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CLIMATE CHANGE MITIGATION STRATEGIES AND THEIR INTEGRATION INTO THE EDUCATIONAL PROCESS

Environmental problems have significantly intensified due to industrial growth and the expansion of human activities, resulting in widespread ecological degradation. Physics, as a core natural science, has contributed both positively and negatively through technologies used in energy production and industrial processes. While physics education currently includes some environmental topics, there remains a critical need to better integrate ecological knowledge across disciplines, particularly in physics curricula. This integration is essential because physics underpins key environmental processes and technologies, such as climate modeling, renewable energy systems, and innovations like carbon capture. Physics helps explain fundamental biosphere elements including the Sun, atmosphere, water, and soil, and provides understanding of critical concepts such as temperature, electromagnetic radiation, diffusion, and radioactive emissions. These concepts are vital to comprehending environmental pollution and climate change. At COP29, discussions emphasized renewable energy development and climate change mitigation, highlighting physics' role in improving energy efficiency and understanding atmospheric dynamics. Climate models based on physical laws enable predictions that inform policy and technology development.

Global environmental challenges fall into two major categories: events causing global warming and those causing widespread pollution. In Azerbaijan, environmental education is legally mandated to be continuous, comprehensive, and accessible, starting from preschool through higher education. This reflects a commitment to raising environmental awareness and training qualified specialists. To address climate change effectively, education must not only provide scientific knowledge but also cultivate ethical and social responsibility. Integrating global environmental issues into curricula fosters students' problem-solving skills and responsibility toward nature. Physics educators play a crucial role by exemplifying environmental care and promoting sustainable practices. Overall, enhancing environmental education in physics is vital for developing conscious citizens who can contribute to solving global ecological problems.

Key words: *Environmental problems, climate change, physics education, renewable energy sources, environmental pollution, climate modeling, sustainable development, environmental awareness, carbon emissions.*

(статтю подано мовою оригіналу)

One of the oldest myths in human history is the story of Adam and Eve. Although there is no single authoritative version, numerous religious sources, legends, and folk tales converge on a central idea: God molded Adam from diverse earthly soils and clay, breathed life and spirit into him. While Adam slept, Eve was formed from his rib. They lived joyfully in the Garden of Eden, abundant and happy. God frequently visited them and permitted them to eat from every tree-except one: the tree of the knowledge of good and evil. They disobeyed this prohibition, coveting the forbidden fruit, and succumbed to sin. As a result, they were exiled from Eden to our world, denied angelic status, and condemned to mortality. The fruit of that tree symbolized God's inviolability of his creatures-the sacredness of nature and its elements-and served as a reminder of preservation and respect.

The myths of Adam and Eve thus became divine references-markers of permission and prohibition-for human interaction with nature. Over time, these moral guidelines evolved into fundamental doctrines, beliefs, and exemplars that promoted respect for nature. Since ancient times, it was understood that nature and human life were interconnected. Ignorant of natural phenomena’s causes, people feared them and attributed these forces to divine powers or gods. They believed that those who violated nature would be punished by these gods. This belief led to the proliferation of deities-Ancient Egypt alone had over 200 gods. These ideas helped persuade people of nature’s sacredness and inviolability.

In pre-Christian Ancient Greece, scholars also revered Earth and its nature. Thales of Miletus (c. 625–547 BC), founder of the early Greek scientific school, expressed in hymn-like verses: “From everything, God is ancient, uncreated; From everything, the world is fair, fashioned by God.” [4].

This idea was widely revered and propagated among contemporaries. In the same era, the philosopher-mathematician Pythagoras of Samos (c. 570–490 BC), founder of a mystical school that maintained secret teachings, believed the Earth was “alive, intelligent, and spherical.”[4] He viewed the world as a sentient being-feeling harm done to it-and said in his essay “On Nature”: “I swear by the air I breathe, I swear by the water I drink…” [4].

From its earliest origins, the Quran-Islam’s holy book-devotes significant attention to the story of Adam and Eve, including the prohibition concerning the tree of knowledge, to symbolize harmony between humanity and nature. The acceptance of Islam starts with the rejection of taghut (an Arabic term meaning “transgression” or “tyranny”) and the embrace of faith. As stated: “There is no compulsion in religion. The right path is distinct from error. So whoever disavows taghut and believes in Allah has certainly grasped the firmest handhold…”[7].

These permissions and prohibitions rooted in divine command deeply shaped human worldviews, fostered respect for nature, and provided a basis for societal and economic structures, religious traditions, and scientific endeavors. People began addressing nature as “Mother Nature” to express affection and gratitude-and now humanity acknowledges that it owes its existence to her.

With the advent of the Industrial Revolution in the 18th century, the wounds inflicted on nature became more visible and widespread. The drive to expand industry came at the cost of environmental degradation. Humanity’s domination over nature gradually altered the Earth's fabric, accelerated by scientific and technological progress.

In regions rich with natural resources, people settled, professions emerged, and societies developed decisively. As populations increased, so did demand – expanding from local to global reach. These changes prompted long-term, often irreversible damage to Earth, triggering dangerous processes threatening life itself.

Alongside the many achievements attained through scientific and technological progress, there have also been significant damages inflicted upon nature and society due to shortcomings and overlooked aspects in the application of certain technologies. Over the past two centuries, the scope of such harm, which has now become a source of fear and a threat to the survival of both humanity and all living organisms, has expanded and taken on a global character.

A process has already begun whereby the large-scale and relentless ecological genocide perpetrated by the world’s developed nations has left the environment facing increasingly global existential threats. Despite various efforts and measures, these remain insufficient – nature and humanity are sounding the alarm. As Professor Salahaddin Khalilov, Doctor of Philosophy and Corresponding Member of the Azerbaijan National Academy of Sciences, states: “As we reflect on the fate of humanity and global problems, the inadequacy of science is becoming ever more apparent. Humanity is beginning to realize that self-understanding through science alone is not sufficient. The path to self-restoration lies not only through rational comprehension, but also through emotional awareness and the re-establishment of humanistic foundations. A new philosophy is emerging at the intersection of emotion and rationality. Whoever joins this process in time and contributes to the development of future-defining ideas–the future belongs to them.” [8, p. 67].

Since the early 20th century, renowned scientists around the world, recognizing the devastating potential of global threats, have been raising their voices. A core issue identified is the marginalization of the humanities:

“The marginalization of the humanities is often attributed to their inability to maintain relevance compared to the prominence of natural sciences and technology.” [10].

A shared global understanding and spirit of international cooperation has begun to emerge in response to these challenges. Scholars increasingly believe that all scientific research and emerging fields of production must be socially oriented and dedicated to the protection of both humanity and the environment. This critical idea is emphasized by renowned American educational theorist Howard Gardner, who asserts: “The mission of the new millennium is to discover how intelligence and ethics can work together to create a desirable world for humanity.” [5].

In this context, prominent scientists who are fully aware of the dangers posed by global problems advocate for a coordinated, purposeful, and consistent policy among all developed nations. They view the restoration and preservation of a natural and harmonious balance between society and nature as the most viable solution. In this regard, the thoughts of the late British theoretical physicist Stephen Hawking are particularly compelling: “We live in a strange and wonderful universe. It takes great imagination to grasp its age, size, power, and beauty. In this vast cosmos, the place we humans occupy may seem small and insignificant. Yet, we strive to fully understand it and learn how to live in harmony with it.” [6].

Today, numerous countries around the world are conducting extensive research aimed at finding solutions to global problems. Various classifications of these global issues have emerged in the scientific community, including: environmental crises, wars (especially nuclear conflict), underdevelopment of Third World countries, demographic challenges, terrorism, and the depletion of natural resources. Among these, the most widespread – and most interconnected with other global challenges – are environmental problems, and within these, the most pressing is climate change.

On June 4–20, 1992, during the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, 154 countries signed the United Nations Framework Convention on Climate Change (UNFCCC) – an international treaty aiming not only to stabilize greenhouse gas concentrations in the atmosphere, but also to strengthen the global response to the “dangerous interference of human activities with the climate system.”

In March 1995, the first Conference of the Parties (COP1) to the UNFCCC was held in Berlin, Germany, to establish binding decisions under the Convention. Initially headquartered in Geneva, Switzerland, the UNFCCC Secretariat was relocated to Bonn, Germany, in 1996.

In 1997, the Kyoto Protocol was signed under the framework of the UNFCCC as the first legally binding agreement, targeting the period from 2005 to 2020. Later, in 2016, the Paris Agreement entered into force, effectively replacing the Kyoto Protocol. The central goal of the Paris Agreement is to limit global warming to well below 2°C, with efforts to keep it below 1.5°C compared to pre-industrial levels. To stay below this 1.5°C threshold, global carbon emissions must be reduced by approximately 50% by 2030 and reach net-zero by the mid-21st century.

The Conference of the Parties (COP), the supreme decision-making body of the Convention, convenes annually to evaluate progress in the fight against climate change and to oversee the implementation of adopted decisions and recommendations. From November 11 to 24, 2024, COP29 was held in Baku, with participation from over 80,000–100,000 delegates representing more than 190 countries. By decree of the President of the Republic of Azerbaijan, Ilham Aliyev, the year 2024 was declared the “Year of Solidarity for a Green World” in Azerbaijan.

One of the most effective solutions to combat climate change is the development of renewable energy sources. Azerbaijan is among the countries with significant renewable energy potential. The technical potential of renewable energy sources in the country amounts to 135 GW onshore and 157 GW offshore. The economic potential is

estimated at 27 GW, including 3,000 MW of wind energy, 23,000 MW of solar energy, and 380 MW of bioenergy. The potential of the country's mountain rivers is also assessed at approximately 520 MW.

For many years, Azerbaijan has prioritized the development of a green energy economy, and numerous strategic measures continue to be implemented in this direction. One of the main targets is to reduce greenhouse gas emissions by 35% by 2030 and 40% by 2050, compared to 1990 levels.

The strategic foundation for renewable energy policy was laid with the decree of President Ilham Aliyev dated February 2, 2021, approving the "Azerbaijan 2030: National Priorities for Socio-Economic Development." One of the five National Priorities outlined in this document explicitly addresses the goal of a "clean environment" and "green growth." More importantly, President Ilham Aliyev declared the liberated territories of Azerbaijan as a Green Energy Zone, with a dedicated Action Plan for 2022–2026. The main goal is to transform these territories into a "net-zero emission" zone by 2050 [2].

In today's world, climate change remains the most pressing environmental concern causing growing anxiety in both nature and society. For instance, the study titled *"Satellite-Based Analysis of Extreme Land Surface Temperatures"* reports that land surface temperatures in the Lut Desert reached as high as 80.8 °C, confirming it as the hottest area on Earth [9].

Similarly, according to the European Copernicus Climate Change Service, July 21, 2024, was recorded as the hottest day ever globally, with a mean surface air temperature of 17.09 °C, exceeding the previous record by 0.01 °C. [3] Prior to that, experts from the same service reported that April 2024 marked the 11th consecutive record-breaking month in terms of global temperature increases. Data from Copernicus indicates that April temperatures were 1.58 °C above historical global averages, and over the past 12 months, global temperatures were 1.61 °C higher than pre-industrial levels, surpassing the critical 1.5°C threshold.

Throughout history, humans have harbored feelings of love and compassion toward nature. Recognizing the direct impact of environmental degradation on human health, people have begun taking the issue of ecological protection seriously. Growing public concern has led to the formation of numerous environmental societies, global and intergovernmental organizations, and state institutions. Today, many countries have established official governmental bodies for environmental protection, including the Ministry of Ecology and Natural Resources in Azerbaijan.

According to a decree signed by President Ilham Aliyev on May 16, 2007, May 23 is celebrated annually in Azerbaijan as a professional holiday for ecologists, public figures, and environmental activists. Additionally, June 5 is observed as World Environment Day.

Various climate action strategies have now taken shape around the globe. These strategies are multifaceted and implemented at international, national, regional, and local levels. As noted by multiple scientific sources, climate-related strategies generally fall into the following major categories:

1. Reduction of Carbon Intensity and Emissions. Reducing carbon intensity primarily involves using clean energy sources such as solar, wind, hydro, biomass, and geothermal energy. The most critical element in this effort is the reduction of dependence on fossil fuels. Due to their high energy density, fossil fuels are widely used in energy production, but their combustion results in the emission of large amounts of greenhouse gases, primarily carbon dioxide (CO_2) and methane (CH_4) – both major contributors to climate change.

2. The most commonly used fossil fuels include coal, oil, and natural gas. These are used to power engines and machinery, provide heating, generate electricity, and are integral in industrial processes, chemical manufacturing, and the production of synthetic fuels. As a result, debates surrounding the phasing out of fossil fuels remain highly relevant. The development of alternative energy sources is considered a central issue in the modern energy management agenda.

3. At the same time, there's a growing need to implement economic instruments to reduce carbon emissions, such as the introduction of carbon taxes, cap-and-trade systems, and the alignment of industrial processes with environmental standards, including eco-compatible production models.

4. Conservation of Natural Resources. Preventing deforestation, restoring degraded forests, establishing new forest belts, and expanding forested areas are crucial steps. Measures should also be taken to combat soil salinization. Protecting water sources, preventing their misuse and wasteful consumption, and improving the efficient and targeted management of water resources are equally important.

5. Ensuring Adaptation to Climate Change. This includes the development of relevant policies and legal frameworks to enable adaptation to the consequences of climate change. Strengthening climate adaptation strategies and infrastructures is essential, along with enhancing preparedness and early warning systems for natural disasters, and modernizing natural disaster management mechanisms. In this context, it is necessary to develop national and regional development plans that reflect robust climate strategies and to implement environmental legislation aimed at protecting ecosystems.

6. Fostering International Cooperation. The formation of global cooperation mechanisms around international climate agreements such as the Kyoto Protocol, the Paris Agreement, and others should align with the interests of both individual states and international organizations. Increasing financial and technological support for developing countries to combat climate change is a key component of this cooperative effort.

7. Strengthening Education and Awareness. Public information campaigns and awareness-raising initiatives about climate change must be intensified. Climate-related educational programs should be integrated and studied

across all levels of education – general education, vocational and technical training, secondary and higher education, as well as in scientific institutions.

In the emergence of environmental problems and the multifaceted development of industry – along with the expansion of their geographic scope – the influence and support of natural sciences have played a significant role. Among them, physics has contributed notably through technologies applied in atomic, thermal, and hydroelectric power plants, factories, and various pollutant industries. Many of these technologies have accelerated the process of ecological degradation. Therefore, incorporating environmental knowledge across disciplines, particularly within the teaching of physics, is of great importance.

Although environmental topics have been somewhat incorporated into the school-level physics curriculum, achieving a truly impactful integration of ecological knowledge in physics education remains a key challenge. Especially in recent decades, physics has evolved significantly, branching into multiple areas and integrating deeply with other fields of science. Due to these characteristics, physics serves as an interdisciplinary engine of innovation, particularly in the field of environmental science.

The environmental knowledge taught within physics education is primarily related to the fundamental elements of the biosphere: the Sun, the Earth's atmosphere, water, and soil. Thus, disruptions in physical parameters that characterize different environments can be understood both as signs of pollution and climate change, and vice versa. In this context, it is essential to recall several physics-related concepts that are crucial to understanding nature: temperature, electromagnetic fields, electromagnetic radiation, density, humidity, diffusion, electric fields, sound, radioactive substances and their emissions, and so on.

At COP29, key topics of discussion included the development and application of renewable energy technologies and strategies to combat climate change. The science of physics is directly related to renewable energy sources, principles of energy systems, energy production, storage, usage, atmospheric sciences, and climate modeling. Through scientific research in the field of physics, it is possible to enhance the efficiency of these technologies and ensure their wider implementation:

– The physics of atmospheric gases, water vapor, and other components is critical to understanding the dynamics of the climate system. Climate models are built on the basis of physical processes. For example, by studying the heat-retention properties of carbon dioxide in the atmosphere, it becomes possible to make well-founded conclusions about the causes of global warming.

– Physicists develop complex mathematical models to predict climate changes. These models help analyze shifts in the atmosphere, sea level rise, and weather patterns. The results obtained from such modeling are typically used by governments in shaping their climate policies and strategic planning.

– The data generated from these models are also invaluable in the development of new technologies and materials essential to climate mitigation. For instance, energy storage systems, more efficient batteries, insulation materials, and carbon capture technologies all rely on fundamental physical laws and principles.

– The use of renewable energy sources, such as solar and wind energy, is of critical importance in reducing carbon emissions. The science of physics, with its underlying laws and principles, plays an indispensable role in improving the efficiency of such energy systems and enhancing the overall effectiveness of renewable energy production.

The scope of environmental knowledge and ecological education that is considered relevant to be taught within physics education should be redefined. A systematic approach must be applied to fully comprehend the biosphere, and the human factor and its role must be properly identified. From this perspective, global environmental issues in scientific literature are typically categorized into two main directions:

1. Events that lead to global warming, including ozone layer depletion, the warming of the world's oceans, thermonuclear warfare, and so on.
2. Events that cause global pollution, such as air and water pollution, the depletion or extinction of soil minerals, deforestation, desertification, and others.

Article 68 of Chapter X. I. of the Law of the Republic of Azerbaijan “On Environmental Protection and Use of Natural Resources” is devoted to the universality, complexity, and continuity of environmental education and awareness [1]. According to this article, in order to raise the environmental culture of society and prepare qualified specialists, the law mandates the creation of a continuous, comprehensive, and accessible system of environmental education and upbringing – starting from preschool and extending through general education, vocational training, and higher education institutions. The law also emphasizes that environmental awareness is an integral part of sustainable development, supporting scientific research, teacher training, and continuing education in this field.

Against this background, the integration of global environmental issues, particularly those related to climate change, into the curricula of general and higher education institutions is of high relevance. Therefore, it is appropriate to propose the following science-based recommendations for incorporating climate change topics into the education process:

– Timely informing young people about global problems encourages them to grow into more conscious and responsible citizens. In such a purpose-driven educational process, students not only gain knowledge about these issues but also develop practical skills and a sense of responsibility to address them.

– Issues such as climate change, social injustice, and inequality should be examined not only from a scientific perspective but also through the lens of ethical and social values. Such analysis helps learners distinguish the moral and social dimensions of these problems, ultimately encouraging more responsible behavior.

– The inclusion of global challenges – especially those related to climate change – into school and university curricula, and their reflection in textbooks, fosters a problem-solving mindset in students aimed at tackling these critical issues.

– Research into global problems is invariably based on scientific and technological knowledge. Successful results achieved in science clearly demonstrate to students the relevance and importance of science and technology, reinforcing their interest and commitment to these fields. To fulfill these educational objectives, it is important to strengthen cooperation across all educational institutions.

In the context of physics education, several key aspects should be emphasized to effectively foster ecological awareness and education:

– Ensuring that environmental content is grounded in scientific principles;

– Providing learners not only with nature-related knowledge but also keeping their environmental literacy aligned with modern trends;

– Focusing on the cultivation of responsible resource use and sustainable practices within environmental education;

– Promoting technical thinking skills in the environmental education process;

– Highlighting human error in industrial processes as a primary driver of environmental degradation;

– Emphasizing the importance of cultivating love and care for nature, with a particular focus on the teacher's personal example – especially the role of physics educators – serving as a powerful model for students.

Bibliography:

1. Azərbaycan Respublikası. *Təbiəti mühafizə və təbiətdən istifadə haqqında: Azərbaycan Respublikasının Qanunu* № 79, 25 fevral 1992-ci il E-qanun.az hüquqi məlumat portalı. URL: https://e-qanun.az/framework/6900
2. Azərbaycan Respublikası Prezidentinin Sərəncamı. "Azərbaycan 2030: *Sosial-iqtisadi inkişafın Milli Prioritetləri*" : 2 fevral 2021-ci il. E-qanun.az hüquqi məlumat portalı. URL: https://e-qanun.az/framework/46875
3. Copernicus Climate Change Service. *Earth's hottest June – and the hottest day ever recorded* 2024, iyul. URL: https://climate.copernicus.eu/earths-hottest-june-and-hottest-day-ever-recorded
4. Diogenes Laërtius. *Lives and Opinions of Eminent Philosophers*. Book VIII. / Transl. C. D. Yonge Laërtius c. 230 AD.
5. Gardner H. Intelligence Reframed: *Multiple Intelligences for the 21st Century*. New York : Basic Books, 1999. 304 p.
6. Hawking S., Mlodinow L. *Zamanın daha qısa tarixi*. – Bakı: Parlaq İmzalar Nəşriyyatı, 2016. 256 s.
7. Qurani-Kərim. *Bəqərə surəsi*, ayə 256.
8. Xəlilov S. *Fəlsəfə və ədəbiyyat*. – Bakı: "Zərdabi Nəşr" MMC, 2023. 592 s.
9. NASA Earth Observatory. *Satellite-Based Analysis of Extreme Land Surface Temperatures*. 2021.
10. *The Humanities in the 21st Century: Perspectives from the Arab World and Germany.* Dossiers, Forum Transregionale Studien, 2/2022. 246 p.

References:

1. Azərbaycan Respublikası (1992). *Təbiəti mühafizə və təbiətdən istifadə haqqında: Azərbaycan Respublikasının Qanunu* № 79, 25 fevral 1992-ci il [Law on Environmental Protection and Use of Natural Resources]. Bakı, rəsmi nəşr. URL: https://e-qanun.az/framework/6900 [in Azerbaijani].
2. Azərbaycan Respublikası Prezidentinin Sərəncamı (2021). "Azərbaycan 2030: *Sosial-iqtisadi inkişafın Milli Prioritetləri*" [Azerbaijan 2030: National Priorities for Socio-Economic Development]. Bakı, rəsmi nəşr. URL: https://e-qanun.az/framework/46875 [in Azerbaijani].
3. Copernicus Climate Change Service (2024). *Earth's hottest June – and the hottest day ever recorded*. URL: https://climate.copernicus.eu/earths-hottest-june-and-hottest-day-ever-recorded
4. Diogenes Laërtius (c. 230 AD). *Lives and Opinions of Eminent Philosophers*, Book VIII / Transl. C. D. Yonge Laërtius.
5. Gardner H. (1999). *Intelligence Reframed: Multiple Intelligences for the 21st Century*. New York, Basic Books. 304 p.
6. Hawking S., Mlodinow L. (2016). *Zamanın daha qısa tarixi* [A Briefer History of Time]. Bakı, Parlaq İmzalar Nəşriyyatı [in Azerbaijani].
7. Qurani-Kərim (n.d.). *Bəqərə surəsi*, ayə 256 [Quran, Surah Al-Baqarah, Ayah 256]. [in Arabic].
8. Xəlilov S. (2023). *Fəlsəfə və ədəbiyyat* [Philosophy and Literature]. Bakı, Zərdabi Nəşr MMC, 592 s. [in Azerbaijani].
9. NASA Earth Observatory (2021). *Satellite-Based Analysis of Extreme Land Surface Temperatures*
10. Forum Transregionale Studien (2022). *The Humanities in the 21st Century: Perspectives from the Arab World and Germany. Dossiers,* 2/2022, 246 s.

Відаді Омар оглу Оруджов, Хазай гизи Севіндж Джалілова. Стратегії пом'якшення наслідків зміни клімату та їх інтеграція в освітній.

Екологічні проблеми значно загострилися через промислове зростання та розширення людської діяльності, що призвело до масштабної деградації екосистем. Фізика як фундаментальна наука зробила як позитивний, так і негативний внесок у цей процес через технології, що використовуються у виробництві енергії та промислових процесах. Хоча екологічні теми вже частково входять до фізичної освіти, існує критична потреба в кращій інтеграції екологічних знань у міждисциплінарні курси, особливо в програми з фізики. Це важливо, оскільки фізика лежить в основі ключових екологічних процесів і технологій, таких як моделювання клімату, системи відновлюваної енергії та інновації на кшталт уловлювання вуглецю. Фізика допомагає пояснити основні елементи біосфери – Сонце, атмосферу, воду та ґрунт, а також забезпечує розуміння критично важливих понять, як-от температура, електромагнітне випромінювання, дифузія та радіоактивні викиди. Ці поняття є ключовими для розуміння забруднення довкілля та зміни клімату. На COP29 основну увагу приділено розвитку відновлюваної енергії та пом'якшенню наслідків зміни клімату, при цьому підкреслено важливу роль фізики в підвищенні енергоефективності та вивченні атмосферної динаміки. Кліматичні

моделі, засновані на фізичних законах, дозволяють робити прогнози, які впливають на розробку політики та технологій. Глобальні екологічні виклики поділяються на дві основні категорії: події, що спричиняють глобальне потепління, та ті, що викликають широкомасштабне забруднення. В Азербайджані екологічна освіта законодавчо визначена як безперервна, всеохопна та доступна – від дошкільного до вищого рівня освіти. Це свідчить про прагнення підвищити екологічну обізнаність та підготовку кваліфікованих спеціалістів. Для ефективного реагування на зміну клімату освіта повинна не лише надавати наукові знання, але й формувати етичну та соціальну відповідальність. Інтеграція глобальних екологічних проблем у навчальні програми сприяє розвитку в учнів навичок розв’язання проблем і відповідальності за природу. Викладачі фізики відіграють ключову роль, демонструючи турботу про довкілля та просуваючи сталу практику. Загалом, удосконалення екологічної освіти в курсах фізики має вирішальне значення для формування свідомих громадян, здатних зробити внесок у вирішення глобальних екологічних проблем.

Ключові слова: *Екологічні проблеми, зміна клімату, фізична освіта, відновлювані джерела енергії, забруднення навколишнього середовища, кліматичне моделювання, сталий розвиток, екологічна обізнаність, викиди вуглецю.*

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ФОРМУВАННЯ ЦИФРОВОЇ КОМПЕТЕНТНОСТІ ВИКЛАДАЧА В ПРОЦЕСІ ВПРОВАДЖЕННЯ СУЧАСНИХ ОСВІТНІХ ТЕХНОЛОГІЙ У ВИЩІЙ ШКОЛІ

У статті окреслено основні напрями та засоби впровадження сучасних освітніх технологій у діяльність викладачів вищої школи, розглядається значення та шляхи формування цифрової компетентності викладачів закладів вищої освіти в умовах сучасного інформаційного суспільства. Акцентується увага на тому, що цифрова компетентність є не лише вимогою часу, а й європейським стандартом, що сприяє ефективній професійній діяльності викладача. Проаналізовано наукові дослідження вітчизняних та зарубіжних вчених, які вивчають вплив цифрових технологій на якість освіти та розробляють методики їх ефективного використання. Окреслено ключові аспекти розвитку цифрової компетентності, такі як підвищення кваліфікації та обмін досвідом. Зазначено, що ефективне впровадження сучасних освітніх технологій вимагає комплексної готовності викладачів, технічного забезпечення та методичної підтримки. Особлива увага приділяється інтеграції цифрових технологій у педагогічну діяльність, включно з використанням платформ управління навчанням (LMS), інструментів штучного інтелекту (ШІ), хмарних сервісів та віртуальної/ доповненої реальності (VR/ AR). Досліджено рівень сформованості цифрової компетентності викладачів вищої школи та виявлено основні тенденції, труднощі та потреби викладачів закладів вищої освіти щодо впровадження інформаційно-комунікаційних технологій (ІКТ) у професійну діяльність. Аналіз показав переважно позитивне ставлення до цифрових освітніх технологій і визнання їх впливу на ефективність навчального процесу. Визначено рівень цифрової компетентності викладачів, найбільш уживані цифрові платформи, основні бар’єри у використанні ІКТ, а також форми підвищення кваліфікації, які вони вважають найефективнішими. Отримані результати підтверджують необхідність комплексної підтримки викладачів у технічному, методичному та освітньому напрямах для успішної цифрової трансформації вищої освіти.

Ключові слова: *цифрова компетентність викладача, сучасні освітні цифрові технології, цифровізація освіти.*

Цифрова компетентність набула значної уваги в науковому середовищі у зв’язку з розвитком різноманітних комунікаційних інструментів. З переходом до компетентнісного підходу зростає потреба розвитку цифрової компетентності викладачів закладів вищої освіти. Викладачі мають не лише вміти користуватися технологіями, а й аналізувати їх вплив на ефективність навчання здобувачів у конкретних умовах, тобто цифрова компетентність викладача включає здатність поєднувати технології з педагогічними цілями.

Цифрова компетентність викладачів ЗВО є вимогою сучасності необхідною для ефективної роботи викладача в умовах інформаційного суспільства. Це свідчить про те, що без володіння цифровими інструментами викладач не має змоги повноцінно реалізовувати свою професійну діяльність. Крім того, цифрова компетентність виступає як європейський стандарт, так як входить до восьми ключових компетентностей Європейського Союзу для навчання протягом усього життя, що демонструє її стратегічне значення не лише в освітньому процесі, а й у розвитку особистості та професіонала. З одного боку, новітні технології відкривають нові можливості для викладання й навчання, мотивуючи викладача оновлювати свої підходи. З іншого, їхня кількість та швидкий розвиток створюють певні труднощі, які стосуються насамперед того, що викладачі не встигають ознайомлюватися з усіма інноваціями, що призводить до професійного навантаження та технологічного відставання.

Формування цифрової компетентності потребує підтримки, постійного розвитку, адаптації до змін і здатності інтегрувати технології в освітній процес, а також пошук ефективних моделей впровадження цифрових технологій у вищу освіту.