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Application of Information Technologies in Mathematics and Its Methodology

Abstract

This article analyzes the role and significance of information technologies (IT) in the teaching and application of mathematics. In the modern era, mathematics is closely connected not only to theoretical but also to practical and applied aspects of information technologies. The paper explores various software tools, digital platforms, interactive teaching resources and their methodological foundations. The main objective is to demonstrate how IT tools can be effectively integrated through appropriate methodologies to enhance both the teaching and application of mathematics.

Keywords: *mathematics, information technologies, teaching methodology, mathematical modeling, software tools, mathematics education*

Introduction

The 21st century is characterized by the rapid development of information and communication technologies (ICT), which has necessitated a transition to a new phase not only in daily life, but also in education and scientific research. This transformation has significantly influenced the education system and has extended its impact to fundamental disciplines such as mathematics. Mathematics is not only a theoretical field, but also serves as an applied science integrated into engineering, economics, technology and information sciences. From this perspective, its integration with information technologies is of strategic importance for both teaching and research.

The application of IT in the teaching of mathematics entails not only an expansion of technical capabilities, but also a modernization of teaching methodologies and pedagogical approaches. International studies have demonstrated that the purposeful use of ICT strengthens the interaction between teacher and student and allows for the visual, interactive, and dynamic presentation of abstract concepts (Tinsley, Johnson, 1998; Tooke, Henderson, 2001; Ismayilova, Ahmadov, Humbataliyev, 2020; Humbataliyev, Huseynova, 2024; Humbataliyev, Musayeva, 2019; Humbataliyev, Tagıyeva, Melikadə, 2019).

Research

Research shows that software such as *Mathematica* and *MATLAB*, as well as electronic resource databases and digital platforms, enable students to better comprehend mathematical models and apply them in real-life contexts. Wang (Wang, 2011) notes that the integration of modern IT tools into mathematics instruction makes lessons more engaging, goal-oriented, and outcome-driven. He also highlights observable improvements in students' academic performance in ICT-enhanced classrooms.

This integration is even more significant at the university level. Borovik (Borovik, 2011) emphasizes that the appropriate use of information technologies in higher education not only facilitates students' understanding of the subject matter but also promotes the development of research-oriented learning skills. He asserts that technological integration fosters students' ability to work independently while guiding them toward scientifically grounded thinking. In post-Soviet countries, significant efforts have also been made in this domain.

For instance, Rahimov (Rahimov, 2024) underscores that the application of ICT in the periodic teaching system at technical universities contributes meaningfully to outcome-oriented instruction in mathematics. Similarly, Abdullayev (Abdullayev, 2021) argues that, from a methodological standpoint, IT tools enhance the flexibility and practicality of both the teaching process and teacher training in mathematics. Therefore, the objective of this study is to systematize current scientific and pedagogical approaches to the integration of IT in mathematics instruction and application, to examine the methodologies being employed, and to evaluate their effectiveness based on existing literature.

The application of IT in mathematics teaching and research enables more effective knowledge acquisition, fosters analytical thinking, and supports practice-oriented learning. This article proposes specific approaches for the phased and methodical integration of ICT in mathematics education and offers strategies for enhancing both teacher and student competencies. Moreover, it introduces a locally adapted model for implementing ICT in the education system. The proposed methodology is aimed at improving the quality of mathematics education and increasing the efficiency of scientific research.

1. The Role of Information Technologies in Mathematics Education. In the modern era, the role of information technologies (IT) in mathematics education is becoming increasingly significant. The integration of ICT tools enhances the interactivity and efficiency of the teaching process while also fostering students' analytical thinking and problem-solving skills. In this regard, the primary IT tools used in mathematics instruction can be grouped as follows:

- Interactive Graphing Software: Programs such as *Desmos,* and *Mathematica* allow students to visualize and manipulate the graphical representations of mathematical functions in real-time. These tools are particularly important for the visual analysis of logical relationships and abstract concepts, aiding in deeper conceptual understanding (Tooke, Henderson, 2001; Tinsley, Johnson, 1998; Humbataliyev, Nabiyeva, 2018).
- Computational Engines: Tools like *Wolfram Alpha* and *MATLAB* simplify mathematical computations and the development of complex models. They provide students with the capability to perform a wide range of tasks-from basic arithmetic operations to solving differential equations. Additionally, these platforms serve as indispensable resources for academic and scientific research (Borovik, 2011; Humbataliyev, Jabailzade, 2018).
- Online Learning Management Systems (LMS): Platforms such as *Moodle*, *Google Classroom*, and others play a pivotal role in organizing course content, distributing assignments, and assessing student performance within educational environments. These LMS platforms facilitate both distance and hybrid learning models, offering flexibility for educators and learners alike (Rahimov, 2024).
- Virtual Laboratories and Simulation Software: The use of simulations in fields such as mathematical analysis, probability theory, and statistics elevates the instructional process to a more interactive and practical level. These tools help students better internalize complex topics and encourage research-oriented engagement in the learning process (Wang, 2011).

2. The Application of Information Technologies in Mathematical Research. In contemporary scientific research, the role of information technologies (IT) is growing steadily, and mathematics is no exception. The integration of ICT in mathematical research significantly enhances precision, productivity, and the scientific reliability of outcomes. The following are the main IT applications widely used in mathematical research:

- Statistical Analysis of Big Data: Modern mathematical research increasingly involves the statistical analysis of large datasets. Algorithms and software developed for this purpose facilitate the construction of complex statistical models, the detection of patterns in high-dimensional data, and the generation of predictive insights. Techniques from graph theory and combinatorics are frequently applied in structural analysis of large-scale data (Rahimov, 2024).
- Symbolic Computation and Differential Equation Modeling: Tools such as *Wolfram Mathematica*, *Maple*, and *MATLAB* support symbolic computation and enable both analytical and numerical solutions of differential equations. These capabilities facilitate the construction of more complex and realistic mathematical models, allowing researchers to describe problems with greater accuracy and simulate various scenarios (Borovik, 2011).

- Data Analysis through Graph Theory and Combinatorics: These areas of mathematics are particularly effective in the investigation of network structures, relationships, and combinatorial problems. When combined with IT tools, such approaches support structural data analysis, the resolution of optimization problems, and the development of robust scientific models (Tinsley, Johnson, 1998).

3. The Synthesis of Mathematics and Information Technologies: Methodological Aspects. The application of information technologies (IT) in the teaching and research of mathematics requires not only the use of technical tools but also the development of new methodological frameworks. An effective methodology should be based on several core principles that enhance both the quality of instruction and the productivity of research activities.

- 1. Gradual Implementation Principle. According to this principle, IT tools are introduced into the teaching process progressively. Initially, traditional teaching methods such as lectures and blackboard explanations are reinforced. Subsequently, interactive software and graphical tools are integrated into instruction. This phased approach facilitates the adaptation of both teachers and students to IT resources and ensures that technology becomes an integral part of the educational process (Abdullayev, 2021).
- 2. Visual Representation and Analysis. Due to the abstract nature of many mathematical concepts, visual representation is essential in teaching. Interactive graphing tools such as *Desmos* allow for the visualization of functions, geometry, and probability, thereby deepening students' conceptual understanding. This approach also promotes the development of analytical thinking and clarifies the practical aspects of mathematical relationships (Tooke, Henderson, 2001).
- 3. Research-Oriented Approach. The use of ICT provides opportunities for students and researchers to model and solve mathematical problems. This approach transforms mathematics into a scientific discipline that addresses real-world problems, not just theoretical constructs. Modern software tools enable interactive research processes, allowing students to test their hypotheses and visualize outcomes (Wang, 2011).
- 4. Integrated Instruction (within the STEAM Framework). The synthesis of mathematics and IT is a key component of the contemporary STEAM (Science, Technology, Engineering, Arts, Mathematics) education model. The joint teaching of mathematics and IT fosters interdisciplinary knowledge and enhances students' creativity and critical thinking skills. This approach makes the learning process more engaging and relevant and equips students for success in multidisciplinary fields (Abdullayev, 2021).

4. Challenges and Solutions in the Application of Information Technologies. The integration of information technologies (IT) into the teaching and research of mathematics, while highly beneficial, also presents several challenges. These obstacles can reduce instructional efficiency and hinder the widespread adoption of ICT tools. Below are the key challenges along with potential solutions.

4.1. Shortage of Technological Equipment. Many educational institutions lack the necessary technological infrastructure to fully support effective ICT implementation. The limited availability of computers, interactive whiteboards, and licensed software often restricts the use of IT in classroom instruction. Furthermore, inadequate access to stable and high-speed internet complicates the digitization of learning processes (Rahimov, 2024).

4.2. Limited Digital Competence Among Teachers. The effective application of ICT largely depends on teachers' digital literacy and their ability to use technological tools. However, many educators struggle to adapt to new software and platforms, which restricts the integration of IT in their instructional practice. A lack of access to professional development programs and insufficient methodological support exacerbate this issue (Abdullayev, 2021).

4.3. Scarcity of Methodological Resources. The absence of localized and specific methodological materials, textbooks, and training programs tailored to ICT-based mathematics instruction negatively affects pedagogical effectiveness. Existing resources are often too general and not adequately adapted to the characteristics of local education systems (Borovik, 2011).

4.4. Proposed Solutions. To overcome the aforementioned challenges, the following measures are recommended:

- Organization of Professional Development Programs for Teachers: Continuous training initiatives should be developed and implemented to enhance teachers' ICT competencies. These programs should focus on interactive teaching strategies, educational software usage, and the integration of IT tools into pedagogical practices (Abdullayev, 2021).
- Development of Open Educational Resources (OER): Locally relevant, ICT-oriented methodological materials, online textbooks, and instructional modules should be designed to meet the needs of both students and educators. Such resources can also promote opportunities for self-paced and individualized learning.
- Establishment of Local and Regional IT Resource Centers: Centralized resource hubs for schools and universities should be developed to ensure access to ICT infrastructure, software tools, and teaching materials. These centers can provide both material and technical support, significantly enhancing IT adoption in education (Rahimov, 2024).

Conclusion

The integration of information technologies into mathematics education and research is an essential and irreversible process in the modern era. A well-structured methodology not only improves instructional quality but also opens up new opportunities for scientific inquiry. This synergy plays a pivotal role in expanding the application domains of mathematics and in preparing the next generation of researchers and professionals.

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Technologies of Using Museum Materials in Teaching the History of Azerbaijan Literature

Abstract

The article is about the role of museums in the learning of the history of Azerbaijan literature. It is noted that the museums are scientific-research institutes which learn life and work of prominent historical figures. Also various documents, photographs and personal items of poets and writers are kept in museums.

Azerbaijani literature has not smooth road in its development. It gave to the world literature big artists such as Nizami, Fuzuli, Khatai, Vagif, J.Mammadguluzadeh, M.A.Sabir, S.Vurgun, A.Vahid.

In article it is also states that currently teaching in secondary schools and universities demand, interactive methods and modern approaches. In this sense to learn the life and work of poets and writers of Azerbaijan literature history with help of modern methods it is also important to be taught on the basis of the museum.

Keywords: *the material and spiritual culture, museums, exhibits, literature history, teaching process, museum and cultural heritage*

Introduction

Museums play a major role in preserving the literature, art and cultural traditions of each nation, and in studying the history, literature and culture of the people on the basis of these monuments. Museums are scientific and research institutions where material and cultural monuments are collected, preserved, studied, publicly demonstrated and promoted and where secular and religious objects, documents and exhibits of historical and artistic importance are preserved and stored (Abdullayev, 1978). Museums are also scientific and research centers in terms of shedding light on the life and creative path of prominent historical figures, literary and artistic figures, studying their personal belongings, historical documents, manuscripts and preserving them for future generations.

In modern times, the application of innovative approaches in the education system has become a necessity. The synthesis of information and communication technologies (ICT) and museum materials in teaching the history of literature makes the study of this subject more interesting and effective (Aliyeva, Mammadova, n.d.; Ilyasov, 2023). Through digital technologies, exhibits related to the history of literature preserved in museums – manuscripts of writers and poets, personal belongings, rare publications, photographs, etc. – are transferred to a virtual space and presented in the form of interactive presentations. This allows students and pupils to delve deeper into the lives and creativity of historical figures.

Research

Technologies such as augmented reality (AR), virtual reality (VR), 3D modeling and interactive touch screens, which are used in modern museums, ensure that lessons are built not only on a theoretical, but also on a practical basis (*Mezhdunarodnyi zhurnal ehksperimental'nogo obrazovaniya,* 2016). For example, a student can view a museum exhibit with a mobile device and obtain additional information, a video or an audio guide about that exhibit (Anderson, Krathwohl, 2001). Through online museum platforms, anyone, regardless of region and physical location, can virtually view museum expositions and use this information in education.

Since the second half of the 19th century, the rapidly developing processes in the socio-political, cultural and intellectual life of Azerbaijan have in turn given impetus to the organization of museum

work and the creation of modern-type museums in our country has begun. In our country, historical and local history museums, house museums of prominent historical figures, literary and artistic figures, memorial museums have been organized.

Like the history of the Azerbaijani people, the path of its literature has not been smooth. It has not been easy to preserve the ancient and rich Azerbaijani literature, which has been subjected to various foreign pressures throughout history, and to pass on to future generations what its creators have created over the millennia. Our literature, distinguished by its rich and humanistic ideas, has given the treasury of human culture Nizami, Fuzuli, Nasimi, M.P. Vagif, M.F.Akhundzadeh, J.Mammadguluzadeh, M.A.Sabir, H.Javid, J. Jabbarli, S.Vurgun, A.Vahid and many other eloquent poets. The role of museums that preserve personal belongings, memorial documents, etc., along with historical sources and sources, in studying the life and work of each of them is undeniable.

Although various forms and types of teaching are widely used in secondary schools and higher education institutions today, the modern public, political, social situation and the world education system require a special form of visuality - multi-motive of literary-artistic, historical-social, aesthetic information. Documents and exhibits preserved in museums as visual-illustrative materials in this sense provide extensive information about the literary landscape of the environment to which poets and writers belong and the creative path.

In the Azerbaijani context, the application of interactive technologies can be observed in a number of prestigious literary museums. For example, the National Museum of Azerbaijani Literature named after Nizami Ganjavi has taken innovative steps in recent years to support the learning process with virtual excursions, digitized exhibits and interactive presentations. Here, manuscripts, portraits and personal belongings of classical Azerbaijani writers are presented in digital format and used for visual and text-based analysis in lessons. The Nizami Literary Museum and the memorial house-museums of individual artists are the main places that can visually revive the development path of the history of Azerbaijani literature from ancient times to the present day, and the lives, creativity of the travelers of this path, and the environment in which they were surrounded.

By getting acquainted with the souvenirs, personal belongings, writing samples, and household items preserved in the Nizami Literary Museum, students and pupils are once again convinced of the richness of literary and cultural monuments that are considered the national wealth of the Azerbaijani people. The museum reflects the historical development path of Azerbaijani literature from ancient times to the modern era. In the expositions that meet modern world standards, reconstructed, fully computerized, and enriched with innovative tools, the life and creativity of artists throughout the stages of development of Azerbaijani literature are reflected in various documents and writing samples. Ancient manuscripts, paintings, carpets, examples of material culture, rare printed books, exquisite miniatures, manuscripts of famous calligraphers, numismatic examples, writers' souvenirs, documentary photographs, sculptures, maps, examples of applied art, etc. are visual aids that help in teaching the lives and creativity of poets and writers, as well as artistic works. Students and pupils visiting the museum can get acquainted with valuable audio-video materials through monitors - fragments from various films, stage plays, works by prominent Azerbaijani composers, and examples of poetry performed by famous actors. Expositions reflecting the creativity of Shams Tabrizi, Zulfiqar Shirvani, Molla Gasim Shirvani who lived in different periods and rich materials in special corners dedicated to Shah.I.Khatayi, H.Zardabi, H. Javid, A.Vahid form a complete picture of the artist's era and environment. A significant part of the exhibits of historical and artistic importance were collected in later periods, mainly in private collections. Along with theoretical knowledge, even acquaintance with the ordinary cigarette case or wristwatch used by the artist brings him closer to the human being, even if not physically, spiritually.

Personal belongings of individual poets and writers collected in their home museums are rich sources of information about the artist's biography, published works, friends of art, literary world, etc. When teaching the life and work of M.F.Akhundzadeh, J.Jabbarli, A.Shaig, H.Javid, M.Mushfig, S.Vurgun, visiting their home museums, holding literary and artistic compositions directly in the house where the artist lived and ended his life, along with the formation of artistic taste and aesthetic values, is a clear example of respect and reverence for the artist's spirit.

Analyses confirm that contact with museums encourages students to conduct research and directs them to mass activities. Teaching general topics from the history of literature in museums, referring to museum materials, aims to create a connection between literature and the subjects of history, geography, and fine arts, and ultimately to increase the effectiveness of teaching. Each exhibit and object, written text in the museum allows you to come into contact with real sources of knowledge, increases the ideological and aesthetic content of the writer's works, the power of emotional impact, creates conditions for a deep understanding of the artist not only as a creator of works of art, but also as a person in everyday life, in a natural state of work. Various photos, material objects are compared in connection with the past and the present, they see, observe and learn to compare the diversity of forms of expression in works of art and words of any topic. The knowledge acquired in the process of such pedagogical activity becomes solid and is not forgotten.

The creation of the House Museum of many literary and artistic figures, including the 20th century Azerbaijani playwright and philosopher, poet Huseyn Javid, at the initiative of the national leader Heydar Aliyev is commendable. By the decision of the Cabinet of Ministers of the Republic of Azerbaijan No. 160 dated July 10, 1995, the H. Javid House Museum was located on the 3rd floor of the M. Fuzuli Institute of Manuscripts building, in the apartment where the poet lived from 1920 to July 4, 1937 and created most of his works (Klassifikatsiya pedagogicheskikh tekhnologii, n.d.). The museum has collected materials related to the heritage of Huseyn Javid and the Javids. A trip to the museum during the study of Javid's work allows you to use a variety of materials related to the poet's era, environment, pen friends, early printed works, and family members. Personal belongings, writing samples, and household items belonging to Javid create a complete picture not only of the great artist's life path, but also of the mood of the repression period, various human destinies, socio-social contradictions, and material-cultural examples. While at H.Javid's house museum, students (pupils) get acquainted with collections of academic research dedicated to Javid studies, the French translation of Javid's work "Sheyda" in ten foreign languages (Russian, English, German, French, Polish, Belarusian, Bulgarian, Ukrainian, Czech, Greek), the collection of poems "Love is the Greatest Religion" and the re-transliterated version of the book "Literary Lessons" published by the playwright in 1910 together with A.Shaig. The music discs preserved in the museum about Ertugrul Javid, who lived a short but meaningful life in the history of literature, the scientific reviews and articles written by the young poet, artist and composer after studying folklore materials collected from various regions of Azerbaijan, increase the interest of students in research. The expositions in the house-museum of Huseyn Javid are also equipped with modern technologies, and information about the writer's life and creativity is presented through multimedia. Such examples increase the interest of students in literature, create a real sense of connection with the past and make learning more meaningful.

Public figure, publicist, playwright, creator of the first satirical magazine “Molla Nasraddin” in the East J.Mammadguluzadeh understood and correctly assessed the role of museums at the end of the 19th century. The museum of local history, organized on his initiative and with his close participation, is considered one of the two museums. The memorial house-museum of the writer, the creator of the museum, where more than 4600 exhibits are preserved, does not consist of personal belongings and writing samples, but is rich in other historical magazines, manuscripts, and posters from the period when the “Molla Nasraddin” collection was published. In addition to the artistic creativity of the great democratic writer, documents reflecting the socio-political activities and secret moments of his personal life visually complement the theoretical information provided in textbooks on the history of literature.

The subsequent transformation of the houses where poets and artists lived into memorial museums to perpetuate their memory is considered one of the most successful steps of state policy in the field of museums. As one of such museums still organized in the post-Soviet space, the S.Vurgun Memorial Museum presents the last years of the poet's life, the period when he was engaged in intense creativity and public activity on the basis of countless exhibits. The living room, study and bedroom are preserved as they were during the poet's lifetime. Familiarization with the poet's belongings, commemorative photos, letters, state documents is a cultural center that fulfills a sacred mission in the study of S. Vurgun's life and work, and his literary heritage.

The objects, writings and exhibits preserved in the memorial museums ofN.Narimanov, A.Shaig, M.S.Ordubadi in Shamakhi, M.A.Sabir in Shamakhi, M.Mushfig in Khizi, and M.F.Akhundzadeh in Sheki, established in accordance with the order "On the establishment of memorial museums of cultural and artistic figures" are documents of historical importance. The M.S.Ordubadi memorial museum, whose exposition consists of two rooms, exhibits a bust of the writer made of white marble, a painting "General view of the city of Ordubad" made of oil paint. M.S.Ordubadi's activities during the years of exile, manuscripts of the novel "Dusky Tabriz" and photos of the places that immortalized his name more than 200 exhibits allow us to determine the role of the writer in the history of literature.

Conclusion

Reflecting the history of literature and the path of development of our people's culture from ancient times to the present day, Azerbaijani museums play an important role in the preservation and promotion of the rich cultural heritage of our country.

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Multimedia Support for Standardization of Oil Slick Shapes on the Sea Surface Based on Radar Satellite Data

Abstract

The work proposes an innovative approach to identification and quantitative assessment of oil slicks in the sea based on radar satellite data. Information multimedia support for standardization has been developed, based on the basic geometric shapes of oil slicks on the sea surface. In some cases, this approach allows for prompt assessment of the area of pollution. A diagram of the algorithm for animating an oil slick and a diagram of computer animation of the spread of an oil slick on the sea surface based on radar survey data have been developed. The advantages of monitoring using radar satellite data are shown. The main capabilities of the multimedia approach: presentation of information in new forms, presentation of information using a combination of multiple forms, a new level of interactive communication when modeling the problem under study. In general, this study has laid an important foundation for prompt and accurate identification and quantitative assessment of oil slicks in the sea.

Keywords: *multimedia, standardization, oil slick, radar date, modeling*

Introduction

Oil and gas exploration, oil production, improvement of transportation methods have not reduced the risks of negative impact on the environment (Kostianoy, 2016). The purpose of this work is to create multimedia material for standardization of basic forms of oil slicks on the sea surface based on radar satellite data (Lisickij, 2014; Sattarov, 2023, 483-488). Satellites equipped with radars are usually used to detect oil slicks on the sea surface. The resulting images of oil slicks are quite high-contrast. At the same time, optical satellite data carry important information about oil spills only in cloudless weather. Accelerated development of information technology contributed to the emergence of the concept of “multimedia”. This technology was aimed at using new forms of information in scientific research: animation, video, sound, etc. This contributed to an increase in the information content when modeling the problem under study.

Research

As is known, a standard is a normative and technical document establishing a set of norms, rules, requirements mandatory for implementation in certain areas of activity (GOST 1.06-68).

In this regard, the pollution standard is the maximum concentration of a substance that enters or is contained in the environment, permitted by regulatory documents. From the standpoint of ecology, an environmental standard is the degree of maximum permissible human intervention in ecosystems. It ensures the preservation of ecosystems of the desired structure and dynamic qualities (reliability and sustainability). An environmental global standard is the preservation of the biosphere and climate of the planet in a form that is suitable for normal human life.

As for the standardization of the environment (water, air, soil, etc.), it sets the limits within which changes in its natural properties are allowed. For example, to assess the state of the ecosystem of individual areas of the Caspian Sea, four gradations are adopted: stable, transitional, critical and catastrophic.

Based on the monitoring system materials, two concepts were considered that assess the quality of water and the ecological state of various water areas of the Caspian Sea. Global environmental problems are caused by human activity that is not consistent with the laws of nature. These problems include: climate change, reduction of the ozone layer, acid rain, reduction of biodiversity, depletion of natural resources.

The system of sources of environmental law includes the constitution, laws and by-laws. If the constitution forms the basis for legal regulation of environmental protection, then the most important source of environmental law is legislation. The formation of modern legislation on environmental protection is of priority importance. The most important legislation is on the protection of atmospheric air, water, soil. Thus, environmental monitoring is characterized as one of the measures of environmental protection, a function of public administration and a legal institution. Based on this, environmental monitoring is a system of long-term observations, assessment and forecast of the state of the natural environment and its changes.

Aerospace information is used in various industries and serves to solve practical problems, including:

- monitoring of oil pipelines;
- monitoring of oil pollution of the sea surface, etc (Zhantaev, 2019).

Aerospace monitoring of oil pollution of the sea surface is based on radar and optical satellite data. Optical satellite data of the observed region depends on weather conditions. At the same time, radar satellite data are all-weather. Thus, radar satellite information is most convenient for detecting oil spills and forecasting their spread.

Oil spills are classified both by shape (linear, curved, heterogeneous) and by size (less than 1 km, 1-5, 5-10, 10, more than 10 km). Oil pollution of the sea surface can occur as a result of accidents on drilling platforms, terminals, pipelines, tanker accidents, etc.

All-weather radar satellite data are the most convenient for detecting and forecasting the spread of oil spills. In order to promptly eliminate an oil spill, it is necessary to assess when and which areas of the sea surface will be subject to oil pollution. Visual observation data from the air (helicopters) and ships (ships), as well as satellite data, indicate the location of the spill at a certain point in time.

All methods of determining and tracking the trajectory of a slick have limitations. In this regard, preliminary graphical modeling of the dynamics of a slick on the sea surface is convenient. The movement of a slick is caused mainly by the combined effect of sea currents and wind (Lisitsky, 2016; Peterson, 2020).

Based on the above, a diagram of the algorithm for animating an oil slick has been developed and a diagram of computer animation of the spread of an oil slick on the sea surface based on radar data is given.

Figure 1 shows a schematic of the oil slick animation algorithm.

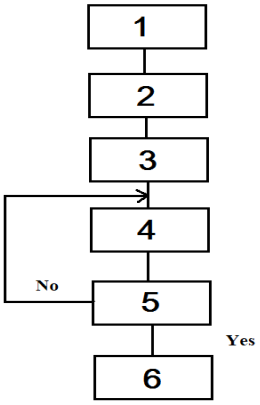

Figure 1. Scheme of oil slick animation algorithm
1– start; 2 – input of initial data; 3 – start of oil slick animation; 4 – increase in oil slick size, 5 – condition for achieving the specified slick size, 6 – end

Figure 2 – shows an animation diagram of oil slick spreading on the sea surface.

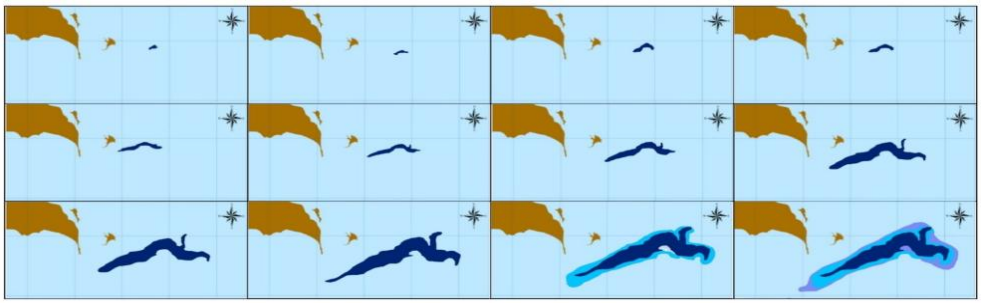

Figure 2. Animated diagram of the spread of an oil slick on the sea surface

During the evolution process, an oil slick undergoes a number of transformations. At the beginning, it has a complex shape, which is elongated in the direction of the wind. As noted in (Arkhipov, 2018), there are various approaches to modeling the spread of oil spills (in particular, models that lead to partial differential equations, models based on the wandering particle method). Such approaches allow for some additional features, the irregular shape of the spill, but they usually require large computational costs and are quite difficult to implement.

The accumulated experience in the process of computer animation of an oil slick has allowed us to develop the following approach.

In some cases, it is necessary to quickly calculate the area of the sea area polluted with oil.

In some cases, urgent calculation of the area of oil pollution at sea is required. We propose an approach for operational calculation of the area of oil pollution at sea based on remote sensing data. As you know, polygons (side length a) are as follows].

- triangular (number of sides 3);
- square (number of sides 4);
- pentagonal (number of sides 5);
- hexagonal (number of sides 6);
- octagonal (number of sides 8);
- decagonal (number of sides 10).

Triangular	$\frac{a^2}{4}\sqrt{3}$
Square	a^2
Pentagonal	$\frac{a^2}{4}\sqrt{25+10\sqrt{5}}$
Hexagonal	$\frac{3}{2}a^2\sqrt{3}$
Octagonal	$2a^2(1+\sqrt{2})$
Decagonal	$\frac{5}{2}a^2\sqrt{5+2\sqrt{5}}$

According to the series of variables a = 10 - 100, the corresponding areas for a number of polygons were calculated (Sattarov, 2024). The above contributes to the intensification of computer graphics modeling in the assessment of the area of sea surface pollution. Below are fragments of the calcu lation of the areas of polygons using the corresponding formulas (Biao Zhang, 2011; Li, D, 2023).

Triangular

a1 = 10	Σ1 = 43.3
a2 = 20	Σ2 = 173.20
a10 = 100	Σ10 = 4330

Square

a1 = 10 Σ1 = 100
a5 = 50 Σ5 = 2500
a9 = 90 Σ9 = 8100

Pentagonal

a2 = 10 Σ1 = 684,025
a3 = 30 Σ3 = 6156,225

Hexagonal

a1 = 10 Σ1= 259,8
a4 = 40 Σ4= 4156,8

Octagonal

a2=10 Σ1 = 482,84
a6=60 Σ6 = 17382,24
a9=90 Σ9 = 39110,04

Decagonal

a1 = 10 Σ1 = 1677,075
a10 = 100 Σ10 = 167707,5

Figure 3 shows several regular polygon shapes.

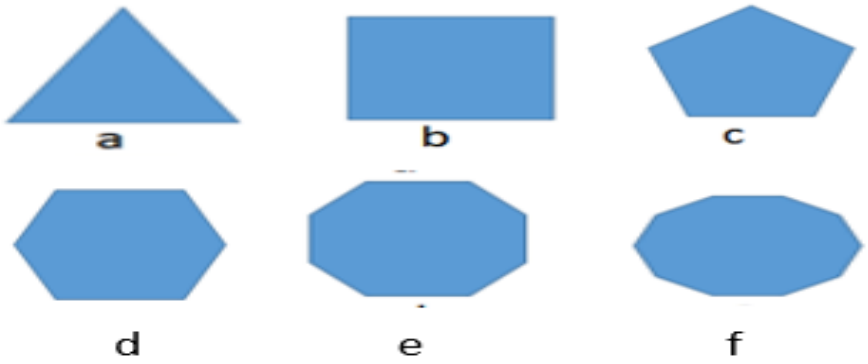

Figure 3. Several regular polygonal shapes

a - triangular, b - square, c - pentagonal, d - hexagonal, e - octagonal, f – decagonal

Further development of this method is the collection, careful selection of informative characteristics of the problem area based on IF – THEN heuristics. The above will provide intellectual support in solving the problem based on cognitive and expert systems technologies (Stuart, 2020; Sattarov, 2024).

Conclusion

1. It is known that the total area of the surface that borders the oil slick (rectangle) is calculated by multiplying the length by the width.
2. The proposed method allows one to determine the area of the polygon by the known length of its edge.
3. The shape of the newly formed slick (from several hours to several days) depends mainly on the wind.
4. The noted geometric images can serve as material for standardizing the basic shapes of oil slicks at sea.
5. Further development of the proposed method will be intellectual support based on cognitive and expert systems technologies.

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Advantages of STEAM Technology in Teaching Practical Lessons in Biology

Abstract

Science and STEAM integration bring together a variety of disciplines to promote a holistic approach to problem-solving and learning. This integration not only increases the depth of understanding in each area, but also prepares individuals to solve complex problems using a variety of approaches. One of the preferred methods for the STEAM teaching model is the use of E-learning models, which are ways to apply constructivist learning theory in the classroom. E-learning models - Constructivism is based on the application of inquiry learning and conceptual change. E-learning models are being updated and developed rapidly. When teaching practical lessons in biology, STEAM technology can be used to set problems in various ways.

1. Discussion of the problem, 2. Familiarization with visual information, 3. Tables for studying the problem, 4. Study of the topic.

Keywords: *biology, technology, STEAM, method, practical*

Introduction

The multidisciplinary approach of STEAM (science, technology, engineering, arts, and mathematics) offers solutions to many of the challenges facing humanity. Combining these fields of study opens up a variety of opportunities, from applying scientific discoveries to solving real-world problems to creating visually appealing designs. The main component of this STEAM subject combination is biology. The basic ideas of biology, derived from the study of natural systems and living things, are applied in many academic fields and help generate original ideas.

The combination of biology with STEAM subjects can produce innovative and effective results in various fields. For example, in the field of bioengineering, new technologies can be developed by taking inspiration from the structures of biological organisms. By studying the aerodynamic structure of bird wings, more efficient airplane wings can be designed. Together with engineering principles, this design process can help develop new materials and promote innovations in the aerospace industry. The integration of biology with STEAM subjects can also lead to interesting results in the field of art. For example, artists can interpret biological concepts to create visual artwork. Works such as medical illustrations depicting cellular processes or sculptures of biological forms enhance the aesthetic interpretations of scientific knowledge (Lindsay, 2021, e12327).

Research

Setting problems with STEAM methodology in secondary school textbooks can be done in different ways.

1. Problem discussion: Discussing the problem with students to start the lesson. This will help students understand the importance of the problem and share their thoughts on the topic.

2. Visual information introduction: Special materials can be provided to students to familiarize themselves with the problem through visual information, videos, figures or infographics. This will help them to study the problem more closely and increase their interest in the topic of the problem.

3. Problem research schedules: Students are given time to research a specific problem and develop plans for its solution. This provides an opportunity to express their ideas, collect information to investigate the problem and propose various creative solutions.

4. Topic study: Students are given the opportunity to collect and discuss information from various sources to learn more about the topic of the problem.

This is an important step in developing your own ideas and finding ways to solve the problem. Investigating local ecosystems or organizing field expeditions. This is an opportunity for students to observe the beauty of nature, increase their sensitivity to the environment, and think creatively about ways to solve problems (Chistyakov, Zhdanov, Avdeeva, Dyadichenko, Kunitsyna, Yagudina, 2023, em2256).

Currently, STEAM lessons are taught to students in secondary schools starting from the 5th grade, twice a week. If we look at the topics in the curriculum, we will see that the lessons become more complex as the grades go by, and topics that will attract the interest of the students are taught, taking into account their age category (Anwar, Bascou, Menekse, Kardgar, 2019, 2).

For example, let's look at the curriculum designed for 9th grade:

- ✓ Analog devices (Potentiometer)
- ✓ Parking radar system (Ultrasonic sensor)
- ✓ Coded box evaluation
- ✓ Rescue drones
- ✓ Tactical unmanned flight
- ✓ 3D modeling and mapping

When conducting practical experiments in biology, the ability to first collect data and use STEAM technology equipment increases the quality of the lesson. For example, by giving an example related to plant growth, they can test the effect of different soil types or irrigation methods on plant growth. During these experiments, they collect data and analyze this data (Utomo, Hasanah, Hariyadi, Narulita, Umamah, 2020, p.463-476).

This is an example of STEAM methodology in biology lessons.

Experiment: Study the effect of different soil types and irrigation methods on plant growth.

Objective: Different soil types and irrigation methods affect plant development.

Experiment progress:

1. Two different soil types are selected for the experiment (for example, clay soil and sandy soil).
2. Two different irrigation methods are determined for each soil type (for example, regular irrigation and drip irrigation).
3. Plant seeds (for example, beans or wheat) are sown for each combination.
4. At the beginning of the experiment, the growth conditions (light, temperature, etc.) of each group of plants are equalized.
5. Soil moisture is measured regularly throughout the growth process of the plants.
6. At the end of a specified period (e.g. 4 weeks), the growth status and yield of the plants are recorded.

Data collection and analysis:

1. Growth indicators such as plant size, number of leaves, flowering or fruiting status are recorded.
2. The effect of soil moisture and irrigation methods on plant development is observed and recorded.
3. The data obtained are evaluated by statistical analysis.
4. The effect of different soil types and irrigation methods on plant development is evaluated comparatively.

Results:

- The effect of different soil types and irrigation methods on plant development is determined.
- The most suitable soil-agricultural relationship and irrigation method are determined.
- The correctness of the hypothesis is assessed.

These experiments allow students to use both theoretical knowledge and practical skills together. They also give students experience in the processes of collecting and analyzing data, applying the scientific method, and interpreting results. These experiments also develop students' critical thinking skills and help them understand the scientific research process.

Conclusion

The benefits of teaching biology with STEAM techniques can lead to innovative and creative results in various fields. For example, in the field of bioengineering, new technologies can be developed by taking inspiration from the structures of biological organisms. By studying the aerodynamic structure of bird wings, more efficient airplane wings can be designed. This design process, combined with engineering principles, can help develop new materials and drive innovation in the aerospace industry. The necessity of using STEAM methodology in biology lessons is that it allows students to deeply understand and apply information, rather than simply memorize it (Jesionkowska, Wild, Deval, 2020, p.135). This approach helps students develop their skills in understanding and solving real-world problems. The integration of biology with STEAM subjects can also lead to interesting results in the field of art. For example, artists can interpret biological concepts to create visual works of art. Works such as medical illustrations depicting cellular processes or sculptures of biological forms enhance the aesthetic interpretation of scientific knowledge. When applying STEAM methodology to biology lessons, students can create, connect, compare, etc. It is important to focus on the right problem setting to build skills. By engaging in literature reviews, laboratory experiments, or field studies, students develop the skills and confidence needed to become independent researchers and critical thinkers in the field of biology. The application of STEAM methodologies is an effective way to offer students the opportunity to engage in project-based learning, to deepen their understanding of biology concepts, and to develop critical thinking and problem-solving skills. Projects allow students to explore topics of interest in depth, apply their knowledge to real-world problems, and develop practical skills that are essential for success in both academic and professional settings (Herro, Quigley, 2017, p.416-438). STEAM projects often culminate in the preparation and presentation of reports or presentations to communicate the results to others. This component of the project helps students develop communication skills, critical thinking, and the ability to effectively communicate complex scientific ideas to a variety of audiences. Overall, projects and applications offer students valuable opportunities to engage in hands-on learning, apply their knowledge to real-world problems, and develop skills essential for success in biology and beyond. Through experiments in STEAM classes, students gain hands-on experience in scientific inquiry, data collection, and analysis, while also developing laboratory skills and techniques (Juškevičienė, Dagienė, Dolgopolovas, 2021, p.209-228).

By incorporating STEAM elements, educators can create more engaging and interactive learning experiences that encourage interdisciplinary exploration and innovation. In addition, we discussed various ways to teach STEAM methodologies in biology classes, emphasizing the importance of hands-on activities, project-based learning, and collaborative projects. These approaches deepen students' understanding of biological concepts while also developing key skills such as problem solving, creativity, and teamwork.

A pedagogical experiment conducted as part of this study provided valuable insights into the effectiveness of STEAM-based instruction in biology education. The results indicate that students who participate in STEAM-oriented activities demonstrate greater enthusiasm, engagement, and retention of knowledge compared to those in traditional classrooms.

In conclusion, integrating STEAM methodologies into biology classes is essential to prepare students to thrive in a rapidly changing world. By adopting innovative teaching approaches and developing a holistic understanding of science, technology, engineering, arts, and mathematics, teachers can help students become lifelong learners and solve complex real-world problems.

1. The necessity and importance of STEAM methodology in biology lessons are emphasized, and how the application of this methodology can enrich the teaching process is clarified.

2. The problem statement in the methodological literature is refined and existing research on lessons designed to teach biology lessons in accordance with the STEAM methodology in universities and secondary schools is analyzed in detail.

3. Methods and practical issues of teaching STEAM methodology in biology lessons are also evaluated, and research is worked on.

4. STEAM teaching involves students in the process of solving problems and coming up with new ideas by supporting their creativity and innovative thinking.

5. It allows students to apply their scientific knowledge in practice by learning the principles of research and observation.

6. STEAM methodology enables students to express their own ideas and be guided by their own thoughts.

7. STEAM teaching in biology classes helps students to master lectures and increase their research experience.

8. STEAM methodology helps teachers to arouse interest in other areas in biology classes, so that students become interested in various scientific issues and have a wider spectrum of knowledge.

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Green IT: the Importance of Durable Technologies

Abstract

Green IT is an approach that aims to reduce the negative impact of information technologies on the surrounding environment and to encourage the use of durable technologies. This concept ensures efficient use of energy, reduction of carbon footprint and proper management of electron consumption.

The high energy consumption of information centers and IT infrastructures has a serious impact on the surrounding environment. To minimize these impacts, Green IT applies virtualization, cloud technologies and intelligent energy management systems. In addition, re-purposing of equipment and extending the life of technological equipment deteriorates ecological sustainability.

The benefits of green IT are evident both in the economic and ecological fields: companies benefit from their expenses and at the same time help to protect the surrounding environment. This approach creates opportunities for the use of more ecologically friendly and responsible technology in a long-term perspective.

Green IT plays an important role in society's struggle against ecological problems by ensuring the continuous development of technology.

Keywords: *intelligent energy management, Norway sample, reproduction and waste reduction, energy efficiency, carbon footprint, electron wastes, ecology sustainability, waste management*

Introduction

The rapid technological development of modern times penetrates deeply into every aspect of our daily lives, increasing productivity and comfort. Regardless, the effects of this development on the surrounding environment should not be ignored. Protection of the environment, energy efficiency and the continued use of resources occupy an important place among global issues today. For this reason, the "Green IT" concept comes to the fore in order to ensure the development of technology that is durable and compatible with the surrounding environment. In this article The nature of the "Green IT" concept, the areas where durable technologies are applied and their importance in terms of economy, ecology and society will be discussed. The aim is to investigate how technological processes can be made more ecologically responsible, both at the individual and corporate levels, and to take steps in this direction. It is to evaluate.

Research

The impact of the technology sector on the surrounding environment is wide-ranging and multifaceted. This effect is observed at both production and exploitation levels. For this reason, some researchers approach this issue from several perspectives. Considering the following aspects:

- **Energy Consumption and Carbon Emission**

a) IT infrastructure, mainly information centers and servers, demand large amounts of electrical energy. According to the information obtained from the statistics for the year 2023, approximately 2-3% of the global energy demand will be shared by the IT sector. This results in the emission of a large amount of carbon dioxide (CO_2) into the atmosphere and, of course, accelerates climate change (Figure 1).

Figure 1. Traffic environment and technology

Norwegian example: By expanding the volume of UDM on the account of oil revenues, Norway is able to effectively manage the risks of wastes thrown into the ecology that may be created in the future in parallel with it. they could know. In countries that implement parallel development directions, there are generally no "elusive" economic increases. Tekce can skillfully manage not only to expand the UDM, but also to manage the risks that will arise against the backdrop of its expansion.

Norway aims to achieve carbon neutrality by 2030. With this, Norway expresses its commitment to making important contributions to global climate changes. Norway is committed to sustainable transport through incentives and infrastructure, reducing emissions and improving air quality. Norway also attaches importance to energy efficient buildings and smart urban planning. More significant progress has been made on behalf of unsecured energy sources. The Norwegian government has become one of the global leaders in unsecured energy production. This is a phenomenal state for the resurs country (Talibli, 2024).

- **Electron Trashes (E-trashes)**

As a result of the rapid obsolescence or renewal of technological equipment, millions of tons of technology are created in this sector every year. There are many heavy metals (for example, lead, mercury) and poisonous chemicals in the composition of these deposits, which, if not properly castrated, can form in the soil. and pollutes water supplies.

E-tolls are a type of pollution and belong to groups II and III (medium and high) according to the danger they pose. According to the classification of the International Organization for Standardization (ISO), the electronic equipment group includes electronic devices, equipment and equipment, including computer equipment, as well as electrotechnical (electrical) equipment. and in international terminology, it is briefly referred to as WEEE (Waste Electrical and Electronic Equipment)

- **Consumption of natural resources**

Rare metals and minerals (for example, cobalt, lithium) are required for the production of many technological products (tools). The removal of natural resources leads to the degradation of the surrounding environment, the destruction of trees and the decrease in bioreproductivity. In particular, the detection and extraction of rare earth elements causes serious damage to the surrounding environment.

Ecological information from the historical perspective essentially combines the effective drivers of competitive market value. They stimulate the activity of both the producer and the consumer. At the same time, it allows the tasks posed to be fulfilled within the protection of the surrounding

environment at the lowest cost. The effectiveness of ecological information depends on the implementation of legislative and normative acts by institutions. The principle of "if you make it dirty, you have to pay" confirms that the dirty substances carry full financial liability for the pollution (Nabiyev, 2019).

- **Water Utilization**

A large volume of water is consumed in the production processes of IT sector products. For example, during the production of semiconductor chips, water is used to clean and strip it, which causes the natural water resources to decrease. Green IT water utilization focuses on reducing the water footprint of data centers and electronic manufacturing through efficient cooling technologies and water recycling systems (Koomey, 2011). Implementing water-efficient strategies in IT infrastructure not only supports environmental sustainability but also reduces operational costs in the long term (Shehabi, et al. 2016).

- **Detoxification or recycling of processed IT equipment**

In other cases, the reintroduction of technological products is either not successful enough, or in developing countries, it is implemented by methods that do not comply with hazard-free and ecological standards. This poses a serious threat to the health of the people living in the region and to the ecosystems. Accordingly, in order to reduce the effects of the technology sector on the surrounding environment to the least possible level, the modern IT conditions should be implemented. There is a need to move on to practical and continuous production models.

The application of durable technologies brings benefits in a wide range of ways for both companies and society. It is possible to group these advantages in economic, ecological and social aspects.

1. Economic Advantages

a) Reducing Expenses: Optimizing energy efficiency and resources reduces energy and surgical expenses in the long-term perspective. For example, equipping buildings and information centers with energy-efficient systems creates serious profit opportunities for businesses.

b) New Business Opportunities: Durable technologies enable innovation and the formation of new markets. New sources of income are created for startups and companies operating in the field of green technologies.

c) Increase in Brand Value: The activities of companies that are ecologically responsible gain more social support and customer satisfaction. This causes them to gain an advantage in the market competition.

2. Ecological Advantages

a) **Reduction of Waste:** Reproductive and circular economic models counteract the pollution of the surrounding environment by reducing the volume of waste. Circular economics is based on three principles: reduce consumption, reuse and produce again. This principle aims to reduce the amount of waste produced by minimizing the use of materials and resources in the first place. When uses are unavoidable, they should be used or re-manufactured whenever possible (5).

b) **Reducing the Carbon Footprint:** Resilient technologies play an important role in combating climate change, especially by reducing energy demand and emissions. For example, the use of available energy sources significantly reduces carbon emissions. The protection of natural resources requires the adoption of environmentally friendly technologies and conscious consumption habits in order to achieve sustainable development goals (Chepel, 2003).

During emission calculations, the methodology recommended by the IPCC and determined by level approaches was used. As a result of the calculations, the Carbon Trace of the Salcuqlu district in 2015; It has been determined that there is 0.94 million tons of CO2. Among the emissions that constitute the Carbon Trace of the Salcuqlu district, emissions coming from the range lead with 56%. Then, the largest degradation comes from the use of energy for transportation purposes, at 41%. The bottom emissary source is 3% of the total. It reduces 1.55 tons of CO2 emissions per person in the rayon and 457 tons of CO2 emissions per unit area (km2). When the results are evaluated, the carbon footprint of the region is well below the world average. In addition, as a result of the intensive coal mining works carried out on the rayon land, 612360 tons of CO 2 were retained, which significantly contributed to the reduction of carbon emissions in the rayon (Erguch, 2019).

c) **Protection of Natural Resources:** Successful production and consumption models ensure more responsible use of resources. This helps protect limited resources such as water, energy and goods.

3. Social Advantages

a) **Improving the Health of the Community:** As a result of the reduction of pollution and the application of clean technologies, the quality of air, water and soil improves. This allows to maintain the health of the population and improve the quality of life.

b) **Creation of New Workplaces:** New workplaces are opened in the field of development and application of durable technologies. Increase job opportunities, especially in the fields of energy, recycling and ecological services.

c) **Increasing the Ecological Responsibility of the Society:** The promotion of durable technologies leads to an increase in ecological knowledge and responsibility in the society. This contributes to the creation of a stronger and cleaner environment for future generations.

some cases are clearly explained below :

✓ **Increasing Energy Productivity**

Virtualization Technologies: Reduce the number of physical devices by creating virtual environments for servers and computers. This significantly reduces energy consumption and abstraction demands.

Cloud Computing: Cloud services ensure centralized storage and processing of information. This reduces the energy consumption of individual installations and enables more effective use of resources on a large scale. Cloud computing enables on-demand access to shared computing resources over the internet, offering scalability, flexibility, and cost efficiency for businesses and individuals (Armbrust, et al., 2010). Cloud technologies have revolutionized the way businesses operate, offering many advantages in comparison with indigenous domestic systems. These innovative methods have gained considerable popularity in recent years due to their consistency, agility and determination. By turning cloud technologies into an integral part of modern computing, it offers a range of functions that enable businesses and individuals to approach information technologies (Mardanzadeh, 2024).

Energy-Efficient Equipment: The use of certified equipment that minimizes energy consumption (for example, Energy Star or EPEAT certified devices) saves electrical energy.

✓ **Utilization Optimization of Resources**

Reproduction and Circular Economy: The technology used reduces the waste of repurchasing equipment and minimizes the need for new goods. This significantly reduces the impact of electron particles on the surrounding environment.

Going to paperless information: Numerical syntaxization and electronic signature technologies reduce the need for paper, ultimately detrimental to the protection of documents.

Smart Sensor and Automation Systems: Automation of lighting, heating and abstraction systems in smart buildings optimizes energy and energy consumption. These technologies work only when necessary, eliminating waste.

✓ **Information Management and Analytics**

Big Data Analysis: Information analytics technologies allow enterprises to obtain detailed information regarding energy and reinsurance usage. Based on this information, more productive management strategies can be implemented.

Monitoring in Real Time: Systems that monitor energy consumption in real time detect waste and provide the opportunity for immediate intervention. This docking reduces energy consumption to a minimum level. Real-time monitoring allows for the prompt tracking of system and process status, ensuring timely response to changes (Kuznetsov, 2018).

✓ **Business and Digital Friendship from a Distance**

Teleconference and Distance Work Technologies: Allowing workers to work from a distance reduces energy consumption and carbon emissions associated with transportation. Numerical collaboration platforms create wide opportunities for reducing office space and saving energy.

Conclusion

Green IT environments offer many technology and management aspects to optimize energy and energy consumption. These situations give good results in the protection of the surrounding environment by simply increasing the energy efficiency, both in establishments and among individual users. According to the established energy integrations:

1) Solar - Energy demand: Information centers and facilities increase energy efficiency and reduce carbon footprint by transferring energy to available energy sources.

2) Energy Saving Technologies: Energy saving technologies integrated into IT systems make energy use more balanced and productive. How can he optimize his appetite?

Green IT technologies are of great importance for the modern society in terms of protecting the surrounding environment and effective use of resources. Problems such as energy consumption, electron waste and carbon emissions resulting from the rapid development of the technology sector require resistant solutions. Green IT partners present strategic steps aimed at eliminating these problems. Green IT for enterprises reduces operational expenses, increases competitiveness and improves ecology. It creates great advantages in terms of increasing responsibility. For society, these situations result in preserving ecological pollution, improving health and creating new job opportunities. Therefore, every step taken towards the reconciliation of technology and the surrounding environment creates a more resilient environment. It is important for the future and the clean planet. With the broad application of the green IT concept, it is possible to achieve significant positive changes in both economic and ecological fields.

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