Теорія та методика навчання біології

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EUROPEAN APPROACHES AND PRACTICES IN NON-FORMAL BIOLGY FOR FUTURE UKRAINIAN TEACHERS

This article examines the development and integration of non-formal biological education practices within the European Union and their potential adaptation in Ukraine, particularly in the training of future biology teachers. Non-formal education, characterized by its flexibility, learner-centeredness, and experiential nature, complements formal education by offering innovative approaches such as virtual excursions, interactive workshops, and citizen science projects. The study highlights the importance of combining formal, non-formal, and informal learning formats to enhance ecological awareness, critical thinking, and practical skills in biology. Through a comprehensive literature review and analysis of European best practices-such as outdoor science centers in Finland, student laboratories in Germany, and science festivals in France-the article identifies effective tools and strategies to enrich biology education. It also reviews Ukraine's current non-formal biological education landscape, including initiatives by the Minor Academy of Sciences and regional ecological centers, noting both achievements and challenges like limited integration into teacher education programs and unequal access. The authors propose concrete steps to adapt European experiences to the Ukrainian context: updating curricula, developing methodological materials, fostering international cooperation, and utilizing digital technologies. The interdisciplinary approach combining pedagogy, biology, and innovative methods is emphasized as essential for preparing motivated, qualified educators capable of implementing modern, engaging biological education. This work contributes to the ongoing modernization of Ukraine's education system, advocating for the wider adoption of non-formal educational formats to cultivate environmentally responsible citizens and improve the quality of biological education amid contemporary challenges.

***Keywords**: non-formal education; environmental education; virtual nature excursions; biology teacher training; ecological literacy; educational innovation; Ukraine; interdisciplinary approach; European practices.*

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ЄВРОПЕЙСЬКІ ПІДХОДИ ТА ПРАКТИКИ НЕФОРМАЛЬНОЇ БІОЛОГІЧНОЇ ОСВІТИ ДЛЯ МАЙБУТНІХ УКРАЇНСЬКИХ ВЧИТЕЛІВ

У статті досліджується розвиток і інтеграція практик неформальної біологічної освіти в межах Європейського Союзу та можливості їх адаптації в Україні, зокрема у процесі підготовки майбутніх учителів біології. Неформальна освіта, що вирізняється гнучкістю, орієнтацією на здобувача та досвідним характером навчання, доповнює формальну освіту, пропонуючи інноваційні підходи - такі як віртуальні екскурсії, інтерактивні майстерні та проєкти громадянської науки. У дослідженні підкреслено важливість поєднання формальної, неформальної та інформальної освіти для розвитку екологічної свідомості, критичного мислення та практичних навичок у біології. На основі ґрунтовного аналізу літератури й європейського досвіду - зокрема діяльності наукових центрів просто неба у Фінляндії, студентських лабораторій у Німеччині та наукових фестивалів у Франції - визначено ефективні інструменти й стратегії збагачення біологічної освіти. Також розглянуто сучасний стан неформальної біологічної освіти в Україні, зокрема ініціативи Малої академії наук та регіональних еколого-натуралістичних центрів, окреслено досягнення та проблеми, серед яких - недостатня інтеграція у систему підготовки вчителів і нерівний доступ до освітніх можливостей. Автори пропонують конкретні кроки з адаптації європейського досвіду до українського контексту: оновлення навчальних програм, розроблення методичних матеріалів, розвиток міжнародної співпраці та активне використання цифрових технологій. Підкреслюється міждисциплінарний підхід, що поєднує педагогіку, біологію та інноваційні методи, як необхідна умова підготовки мотивованих і компетентних педагогів, здатних реалізовувати сучасну, змістовну та привабливу біологічну освіту. Дослідження робить внесок у процес модернізації освітньої системи України, обґрунтовуючи потребу ширшого впровадження неформальних освітніх форматів для формування екологічно відповідальних громадян і підвищення якості біологічної освіти в умовах сучасних викликів.

Ключові слова: *неформальна освіта; екологічна освіта; віртуальні екскурсії в природу; підготовка вчителів біології; екологічна грамотність; освітні інновації; Україна; міждисциплінарний підхід; європейські практики.*

Introduction. Since the late 20th century, the countries of the European Union have entered a stage of institutionalizing elements of non-formal education. In the 1960s–70s, many European

countries established youth education centers, natural science museums with interactive exhibitions, scout movements, and summer biology camps aimed at exploring nature. All these and many other practices required official documentation and recognition at the national level. At the beginning of the 21st century, numerous documents were developed within the European Union to regulate the implementation of non-formal education in society. In 2006, the Council of Europe adopted the *Recommendation on Key Competences for Lifelong Learning*, which highlighted the role of non-formal education in developing the specified competences [15].

In 2011, UNESCO provided an official definition of non-formal education in its documents. It is appropriate to cite the full definition: «Non-formal education is characterized by being an addition, an alternative, and/or a complement to formal education within the lifelong learning process. It is intended to ensure the right of access to education for all. Non-formal education caters to people of all ages, but does not necessarily apply a continuous pathway-structure; it may be short in duration and/or low-intensity, and is typically provided in the form of short courses, workshops, or seminars. Generally, it does not lead to certification, although it may provide a pathway to formal education and training or recognition of prior learning. It may cover programs contributing to adult and youth literacy and education for out-of-school children, as well as programs on life skills, work skills, and social or cultural development» [31].

This definition became a cornerstone in the creation of the legal framework for non-formal education in EU countries.

In 2012, at UNESCO's initiative, the *Global Observatory on Recognition, Validation and Accreditation of Non-formal and Informal Learning* was established. Its purpose was to document and support these processes in the member states. The platform continues to promote the legitimacy of learning outcomes acquired outside the formal education system by sharing practical experience, facilitating knowledge exchange, and developing methodological guidelines [39].

At the same time, the Council of Europe established a *Department of Formal and Non-formal Education*, which focuses on supporting quality civic education based on universal human values.

Non-formal education has become an integral part of the European Union's youth policy. In 2015, the Council of Europe and the European Commission published a document aimed at supporting and recognizing non-formal education and learning among young people. This document emphasized the importance of non-formal education for the younger generation and called for its official recognition and integration into national policy [14].

The *European Youth Foundation (EYF)* was created to support projects based on non-formal educational approaches, recognizing their key role in developing youth skills and competences. The youth sector of the Council of Europe, including the EYF, actively promotes the development and recognition of non-formal education through financial support of relevant projects [29].

The *European Youth Strategy*, which defines the EU's youth policy for 2019–2027, outlines a number of measures and initiatives aimed at supporting youth organizations and programs that provide opportunities for non-formal learning [16].

The *European Qualifications Framework (EQF)*, introduced in 2008 and updated in 2017, serves as a tool for recognizing and comparing qualifications and learning outcomes acquired in non-formal and informal contexts across Europe. It is based on learning outcomes and encompasses all types of qualifications, acting as a mechanism for harmonization between national qualification systems.

The Erasmus+ program also actively supports the development of non-formal education, particularly in the youth sector, through the implementation of various initiatives and the creation of supportive documents. One such resource is the *DROP'IN Handbook*, a catalog of non-formal education methods, offering practical tools for working with young people based on engagement, flexibility, and experiential learning [30].

Another document under Erasmus+ related to non-formal education is the *Current Situation of Non-formal Education (YES2NFL)* report. This document provides recommendations for the

recognition and integration of non-formal learning into national education systems in partner countries [13].

Even this incomplete list of official documents demonstrates the significance and relevance of non-formal education within the educational space of the European Union.

Based on the above, the purpose of this article is to identify effective forms, tools, and approaches to non-formal education in the countries of the European Union and to explore the potential for their integration into educational programs at higher education institutions in Ukraine for the preparation of future biology teachers.

Literature Review. The principles of integrating non-formal education into the educational process have been the subject of numerous scholarly and pedagogical studies, as well as public discussions. It should be noted that non-formal education is viewed in the countries of the European Union from various perspectives and in different contexts. Any non-formal education program must be learner-centered, voluntary, focused on values, attitudes, skills, and knowledge; its outcomes should be tracked, recorded, and verified; and it should provide additional educational resources for people with limited opportunities [35].

Comprehensive research has been conducted analyzing hundreds of journalistic reports on decisions by local communities regarding non-formal education in developing countries [19, p. 125]. Although Ukraine does not belong to this category, similar processes in non-formal education are observed-namely, the growth of programs outside formal education promoted by social organizations, non-governmental movements, and other charitable institutions.

Based on data from the European Social Survey, evidence was found of a positive correlation between participation in adult non-formal education and a socio-psychological phenomenon such as the sense of subjective well-being [8, p. 130].

Alongside non-formal and informal education, the concept of «civic education» also circulates in society. An analysis of this concept and its relationship with non-formal education was conducted [9, p. 90]. The author notes that non-formal education contributes to the development of critical thinking and other cognitive changes in learners.

A thorough study comparing formal, non-formal, and informal education across various indicators can also be considered essential [21]. It is noted that non-formal and informal education partially overlap in the ways knowledge and skills are acquired, which is why these terms are often used interchangeably in the literature. The authors propose viewing non-formal education as a hybrid form of extracurricular and out-of-school learning. While this may be reasonable, it is important to distinguish between the three fundamentally different forms of education and learning: formal, non-formal, and informal. The article also presents a relevant idea that school curricula should be changed to ensure that students engage in all types of learning during their studies.

Despite the widespread implementation of civic education for youth in the European Union, out-of-school learning environments still receive insufficient attention. The volume and quality of literature and methodological resources for using non-formal education platforms remain inadequate to meet societal needs. Significant discrepancies exist between youth and youth policy developers in their understanding of how to use various learning environments in youth organizations [3].

Results from linear regression modeling of non-formal continuing professional education show that the likelihood of participating in such education decreases with age. In contrast, factors such as gender and country of origin do not significantly impact participation in continuing professional education. The general level of education has a positive influence on participation in non-formal continuing professional learning [23].

We live in a technological society characterized by increasing digitalization. Adults who received formal education often face challenges in a tech-saturated environment. Non-formal and informal learning, which lead to the development of specific skills, can help address these issues. A study was conducted to assess problem-solving skills among adults aged 16–64. This novel approach to investigating non-formal and informal learning was based on data from the Programme for the

International Assessment of Adult Competencies (PIAAC). The authors concluded that overall problem-solving ability was higher among individuals who participated in both formal and non-formal learning activities. Interestingly, the connection between formal learning and the ability to function in a technological society was weak, pointing to shortcomings in formal education and advantages of non-formal learning in this context.

Regarding the emotional aspect of non-formal education, very few studies have been conducted [36; 40, p. 398].

However, due to its voluntary nature, non-formal education is likely to be enjoyable. While this is an optional aspect, given equal characteristics of educational activities, a positive emotional environment significantly enhances learning outcomes.

Another area of debate concerning various forms of education in the European Union is the validation of learning outcomes. Souto-Otero pointed out that validation in formal education tends to be selective and instrumental [42, p. 370]. Validation is a common practice in accreditation, licensing, and evaluating institutional effectiveness. In such contexts, educational institutions often claim credit for learning that occurs outside their formal structures-learning that is essentially non-formal or informal. This happens when the validated non-formal and informal learning aligns with established educational programs and does not require significant pedagogical or assessment changes.

We have provided this brief overview of recent literature to highlight the multifaceted nature of research into the social phenomenon of non-formal education and its relevance in the modern educational landscape of EU countries.

The goal of our study is to identify the specific forms, tools, and approaches of non-formal education, particularly in the field of biology and, more broadly, the natural sciences. Although numerous practices exist for implementing this type of education, there is a noticeable lack of original research on the topic. Alnajjar developed a science curriculum for middle school students based on non-formal learning methods [4, p. 891]. The study involved an experimental group receiving non-formal education and a control group following the standard curriculum. Measurements of learning attitudes and academic outcomes were taken and analyzed statistically. The findings indicate a positive impact of non-formal learning on anticipated educational results and student motivation.

The establishment of modern non-formal laboratory environments at universities and research institutions has become a growing trend in the EU. These centers are particularly attractive to students who tend to reject traditional formal education [1, p. 15]. As the composition of learners becomes increasingly diverse, non-formal education may help integrate science education into broader learning frameworks.

Contemporary systemic studies by EU researchers on the application of non-formal education in specific subject areas, such as biology, are practically non-existent. This conclusion holds true even after analyzing relevant literature by Ukrainian authors.

In our research, we reviewed academic publications by Ukrainian scholars in this field [2, p. 4; 5, p. 30; 6, p 115; 7, p. 5; 25, p. 112; 32, p. 25; 33, p. 265]. These works discuss how non-formal education can address issues overlooked by formal education-particularly in terms of developing new competencies-and analyze the differences among educational forms. However, almost all of these studies remain conceptual and philosophical in nature and only indirectly reference successful practices of non-formal biology education in the EU.

Research Methods: systematic analysis of current literature, synthesis of European experience in non-formal science education, and identification of challenges in ensuring quality control and recognition of non-formal learning. This article is primarily theoretical, with the main hypothesis being that the integration of leading EU practices in non-formal biology education into Ukrainian teacher training programs is feasible, provided that issues related to implementing non-formal education into the national educational system are resolved.

Results. ***The Inter-Format Approach to Implementing Non-Formal Biological Education.*** Biological education increasingly requires the integration of various learning formats-formal, non-

formal, and informal. The inter-format approach is determined by the specific nature of biology as a scientific field and academic discipline, as well as by educational and societal demands. First, biology is an empirical science based on experimental research, observation, and practical activity in natural environments. This necessitates the organization of educational activities beyond the traditional classroom environment: field trips, excursions, work at biological stations, participation in science clubs, etc. Non-formal educational activities provide opportunities for immersive research experiences and the development of independent scientific skills. Second, formal education often struggles to adapt quickly to the rapid evolution of knowledge in the biological sciences. Non-formal education (trainings, summer schools, online courses, workshops) offers a flexible response to these changes. Third, non-formal education fosters critical thinking and self-directed learning. Participation in debates, conferences, biology tournaments, and other science outreach events enables learners not only to acquire knowledge, but also to present it, justify their conclusions, and engage in scientific communication. Through non-formal education, learners gain experience in active citizenship, realize their impact on the environment, and develop ecological awareness.

The motivational aspect is equally significant: non-formal education allows for content adaptation to learners' interests, making education more engaging, personalized, and meaningful. Despite the diversity of approaches and formats, non-formal biological education shares several characteristics with both formal and informal education. Formal biological education takes place in schools, universities, and other official institutions, following structured curricula and standardized (typical) programs aligned with national or international standards. Assessment is formal-tests, exams, written assignments. Learning is systematic, progressing from basic concepts to complex topics (e.g., ecology). The focus is on theoretical content, with practical and research components being less prevalent. The teacher serves as the main knowledge source and controller of the learning process, ensuring compliance with established requirements. In contrast, non-formal biological education takes place outside traditional educational institutions-in museums, clubs, online courses, nature camps, etc. Its key advantage is flexibility: participants can explore topics of interest beyond standard curricula. An inquiry-based approach is widely used-experiments, field research, practical sessions. Education is experience-based: learners gain knowledge through excursions, communication with scientists, and participation in projects. Motivation stems from personal interest; the learner initiates their own learning journey. Instead of formal assessment, feedback, presentations, project work, and self-reflection are utilized. The teacher becomes not only a mentor but also a facilitator or coach, supporting learners throughout their process.

Best Practices of Non-Formal Biological Education in the European Union. During the 20th century, with the development of national education systems across Europe, attention to out-of-school science education increased. In Germany, the UK, and France, early naturalist societies and amateur biology clubs emerged, along with summer field schools for youth. These initiatives were supported by universities and museums and played an important role in spreading biological knowledge beyond the formal educational system. Since the early 21st century, non-formal biological education in Europe has increasingly developed in digital formats. Online platforms like TED-Ed, Coursera, and FutureLearn, as well as mobile apps and virtual labs, have broadened access to biological content.

TED-Ed is an educational platform aimed at spreading ideas through animated video lessons accompanied by experts, educators, and artists. It also offers interactive tools for creating custom lessons, initiating discussions, and tracking learner progress [45]. TED-Ed videos are available for free on its official YouTube channel.

Coursera is a global online learning platform offering courses, specializations, certificates, and degrees from top universities and companies such as Harvard, Stanford, Yale, LSE, Google, IBM, and Meta. It provides diverse formats-video lectures, interactive tasks, quizzes, and final projects-and allows learners to earn professional and academic certificates and degrees [12]. Public initiatives, such as science cafés and biology festivals, also promote scientific culture and ecological consciousness. In the EU, numerous successful practices in non-formal biological education are

implemented. Finland actively integrates non-formal learning with a nature-based approach, using outdoor education, eco-centers, and camps from early childhood onward. The Finnish Education Evaluation Centre (FINEEC), part of the national education agency, monitors quality and assessment at all levels [17].

Public science events such as *Science on the Road* and *LUMA Centre Finland* engage schoolchildren in biology research. These short, interactive workshops are funded by charities, making them accessible and removing financial barriers. Event announcements are distributed via social media [41].

LUMA Centre Finland is a network of science education centers at Finnish universities promoting STEM (Science, Technology, Engineering, and Mathematics) through innovative methods. It supports lifelong learning for teachers from preschool to higher education and includes 13 regional centers [24].

In **Germany**, Schülerlabore (student labs) based at Max Planck Society institutes and universities offer real experimental experiences. Museums like *Museum für Naturkunde* in Berlin run educational programs popularizing biology. Schülerlabore are often featured in national initiatives such as Germany's Education for Sustainable Development Action Plan and the "Globales Lernen" portal, which provides continuously updated educational resources [46].

Germany also participates in the **Cell EXPLORERS** initiative-a pan-European project where researchers, students, and universities collaborate on non-formal science education. It emphasizes voluntary participation and excludes formal assessment, focusing instead on building science communication skills and fostering enthusiasm [10].

The concept of **Citizen Science** underpins another European initiative encouraging public involvement in biological research and incorporating non-formal science best practices into university curricula [11].

France supports non-formal biological education through events like *La Nuit des Sciences* and *Fête de la Science*, which feature open laboratories, lectures, and workshops. Eco-education networks such as *Maisons de la nature* provide children and youth with hands-on, playful, and exploratory engagement with nature. *La Nuit des Sciences*, held every even-numbered year across European countries, takes place in green public spaces and features creative, interactive scientific shows and exhibitions [22].

This overview of EU practices demonstrates a variety of inter-format approaches adapted to national contexts, all sharing a common goal-making biological science accessible and engaging for everyone. European countries focus on interactive and research-based methods that stimulate youth interest in science and foster collaboration with professionals and students, ultimately cultivating a deeper understanding of biology.

These initiatives offer valuable benchmarks for developing non-formal education, showing how learning can be effectively combined with scientific research and civic initiatives to create a more integrated educational landscape across Europe.

Discussion. ***The State of Non-Formal Biological Education in Ukraine.*** Non-formal biological education in Ukraine is evolving as a valuable complement to the formal education system, contributing to the development of practical skills, critical thinking, and ecological awareness. The legal foundation is established by the Law of Ukraine «On Education», which recognizes non-formal education as an integral part of lifelong learning, enabling learners to acquire knowledge and skills outside the formal system [44].

In 2018, the **Concept for the Development of Adult Education in Ukraine** was adopted, aiming to create favorable conditions for the advancement of non-formal education, including in the field of biology, by supporting educational initiatives and programs [26].

Recent regulatory documents supporting non-formal education in Ukraine include the **European Guidelines for the Validation of Non-formal and Informal Learning** [38]. Relevant Ukrainian legislation also includes the **Regulation on the Procedure for Conducting Innovation**

Activities in Education, approved by the Order of the Ministry of Education and Science of Ukraine No. 552 dated May 12, 2023 [27].

In Ukraine, non-formal biological education is promoted through the active participation of various organizations and educational institutions. Higher education institutions actively engage students in online platforms such as **Prometheus** and **Khan Academy** for self-directed learning and skill development. These platforms offer free micro-lectures in biology, allowing students to study at their own pace and convenience.

Civic initiatives are also actively promoting non-formal education. For example, the journal *Non-formal Education: Best Practices and Projects* disseminates ideas of non-formal learning among youth. Ukraine has an extensive network of ecological and naturalistic centers, such as the **National Ecological and Naturalistic Center for Student Youth (NENZ)**, which organizes competitions, Olympiads, and festivals for young learners, thereby fostering scientific thinking, ecological awareness, and practical skills [28].

Each region of Ukraine operates a regional ecological and naturalistic center that conducts classes, contests, and environmental campaigns. For example, the **Poltava Regional Ecological and Naturalistic Center** hosts educational competitions such as «The Earth is Our Common Home» and collaborates with local universities to organize scientific events [34].

The **Minor Academy of Sciences of Ukraine (MASU)** is a nationwide educational system that supports the scientific research potential of student youth. Operating as an out-of-school educational institution, MASU represents one of the most successful models of non-formal education in Ukraine. Its core characteristics fully align with the institutional features of non-formal education: voluntary participation, learner autonomy in selecting research methods, and involvement of university scientists as mentors and coaches. Key tools of MASU in the context of non-formal biology education include summer schools and camps, fieldwork, and interactive courses to develop research skills. Relevant MASU sections include «Human Biology», «General Biology», «Ecology», and «Medicine». There is no classical assessment system; instead, the emphasis is placed on learner motivation and achievement. Accessibility is enhanced through the online platform **MANLAB.CAMP**.

Student Scientific Societies (SSS) are voluntary associations of school students operating within schools or out-of-school institutions, often in collaboration with MASU. These societies aim to engage students in research, experimental, and scientific-technical activities. Their work includes biological experiments (e.g., plant research, microscopy), ecological projects (e.g., water monitoring, soil analysis, waste sorting), and medical-biology topics (e.g., lifestyle and health, hygiene). They also integrate STEM approaches, applying IT tools, statistics, and modeling in biology projects. These societies fully embody non-formal education principles: voluntary participation, flexible content, interactivity, partnership, and results-oriented learning.

Universities and scientific institutions organize **summer schools** for students to deepen biological knowledge, conduct experiments, and engage in field research. Likewise, summer camps with ecological and biological orientations provide children with hands-on nature experiences and participation in environmental activities.

Thus, non-formal biological education in Ukraine exists as a significant supplement to the formal education system. It encompasses a broad network of institutions, programs, and initiatives. Nevertheless, several challenges hinder its development.

Challenges in Integrating European Practices into Ukraine's Educational Space. The experience of the European Union demonstrates the importance of innovative approaches to implementing non-formal education in specific disciplines, including biology. One promising direction is the development of **model academic courses in non-formal education for biology students** [20, p. 157]. Such courses are currently absent among the academic components of biology and related specialties in Ukraine, despite some higher education institutions having adopted policies on **recognizing learning outcomes obtained through non-formal and informal education**.

However, key challenges to implementing European practices in Ukraine remain:

1. Insufficient integration of non-formal and informal learning formats into teacher training. Education programs for future biology teachers in Ukraine largely rely on traditional, classroom-based instruction. The limited inclusion of non-formal learning formats restricts future teachers' capacity to apply these approaches effectively in their professional practice.

2. Lack of adapted European practices for biology education. Ukraine's teacher training system does not consistently incorporate leading European methods that foster critical thinking, ecological awareness, and practical skills through non-formal education.

3. Limited opportunities for developing pedagogical competencies in non-formal education. Although the need for alternative teaching methods is acknowledged, the lack of proper training prevents educators from adapting to changing conditions and effectively engaging with students.

4. Low student motivation due to dominance of traditional teaching formats. The prevalence of conventional classroom-based instruction often fails to cultivate genuine interest in biology and ecology among students. There is also insufficient training for future teachers in interactive, extracurricular, and interdisciplinary teaching methods.

5. Need to improve teacher education programs by incorporating non-formal and informal methods. Existing curricula for future teachers inadequately integrate traditional and innovative approaches to learning that could support cognitive engagement and creativity in biology education.

6. Underfunding and unequal access to non-formal education in rural regions. Regional disparities in educational resources limit access to quality non-formal biological education, particularly in remote areas.

Conclusions. We live in a time when traditional forms of education are no longer sufficient to fully meet the demands of society and individuals for personal and professional development. The emergence of new forms of education-namely non-formal and informal learning-attests to their growing relevance and significance.

The future of biological education in Ukraine can be ensured through the research, adaptation, and integration of European practices of non-formal biological education into the curricula of higher education institutions, particularly in the training of future biology teachers. This process requires a detailed analysis of European practices that contribute to the development of biology education through innovative approaches and facilitate the formation of new learning models aligned with current educational challenges.

Further integration of the most effective methods and approaches of non-formal education into teacher training programs in Ukraine should be continued. It is essential to ensure the professional growth of future teachers by providing them with practical tools for organizing innovative learning processes. A key foundation for such transformation should be an interdisciplinary approach that combines theoretical foundations of pedagogy, biology, and non-formal teaching methods.

The use and local adaptation of European practices will promote the integration of modern teaching methods and formats, foster ecological awareness and scientific literacy among students, and ultimately enhance the quality of the educational process.

To achieve the abovementioned goals, we propose the following steps in the training of future biology teachers in Ukraine:

- conduct an analysis of existing models and approaches to non-formal biological education in European Union countries;
- adapt European forms and methods to the Ukrainian educational system;
- analyze Ukraine's regulatory framework and educational standards to identify opportunities and constraints for implementing new approaches in biology teacher training;
- develop methodological recommendations for integrating non-formal learning formats into university curricula;

- design and implement educational courses, programs, materials, and methods that incorporate innovative European practices;

- organize regular workshops, conferences, and round tables for university and secondary school educators on the implementation of non-formal biological education;

- facilitate the exchange of experience between Ukrainian and European experts through international conferences, webinars, and joint scientific projects;

- continue to monitor and assess the effectiveness of innovations through regular feedback collection from students and instructors, surveys, and analysis of implementation outcomes.

Special attention should be paid to the use of digital technologies and interactive learning materials. The proposed approaches are expected to become effective tools for modernizing the Ukrainian education system by responding to contemporary challenges and preparing highly qualified educators capable of introducing innovative practices into biological education.

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