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**PROJECT-BASED LEARNING IN INCLUSIVE EDUCATION AS A TOOL FOR
DEVELOPING ENVIRONMENTAL AWARENESS AND SUSTAINABILITY COMPETENCIES**

Анотація. У статті розглянуто потенціал проєктного навчання в умовах інклюзивної освіти як педагогічного інструменту формування екологічної свідомості та компетентностей сталого розвитку здобувачів освіти. Актуальність дослідження зумовлена потребою оновлення змісту загальної середньої освіти відповідно до принципів Нової української школи, цілей освіти для сталого розвитку та сучасного розуміння інклюзії як забезпечення активної участі всіх здобувачів освіти незалежно від їхніх індивідуальних освітніх потреб, рівня навчальних досягнень чи особливостей комунікації.

Мета роботи полягає в теоретичному обґрунтуванні доцільності використання проєктного навчання в інклюзивному освітньому середовищі та визначенні його можливостей для розвитку екологічної відповідальності, системного мислення, командної взаємодії, критичного аналізу інформації та здатності учнів брати участь у розв'язанні локальних проблем сталого розвитку.

Методологія дослідження ґрунтується на аналізі наукової літератури, нормативних і концептуальних документів у сфері інклюзивної освіти та освіти для сталого розвитку, а також на узагальненні сучасних підходів до організації проєктної діяльності. Використано методи теоретичного аналізу, порівняння, систематизації, педагогічного моделювання та узагальнення. Особливу увагу приділено принципам універсального дизайну навчання, що передбачають варіативність способів подання інформації, залучення здобувачів освіти до діяльності та представлення результатів навчання.

Наукова новизна дослідження полягає в обґрунтуванні взаємозв'язку між проєктним навчанням, інклюзивною педагогікою та формуванням компетентностей сталого розвитку. Доведено, що проєктне навчання в інклюзивному середовищі сприяє не лише засвоєнню знань, а й формуванню ціннісного ставлення до довкілля, відповідальності за спільний результат, уміння працювати в команді та здатності пропонувати реалістичні рішення для школи, громади чи локального середовища. Перспективи подальших досліджень пов'язані з емпіричною перевіркою ефективності запропонованої моделі та розробленням критеріїв оцінювання сформованості екологічної свідомості й компетентностей сталого розвитку у здобувачів середньої та вищої освіти.

Ключові слова: екологічна свідомість, інклюзивна освіта, компетентності сталого розвитку, проєктне навчання, універсальний дизайн навчання.

Abstract. The article examines the potential of project-based learning in inclusive education as a pedagogical tool for developing environmental awareness and sustainability competencies in learners. The relevance of the study is determined by the need to update the content of general secondary education in accordance with the principles of the New Ukrainian School, the goals of Education for Sustainable Development, and the modern understanding of inclusion as ensuring the active participation of all learners regardless of their individual educational needs, level of academic achievement, or communication characteristics.

The purpose of the study is to theoretically substantiate the feasibility of using project-based learning in an inclusive educational environment and to determine its potential for developing environmental responsibility, systems thinking, teamwork, critical analysis of information, and students' ability to participate in solving local problems of sustainable development.

The research methodology is based on the analysis of scientific literature, regulatory and conceptual documents in the field of inclusive education and Education for Sustainable Development, as well as on the generalization of modern approaches to organizing project activities. The methods of theoretical analysis, comparison, systematization, pedagogical modelling, and generalization were used. Particular attention is paid to the principles of Universal Design for Learning, which provide for variability in the ways information is presented, learners are engaged in activities, and learning outcomes are demonstrated.

The scientific novelty of the study lies in substantiating the relationship between project-based learning, inclusive pedagogy, and the development of sustainability competencies. It is proved that project-based learning in an inclusive environment contributes not only to the acquisition of knowledge, but also to the formation of a value-based attitude toward the environment, responsibility for a common result, the ability to work in a team, and the capacity to propose realistic solutions for a school, community, or local environment. Prospects for further research are related to the empirical verification of the effectiveness of the proposed model and the development of criteria for assessing the formation of environmental awareness and sustainability competencies in learners of secondary and higher education.

Keywords: environmental awareness, inclusive education, project-based learning, sustainability competencies, Universal Design for Learning.

Introduction. In the context of contemporary transformations in general secondary education, the development of environmental awareness and sustainability competencies is becoming one of the key tasks of the educational process. The implementation of the New Ukrainian School concept, the growing importance of Education for Sustainable Development, and the need to ensure equal participation of all learners require a revision of traditional approaches to teaching. Modern education should not be limited to the transmission of knowledge about environmental problems, but should create conditions for students to understand the interconnections between environmental, social and economic processes, develop responsibility for the state of the environment, and gain experience in solving real-life sustainability problems [1-3].

This issue becomes especially relevant in inclusive education, where the educational process must take into account the diversity of learners, their different educational needs, levels of academic achievement, communication styles and opportunities for participation. Inclusion in this context should be understood not only as support for students with special educational needs, but also as the creation of a learning environment in which every learner can be actively involved in common educational activities. Therefore, the search for pedagogical approaches that combine accessibility, cooperation, practical orientation and value-based learning is of particular importance [4, 5].

Despite the availability of research on project-based learning, education for sustainable development and inclusive education separately, the problem of their integrated application remains insufficiently explored. In particular, there is a lack of studies that simultaneously consider project-based learning as a tool for developing environmental awareness, sustainability competencies and inclusive participation of learners. The issue of assessing the effectiveness of such projects also remains open, especially in terms of criteria that would reflect not only subject knowledge, but also teamwork, value-based attitudes, environmental responsibility, systems thinking and the ability to propose practical solutions.

Therefore, the relevance of this study is determined by the need to theoretically substantiate and methodologically describe the use of project-based learning in inclusive education as a tool for developing environmental awareness and sustainability competencies. The purpose of the study is to determine the pedagogical potential of project-based learning in inclusive education for developing environmental awareness and sustainability competencies in learners.

The theoretical basis of the study is formed by three interrelated research areas: Education for Sustainable Development, project-based learning, and inclusive pedagogy. Their integration makes it possible to consider the educational process not only as a means of transmitting knowledge, but also as a space for cooperation, practical action, value formation and the development of competencies necessary for responsible participation in society.

A considerable number of studies have been devoted to the theoretical foundations of sustainability competencies. Researchers emphasize that education for sustainable development should form not only environmental knowledge, but also systems thinking, anticipatory competence, normative and value reflection, strategic action, collaboration, critical thinking and integrated problem solving [6-8]. These competencies are particularly important in environmental education, since environmental problems cannot be understood only as natural phenomena. They are connected with social behavior, economic decisions, community development and the quality of human interaction with the environment.

Project-based learning is regarded in the scientific literature as one of the effective approaches to the formation of such competencies. It is based on the investigation of authentic problems, long-term collaborative work, independent decision-making, practical activity and the creation of a socially meaningful educational product. According to the studies of K. Brundiers, A. Wiek, C. Redman, S. Bell, D. Kokotsaki, V. Menzies, A. Wiggins and other scholars, project-based learning contributes to the development of students' autonomy, motivation, communication skills, critical thinking and ability to connect learning with real social and environmental challenges [9-12]. Therefore, this approach is especially relevant for environmental education, where learning content can be directly connected with local problems of the school, community or natural environment.

An important theoretical component of the study is the concept of inclusive education. In the modern understanding, inclusion is not limited to providing support for learners with special educational needs. It involves the creation of an educational environment in which every learner has the opportunity to participate actively, cooperate with others and demonstrate learning outcomes in different ways. Studies on inclusive pedagogy emphasize the need to move from separate adaptations for individual students to the design of an educational process that is initially open to learner diversity [13, 14].

The principles of Universal Design for Learning are of particular importance in this context. They provide for multiple ways of presenting information, engaging learners in educational activities and demonstrating learning outcomes [15, 16]. In project-based learning, these principles can be implemented through flexible distribution of roles, differentiated tasks, alternative forms of communication, various formats of presenting project results and the use of collaborative forms of work. This makes it possible to involve learners with different educational needs, levels of academic achievement, interests and communication styles in common project activities.

The literature on transformative sustainability learning also emphasizes the importance of combining cognitive, practical and value-based components of education. The formation of environmental awareness requires not only knowledge about ecological problems, but also personal involvement, practical experience, reflection and understanding of the consequences of human activity [17, 18]. In this regard, project-based learning can be considered as a pedagogical mechanism that connects knowledge, action and values.

Experimental part. The experimental part of the study was developed as a methodological design of an inclusive project-based learning model aimed at developing environmental awareness and sustainability competencies in learners. Since the research focuses on the pedagogical potential of project-based learning in inclusive education, the experimental design combines elements of pedagogical modelling, a quasi-experimental approach and mixed assessment methods. Such a structure makes it possible to describe not only the sequence of educational activities, but also the tools for evaluating changes in learners' competencies.

The proposed model is based on the implementation of an educational project related to a local problem of sustainable development. The project topic may be selected according to the educational context and the needs of a particular school or community. Possible topics include waste management, water quality monitoring, energy saving, biodiversity conservation, greening of the school area, responsible consumption or environmental behavior of learners. The key requirement is that the selected problem should be understandable, socially relevant and connected with the everyday experience of learners.

The experimental design includes three main phases: diagnostic, formative and evaluative-reflective. At the diagnostic phase, learners' initial level of environmental awareness, understanding of sustainability problems and readiness for teamwork are identified. This may be done through a short questionnaire, discussion, observation or analysis of learners' previous experience. At the formative phase, learners work on a project in inclusive teams, collect and analyze information, distribute roles, develop practical solutions and create a final product. At the evaluative-reflective phase, the results of the project are assessed through observation, analysis of project products, self-assessment, peer assessment and reflective tasks.

An important condition for the implementation of the model is the use of the principles of Universal Design for Learning. These principles provide for multiple ways of presenting information, involving learners in educational activities and demonstrating learning outcomes. In the context of project-based learning, this means that learners may work with different sources of information, perform different roles in a team and present the results of their work in various formats. Such an approach makes it possible to involve learners with different educational needs, levels of academic achievement, interests and communication styles.

The structure of the inclusive project-based learning model is presented in Table 1.

Table 1.

Structure of the inclusive project-based learning model

Stage	Content of activity	Inclusive and UDL-based component	Expected educational outcome
1. Identification of a local sustainability problem	Learners identify an environmental problem relevant to the school, community or local environment.	The problem is discussed in accessible forms; learners may express ideas orally, in writing, visually or digitally.	Awareness of the practical significance of environmental problems.
2. Formation of an inclusive project team	Learners are divided into teams according to interests, abilities and possible forms of participation.	Team composition takes into account different educational needs, communication styles and levels of academic achievement.	Readiness for cooperation and shared responsibility.
3. Distribution of roles	Learners choose or receive project roles: researcher, data collector, analyst, designer, speaker, coordinator, observer or presenter.	Roles are flexible and may be adapted according to individual strengths and needs.	Active participation of all learners in the common project.
4. Collection and analysis of information	Learners collect data through observation, surveys, measurements, interviews, analysis of open sources or comparison of information.	Different tools and formats of work are used to ensure accessibility of the research process.	Development of critical thinking, information literacy and systems thinking.
5. Development of practical solutions	Teams analyze the collected information and propose realistic actions for solving or reducing the selected problem.	Learners may contribute through discussion, visual materials, calculations, planning, communication or creative tasks.	Formation of strategic action competence and environmental responsibility.
6. Presentation of project results	Teams present the results in the form of a report, poster, infographic, video, presentation, exhibition or practical action.	Alternative formats of presenting learning outcomes are allowed.	Development of communication skills and public representation of the project product.
7. Reflection and evaluation	Learners analyze their own contribution, teamwork, difficulties, acquired knowledge and changes in attitudes toward environmental problems.	Reflection may be oral, written, visual or digital.	Awareness of personal progress and value-based attitude toward sustainable development.

The effectiveness of the proposed model should be assessed through a combination of quantitative and qualitative methods. Quantitative data may be obtained from pre- and post-project questionnaires, while qualitative data may be collected through teacher observation, analysis of project products, reflective tasks

and peer assessment. This approach makes it possible to evaluate both the final result and the learning process.

The main evaluation indicators include environmental awareness, systems thinking, teamwork, critical thinking, responsibility for a common result, ability to propose practical solutions and inclusive participation. These indicators reflect the logic of sustainability competencies and allow the educational effect of project-based learning to be assessed beyond subject knowledge.

Thus, the experimental part presents a structured model for organizing project-based learning in an inclusive educational environment. The model combines environmental content, practical activity, teamwork, flexible role distribution and reflective assessment, creating conditions for the development of environmental awareness and sustainability competencies.

Results and discussion. The results of the study are presented as a methodological substantiation of an inclusive project-based learning model aimed at developing environmental awareness and sustainability competencies in learners. The obtained results do not consist in the description of a single isolated educational activity, but in the development of a structured pedagogical model that combines environmental content, inclusive participation, project work and reflective assessment.

As a result of the study, three interrelated components of the model were identified: content, organizational and inclusive, and assessment and reflective. The content component focuses on selecting a real local sustainability problem relevant to learners. The organizational and inclusive component involves forming inclusive teams, distributing roles flexibly and applying the principles of Universal Design for Learning. The assessment and reflective component evaluates not only the final project product, but also cooperation, individual contribution, communication, critical thinking and changes in learners' attitudes toward environmental problems.

The proposed model shifts project-based learning from a product-oriented activity to a means of competence development. Its educational value is determined not only by the final presentation, poster or report, but also by learners' involvement in problem identification, data analysis, decision-making and reflection. The generalized structure of the educational effects of the model is presented in Table 2.

Table 2.

Educational effects of inclusive project-based learning

Component of the model	Pedagogical mechanism	Educational effect
Content component	Work with a real local environmental problem	Formation of environmental awareness and understanding of the practical significance of sustainable development
Research component	Collection, comparison and interpretation of information	Development of critical thinking, information literacy and evidence-based reasoning
Project component	Development of practical solutions and creation of a project product	Formation of strategic action competence and responsibility for the result
Inclusive component	Flexible distribution of roles and different forms of participation	Involvement of learners with different educational needs, interests and communication styles
Collaborative component	Teamwork, discussion and coordination of actions	Development of cooperation, communication and shared responsibility
Reflective component	Self-assessment, peer assessment and analysis of personal progress	Formation of value-based attitudes toward the environment and awareness of individual contribution

The results show that the effectiveness of inclusive project-based learning depends on the quality of pedagogical design. If a project is limited only to the creation of a visible product, its developmental potential decreases. In contrast, when the project includes problem identification, research, discussion, decision-making, practical action and reflection, it becomes a tool for developing sustainability competencies. Therefore, the proposed model should be understood as a sequence of interconnected educational situations rather than as a single task.

A particularly important result of the study is the clarification of assessment criteria for inclusive project-based learning. Traditional assessment often focuses mainly on the final product or the correctness of subject knowledge. However, in the context of sustainability competencies, it is necessary to evaluate a

wider range of educational outcomes. These include environmental awareness, systems thinking, critical thinking, teamwork, inclusive participation, strategic action and reflection.

The proposed criteria are presented in Table 3.

Table 3.

Criteria for assessing the development of environmental awareness and sustainability competencies

Criterion	Low level	Medium level	High level
Environmental awareness	Learner reproduces separate facts about environmental problems	Learner explains the causes and consequences of a selected environmental problem	Learner demonstrates a value-based attitude and connects the problem with personal or community responsibility
Systems thinking	Learner considers the problem as an isolated phenomenon	Learner identifies several environmental and social connections	Learner explains the relationship between environmental, social and economic factors
Critical thinking	Learner uses information without checking its reliability	Learner compares several sources or observations	Learner justifies conclusions using evidence, data or verified sources
Teamwork	Learner performs only an assigned task without interaction	Learner participates in group work and coordinates some actions	Learner actively cooperates, supports others and contributes to a common result
Strategic action	Learner describes the problem without proposing a solution	Learner proposes a general solution	Learner develops a realistic and feasible action or recommendation
Inclusive participation	Participation is uneven or limited to several active learners	Most learners are involved, but roles are not always balanced	All learners have meaningful roles and different forms of contribution are recognized
Reflection	Learner gives a formal answer about participation	Learner identifies difficulties and acquired knowledge	Learner analyzes personal progress, contribution and changes in attitude toward the problem

The analysis of the proposed criteria shows that inclusive project-based learning allows the teacher to assess not only what learners know, but also how they interact, make decisions and apply knowledge in practice. This is especially important for environmental education, because environmental awareness cannot be reduced to the memorization of concepts. It includes the ability to see the consequences of human activity, understand the complexity of ecological problems and participate in solving them at the level available to learners.

The structural model of inclusive project-based learning developed in the study is presented in Figure 1. It reflects the relationship between pedagogical conditions, the main stages of project activity and the expected educational outcomes.

PEDAGOGICAL CONDITIONS	INCLUSIVE PBL MODEL	EXPECTED OUTCOMES
Selection of a local sustainability problem	Preparatory stage and problem identification	Environmental awareness development
Consideration of learners' abilities and needs	Formation of an inclusive team	Inclusive participation of all learners
Flexible roles and accessible tasks	Role distribution and project implementation	Teamwork and practical action
Self-assessment, peer assessment and reflection	Reflection and competence assessment	Sustainability competence formation

Figure 1. Structural model of inclusive project-based learning for developing environmental awareness and sustainability competencies

The discussion of the results confirms that the proposed model corresponds to the logic of sustainability competencies. Work with a local environmental problem contributes to the development of systems thinking, since learners analyze the relationship between nature, human behavior, school life and community needs. The search for practical solutions supports strategic action competence. Teamwork and flexible role distribution contribute to collaboration competence. Reflection makes it possible to transform project experience into personal understanding and value-based attitude toward the environment.

The inclusive potential of the model is connected with the fact that project work creates different forms of participation. Learners may contribute as researchers, observers, designers, speakers, data collectors, analysts, coordinators or presenters. This allows the educational process to take into account different strengths and needs. At the same time, the use of Universal Design for Learning principles prevents inclusion from being reduced to separate adaptations for individual learners. Instead, the project is designed from the beginning as flexible, accessible and open to different ways of learning and communication.

Compared with traditional project activities, the proposed inclusive model has several advantages. First, it shifts the focus from the strongest or most active learners to the participation of the whole team. Second, it allows different forms of contribution to be recognized as educationally valuable. Third, it combines environmental knowledge with practical action and reflection. Fourth, it creates conditions for the development of both cognitive and social components of sustainability competencies.

At the same time, the implementation of the model may involve certain methodological risks. If the teacher does not provide sufficient guidance, the project may become fragmented and lose its educational focus. If roles are distributed formally, some learners may remain passive or excluded from meaningful participation. If assessment is based only on the final product, the process of cooperation, individual progress and inclusive interaction may remain unnoticed. Therefore, the teacher's role as a facilitator is essential. The teacher should support the formulation of the problem, help learners distribute roles, monitor teamwork, provide feedback and organize reflection.

The obtained results also indicate that the proposed model can be adapted to different educational contexts. It may be used in biology, geography, chemistry, technologies, civic education and integrated courses related to sustainable development. Possible project topics include waste sorting at school, water quality monitoring, energy saving, biodiversity observation, greening of the school area, responsible consumption and environmental behavior of students. This interdisciplinary character strengthens the practical significance of the model for general secondary education.

Conclusions. The study substantiates the pedagogical potential of project-based learning in inclusive education for developing environmental awareness and sustainability competencies in learners. It is shown that project-based learning becomes particularly effective when it is organized around a real local sustainability problem, involves learners in practical activity and provides opportunities for cooperation, reflection and the search for realistic solutions.

The main result of the study is the development of a structural model of inclusive project-based learning. The model combines pedagogical conditions, key stages of project activity and expected educational outcomes. Its central elements include the preparatory stage, identification of a local sustainability problem, formation of an inclusive team, distribution of roles according to learners' abilities and needs, project implementation, reflection and assessment of competence development.

The significance of the proposed model lies in the fact that it shifts the focus of project-based learning from the creation of a final product to the development of competencies. In this approach, educational value is determined not only by the quality of a presentation, poster, report or other project outcome, but also by learners' participation in problem identification, data analysis, teamwork, decision-making and reflection.

The use of Universal Design for Learning principles makes the proposed model suitable for inclusive education. Flexible roles, accessible tasks, alternative forms of participation and different formats for presenting results allow learners with different educational needs, abilities, interests and communication styles to be involved in common project activity.

The practical significance of the study is that the proposed model can be used in general secondary education, in particular in biology, geography, chemistry, technologies, civic education and integrated courses related to sustainable development. It may be applied to projects on waste sorting, water quality monitoring, energy saving, biodiversity observation, greening of the school area, responsible consumption and environmental behavior of learners.

Prospects for further research are related to the empirical verification of the proposed model in real educational settings. In particular, it is advisable to test the model in classes with different levels of learner diversity and to compare the dynamics of environmental awareness and sustainability competencies before and after project implementation.

Further studies should focus on developing and validating assessment tools for measuring the formation of sustainability competencies in inclusive project-based learning. Special attention should be paid to indicators such as systems thinking, critical thinking, teamwork, inclusive participation, environmental responsibility, strategic action and reflection.

Another promising direction is the adaptation of the proposed model to different school subjects and interdisciplinary courses. This would make it possible to determine which project topics and forms of organization are most effective for different age groups, educational contexts and types of learner needs.

Further research may also examine the role of digital tools in supporting inclusive project-based learning, including online collaboration platforms, digital portfolios, interactive presentations and tools for visualizing environmental data. This would strengthen the accessibility and flexibility of project activities and expand opportunities for learner participation.

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The article has been submitted to the editorial board 20.06.2026

The article has been recommended for publication 28.08.2026

The article was published on 31.08.2026