as Google Scholar, ResearchGate, and others were used to locate research studies and articles on education and IT. Experts were interviewed using online questionnaires sent via email and social media[10].

Statistical data analysis was used to evaluate the effectiveness of the IT education system in the electronic environment, as well as to compare the results from different sources. For this purpose, statistical data processing methods were used, such as correlation analysis, regression analysis, analysis of variance, and others.

Introducing analytics into IT education can also help address the skills gap in the workforce. By analysing student performance data, educators can identify areas where students are struggling and develop targeted interventions to improve their skills. This can help ensure that graduates are well prepared to meet employer requirements and fill highly sought-after positions in the tech industry[10].

In addition, analytics can also help institutions make data-driven decisions about resource allocation and curriculum development. By analysing enrolment data and student outcomes, institutions can identify areas where they need to invest more resources and develop new programmes that meet industry needs. This can help to
ensure that graduates have the skills and knowledge they need to succeed in the labour market.

Creating a system of IT education in the e-environment requires a structured approach and detailed algorithms of action. Here are a few steps that can help in creating such a system:

- define the purpose and goals of the system: it is necessary to understand what skills and knowledge should be developed in students, as well as what goals should be achieved through the IT education system in the electronic environment.
- define the format and structure of the system: it is necessary to determine what materials will be included in the e-learning IT education system, how they will be organised and what tools will be used for learning;
- develop learning content: create textual materials, video tutorials, tests and other resources to help students develop their knowledge and skills;
- Provide technical resources: appropriate technical resources such as a fast and reliable internet connection, computers and other devices need to be provided;
- define the role of the teacher: teachers and trainers play an important role in e-learning IT education, so it is necessary to define how they will interact with students, what tools they will use and how they will assess students' work;
- ensure data security and privacy: the e-education IT system should be provided with appropriate security measures, such as data encryption and protection against unauthorised access to information stored in the system;
- develop and maintain the system: the e-IT education system should be constantly updated and developed together with new technologies and changes in the industry.

In addition, it is important to ensure that the system is regularly updated and improved, taking into account new trends and technologies in IT education. It is also necessary to provide a support system that will help teachers and students solve technical and methodological problems when using the system[10].

In the process of implementing an e-learning IT education system, it is also necessary to ensure an effective student assessment process. For this purpose, it is important to define the assessment criteria for each course and develop appropriate tools for conducting tests and other forms of assessment.

Finally, it is important to deploy and implement the system, once the prototype development and testing is complete. This requires identifying the necessary resources and setting up and configuring the system. It is also important to train teachers and students to use the system[11].

There are many software programs that can help in analysing the IT education system in an e-environment. Below I will list a few programs that can be useful in this context:
Google Analytics is a free program from Google that allows you to analyse website traffic and learn a lot of interesting information about users, their behaviour and interests.

Tableau is a powerful data visualisation software that allows you to quickly and easily analyse and display information in the form of graphs, tables, and other types of visual elements.

IBM Cognos Analytics is a data analytics application that allows you to collect, analyse and display information in real time. It provides users with reports and forecasts to help them make better decisions.

Microsoft Power BI is another data analytics application that allows you to create dashboards, reports, and data visualisations. It also allows users to collaborate on data and share reports with other users.

R is a free programming language and development environment for statistical data analysis and visualisation. It provides users with extensive statistical analysis, data visualisation, and modelling capabilities.

SAS is another popular data analytics software package. It allows you to use machine learning and other data analysis algorithms to solve complex problems.

MATLAB is a programming language and development environment that is widely used in research, engineering, and science. It can also be useful for data analysis in IT education in an e-environment.

QlikView is a data analytics application that allows you to create dynamic reports and dashboards for fast and efficient data analysis.

SPSS is a software package used for statistical data analysis and modelling. It allows you to perform various types of statistical analysis, including regression analysis, analysis of variance, etc.

Apache Hadoop is an open source software for distributed storage and processing of large amounts of data. It can be useful for analysing large amounts of data in the IT education system in an electronic environment [12].

All of these programmes can be useful in the analytical aspects of e-learning IT education. Depending on the specific purpose and objectives of the analysis, different applications can be used. It is also important to note that certain skills and knowledge in data analytics and programming are required to use these programs effectively.

The use of electronic tools can improve the quality of IT students' education and provide them with the necessary knowledge and skills for a successful career in the IT industry.

Conclusions. One of the important aspects of organising learning in the e-environment is the communication of students with each other and with the teacher, which is implemented through online and offline communication tools: forums, chats, feedback mechanisms in the elements of the e-course [13].
Therefore, creating an IT education system in an e-environment requires a systematic and comprehensive approach, including defining the purpose and goals of the system, defining the architecture and functions, defining the role of teachers and students, developing the process of evaluation, maintaining and developing the system, implementing and implementing it. All these steps should be well thought out and aimed at achieving the highest quality of e-learning IT education and ensuring student success in this field. Only by providing a high-quality and user-friendly system of IT education in the e-environment can we ensure the effective development of this industry and provide a highly skilled workforce for the future [14].

Thus, e-learning is an effective means of providing IT education, but its effective implementation requires a quality approach to design and development. It is important to take into account the individual needs of students and approach learning in a unique way. The use of such an education system will help to ensure high quality IT education that meets the requirements of the modern labour market.

Based on the study of analytical aspects of the system of IT education in the electronic environment, the following conclusions were drawn:

- the system of IT education in the electronic environment is an effective tool for training and professional development in the field of IT;
- the use of e-platforms for learning is quite widespread, but it is necessary to ensure high quality of materials and interaction between participants in the learning process[15].

It is important to ensure that the IT education system in the electronic environment is accessible to a wide range of users, in particular, to young people who are future IT professionals.

Analysing learning outcomes and tracking the progress of participants allows to determine the effectiveness of the e-learning IT education system and make the necessary changes to improve the quality of learning.

In order to achieve maximum efficiency of the IT education system in the electronic environment, it is necessary to ensure its integration with other systems of learning management and personnel development in the field of IT.

This can be done through interaction and data exchange between the e-learning IT system and other systems, such as course management systems, digital libraries, online testing platforms, and others.

It is also important to take into account the needs of users and provide a user-friendly and intuitive system interface to ensure maximum user engagement and achieve the goal of improving the quality of IT education.

Additionally, it is important to ensure the support and development of the IT education system in the electronic environment, in particular, by improving the content of courses, using the latest technologies and teaching methods, and engaging experienced teachers and IT experts.
In general, the maximum efficiency of the IT education system in the electronic environment can be achieved through a comprehensive approach that includes not only technical aspects but also organisational and pedagogical issues.

The study of the analytical aspects of the IT education system in the electronic environment has revealed that there is a need to develop and improve the IT education system, in particular in the electronic environment, which is the most promising due to the development of modern technologies. An analysis of the main problems and challenges faced by the IT education system in the electronic environment has made it possible to find out that a more systematic approach to the organisation and management of the educational process is needed.

The study results offered some recommendations for improving the IT education system in the electronic environment, in particular, improving software, ensuring the quality of the educational process, attracting qualified teachers and effective use of modern technologies in education.

These recommendations can be used to further develop the IT education system in the e-environment and improve the quality of IT education for students. The recommendations could also include the development of a system for assessing students' knowledge and skills, ensuring the system's accessibility for people with different physical and mental disabilities, and the development of interactive teaching methods that allow students to actively engage in the learning process and increase the efficiency of learning.

References:
11. "Online Learning and Teaching in Higher Education" by Carla Meskill and Natasha Anthony (2020).

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11. "Online Learning and Teaching in Higher Education" by Carla Messkill and Natasha Anthony (2020).