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Application of Project Technology and Nanotechnology for Learners' Environmental Culture Formation in the Process of Studying Professional Disciplines: Enhancing Health Issues

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KEYWORDS

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ABSTRACT:

This article explores the application of project technology in fostering learners' environmental culture within the context of professional disciplines, with a particular focus on health-related issues. As the global environmental crisis intensifies, there is an urgent need for educational frameworks that not only impart professional competencies but also instill a sense of ecological responsibility among students. Project-based learning (PBL) engages students in authentic environmental projects that cultivate an active, independent, and creative learning environment, while also enhancing problem-solving and risk management skills. Furthermore, the integration of nanotechnology into the curriculum allows students to explore innovative solutions that promote sustainability, such as the development of eco-friendly materials and pollution remediation techniques. This article presents successful implementation strategies that demonstrate how the synergy between project technology and nanotechnology can create impactful learning experiences, fostering environmental awareness and engagement among future professionals. The findings underscore the significance of this holistic approach in empowering learners to navigate their professional landscapes effectively and to become proactive environmental stewards in their respective fields. Ultimately, this study highlights the vital role of innovative pedagogical methods in shaping environmentally conscious professionals capable of contributing to sustainable development in health and beyond.

Introduction

In an era marked by escalating environmental challenges, the intersection of education and ecological awareness has never been more critical, particularly within professional disciplines that directly impact public health. The integration of project technology and nanotechnology into educational frameworks offers a transformative approach to cultivating an environmental culture among learners, equipping them with the knowledge and skills necessary to address pressing health issues related to environmental degradation.

As global health crises increasingly intertwine with environmental factors—such as air and water pollution, climate change, and the proliferation of hazardous waste—there is a growing recognition of the need for professionals who are not only adept in their respective

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fields but also possess a deep understanding of ecological responsibility. This dual competency is essential for fostering sustainable practices that can mitigate health risks and promote well-being in communities.

Project-based learning (PBL) serves as a powerful pedagogical tool in this context, engaging students in hands-on, authentic projects that address real-world environmental challenges. By working collaboratively on projects that focus on health-related issues—such as the development of green technologies, pollution remediation strategies, and sustainable health practices—students are encouraged to think critically and creatively about the implications of their work on both the environment and public health.

Moreover, the incorporation of nanotechnology into these projects enhances the educational experience by introducing students to cutting-edge innovations that can lead to significant advancements in health and environmental sustainability. For instance, nanotechnology can facilitate the creation of eco-friendly materials, improve waste management systems, and develop targeted drug delivery methods that minimize environmental impact. Nanotechnology, the manipulation of matter at the atomic and molecular level, holds the promise of revolutionizing our ability to design solutions to environmental problems in science, engineering, and medicine. By immersing learners in an educational setting where they can explore the applications of nanotechnology in environmental science and engineering, and develop science projects that apply nanotechnology to environmental issues, we cannot only ensure that they master the required scientific content but also instill the attitudes and behaviors that we hope science will foster. Understanding the role of nanotechnology in designing solutions to environmental problems, and investigating how technology designs can achieve "sustainability", will prompt learners to consider the crucial role of ecology alongside technology.

Project-based learning and nanotechnology create a strong, healthy, cross-disciplinary spine for an informed and active environmental culture. This article is structured around examples of successful cases and methodologies illustrating the seamless integration of 'nano in professional education' through educational activities that lead young people to become active caretakers of the environment. People should consider the vitality of environmental issues in the future, not only of this planet but also of global welfare and development. The advent of a new generation of professionals requires a specialized approach to learning that considers how they can cope with these challenges and offer valuable contributions to a sustainable future for the planet and their communities. This brief introduction is the starting point of a systematic analysis of the educational approaches based on project technology and nanotechnology that foster green generations of learners.

Literature Review

Today, it is hard to imagine a field of human activity unrelated to the environment. Environmental knowledge is important for successful further professional and social activities, regardless of the field of future activity of the learner. Environmental culture is a component of the general culture of a future specialist. At the present stage, the use of innovative educational technologies, among which the project technology occupies a prominent place, is the most effective in the professional training of learners. Therefore, its application in the process of studying professional disciplines is relevant to learners' environmental culture formation.

The scientific literature study shows that various aspects of the problem of forming environmental culture are of interest to many scientists. In particular, environmental culture and environmental education of future specialists are the subject of research by Sovhira (2007), Stetsiuk (2013), Prokhorova (2019), Ponomarenko (2020), and Ponomariova (2013). The work of Lukianova (2016) is devoted to forming the ecological culture of the future teacher. The formation of the ecological outlook of future teachers in the process of ecological education and upbringing is explored by Pustovit et al. (2014). The legal aspect of the problem is highlighted by Boichuk (2013).

In particular, Stetsiuk (2013) believes that "in the pedagogical sense, environmental culture should be considered as the education of environmental literacy, the culture of environmental foresight and the need for it, the culture of behavior and activity in the natural environment" (p. 117).

Kabak (2023) analyzed "the essence, current state, functions, peculiarities of learners' environmental culture formation, outlined the importance of environmental competence as an unknown component of the pedagogical culture of the individual."

Pustovit et al. (2014) conducted a study of the formation of high schoolers' environmental behavior. The authors distinguish "the following structural elements: culture of behavior in the natural environment; culture of treatment of animals and plants; culture of water use; culture of energy consumption; culture of solid waste management; culture of consumption of goods and services."The role of project training in the training of future officers is the subject of research by Kozyar et al. (2023). Kopnina (2018) passionately emphasized the need to strengthen the role of environmental dominance in the educational

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process of higher educational institutions, inspiring us to do more in this field. The methodology of learners' independent work on the formation of environmental culture was developed by Petrovska (2013).

Scientists draw attention to the expediency of using various innovative pedagogical technologies in the process of studying professional disciplines by different categories of learners (Henziora et al., 2015; Zeidmane, 2006). In particular, Burkovska & Pampura (2022) draw attention to the use of the case method. Based on the results of the analysis of the works of modern researchers (Kozyar et al., 2023, pp. 14-15), project technologies play an important role in the training of future specialists. However, these and other scientific works do not focus on using project technology to form the environmental culture of learners.

According to Aparicio et al. (2022), the most significant aspects of the environmental context are remediation and environmental pollution control. Nanomaterials operate at the interface of water and air filtration, and eco-computing can play a role in monitoring ecological problems. By confronting students with case studies and experimenting with nanomaterials used in environmental remediation, technological innovation in university labs is transformed from a distant abstraction into a tangible environmental solution (Stephenson et al., 2023). This experience reinforces many of the urgent environmental problems we face. Also, resource efficiency is one of many benefits of nanotechnology and productivity in agriculture and manufacturing – including via the farmed food system (Hindle, 2023). Nanotechnology can be applied to dramatically increase fertilizer use efficiency and reduce the number of pesticides required in food production, making it easy for learners to understand why it is essential to use resources as efficiently as possible, both in their future careers and in their private lives.

Need to note, the intersection of environmental issues and public health has garnered increasing attention in recent years, highlighting the urgent need for educational frameworks that prepare future professionals to address these challenges (Obrecht et al., 2022). The World Health Organization (WHO) has long recognized the profound impact of environmental factors on health outcomes. Studies indicate that air and water pollution, climate change, and exposure to hazardous materials significantly contribute to a range of health problems, including respiratory diseases, cardiovascular conditions, and various forms of cancer (WHO, 2018). As such, there is a pressing need for educational programs that not only impart professional skills but also instill a sense of ecological responsibility among students (Dunlop & Rushto, 2022).

By integrating environmental health topics into professional curricula can enhance students' understanding of the complex relationships between environmental conditions and public health (Kligler et al., 2021). This integration is particularly crucial in fields such as medicine, nursing, public health, and environmental science, where professionals are often at the forefront of addressing health issues linked to environmental factors.

Project-based learning (PBL) has emerged as an effective pedagogical approach for fostering critical thinking and problem-solving skills among students. PBL engages learners in authentic, real-world projects that require them to investigate and address complex issues, thereby promoting deeper understanding and retention of knowledge (Chang et al., 2024). In the context of environmental education, PBL has been shown to enhance students' awareness of ecological issues and their implications for health (Nanni & Allanm 2020). The studies have documented the positive outcomes of PBL in cultivating an environmental culture among learners. A research study by Singha et al. (2024) found that students engaged in PBL related to environmental health issues demonstrated increased motivation, collaboration, and a sense of agency in addressing real-world problems. This approach not only equips students with the necessary skills to tackle health-related challenges but also fosters a commitment to sustainable practices.

According to Akram et al. (2023), nanotechnology represents a frontier of innovation with significant implications for both health and environmental sustainability. Also, nanotechnology can lead to the development of advanced materials and processes that minimize environmental impact while enhancing health outcomes. Nanomaterials are being explored for their potential in drug delivery systems that reduce side effects and improve treatment efficacy, as well as in environmental remediation techniques that effectively remove pollutants from water and soil (Asil et al., 2020). Integrating nanotechnology into educational programs can provide students with insights into these cutting-edge advancements and their applications in addressing health issues. Exposure to nanotechnology concepts enhances students' understanding of the interconnectedness of health and environmental sustainability (İpek et al., 2020). By incorporating nanotechnology into project-based learning, educators can create powerful learning experiences that empower students to innovate solutions for pressing health challenges.

Methodology

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The initial stage of the research involved analyzing and generalizing theoretical materials to search for factual material, clarifying the problem's development state, and determining the essence and characteristics of environmental culture formation. Pedagogical observation and surveys (a generalization of independent characteristics) were used to determine the state of learners' environmental culture formation. Also, methods of generalization and systematization were used to substantiate the pedagogical conditions for learners' environmental culture formation in the process of studying professional disciplines.

The method of pedagogical experiment was used to test the effectiveness of the identified pedagogical conditions. It consisted of a stating and formative stage. Certain tasks were solved at each of these stages of the experiment. To ensure the robustness of our findings, the method of mathematical statistics was used to assess the reliability of differences in the average values of indicators of learners' environmental culture formedness in the experimental and control groups.

Research methods such as analysis, comparison, and expert evaluation were also used to determine the criteria, indicators, and levels of learners' environmental culture formedness.

Results and Discussion

When nanotechnology becomes a part of educational programs, it's not just about the science. It encourages learners to engage with multiple disciplines, such as chemistry, physics, environmental science, and engineering. This interdisciplinary approach is a great way to gain a comprehensive understanding of how to apply environmental science. Problem-solving in the micro- and nanotechnology space requires more than just technical skills. It also demands soft skills like teamwork and communication, which are essential in the workplace, where future professionals will often work in larger and more diverse teams. The concept of "project" means an idea in the form of an object's prototype. By "project," we mean an innovative form of organizing joint work to achieve a particular result. Given this, the "project" category can be defined as a system that contains planned sequential actions to achieve a specific intended result and is based on developing scenarios for future actions. These scenarios allow us to predict the development of events. A positive feature of the scenario project is the possibility of a preliminary study of the state of affairs and establishing interaction in planning.

It is right to note that "a characteristic feature of a project development is not the study of what already exists, but the creation of new products and at the same time knowledge of what can only arise" (Stetsiuk, 2013, p. 292). In modern conditions, the process of project development is the main mechanism for developing innovative practices and, therefore, should be considered a particular type of creative activity.

"Pedagogical project development" can be understood as creativity aimed at forming and implementing pedagogical ideas and developing directions and methods of activity for solving specific problems. Pedagogical systems, processes, and situations can be projected.

A specific product is created to implement project technology, often due to the joint work of teachers and learners. Project technology as a pedagogical phenomenon creates conditions for value rethinking, application, and acquisition of new knowledge and ways of doing things.

The essence of project technology lies in an integral system of didactic tools (content, methods, techniques) that focuses the educational process on the structural and organizational requirements of educational design. Project technology's peculiarities are its dialogic, problematic, contextual, and integrative nature.

The dialogic nature allows learners to engage in dialogue with themselves and with others during project implementation. In dialogue, a free "disclosure of personality" is carried out. Dialogue in project technology serves as a specific socio-cultural environment that creates conditions for learners to accept new experiences and rethink previous ones.

The problematic nature arises when solving a problematic situation that leads to the beginning of active mental activity, manifestations of independence, resolving contradictions between known facts, and the inability to explain new facts and phenomena.

The contextuality in project technology allows the creation of projects that are close to the life of learners to realize the place of the science they study in the general system of knowledge. In particular, educational projects with elements of orientation to the formation of environmental culture are related to the fundamental values of humanity: the problems of environmental preservation, restoration of natural resources, and demographic problems (Daud & Uwe, 2016).

The integrative nature of project technology provides for an optimal combination of knowledge acquisition concepts and theories of the environmental content of disciplines studied by learners in the course of their professional training. Thus, a pedagogical project is a conceptually grounded, technologically supported, holistic, flexible process aimed at achieving a socially significant, effective, innovative educational product—

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in our case, the formation of the learner's environmental culture.

The educational process using project technology is built not according to the logic of the discipline but according to the logic of learners' activities. Therefore, this technology provides information pauses to assimilate the content of new material, the implementation of project elements in an individual format as independent research, and practical tasks under the guidance of a teacher.

Project technology is the basis for the emergence of project thinking in learners, which "consists in the ability to comprehend future actions using logical operations and procedures. In particular, such procedures are structuring information about objects, scenarios of their development, and internal and external relations" (Volobuiev, 2023, p. 116).

There are different approaches to the classification of projects in the pedagogical literature. They differ according to the following criteria:

I. The composition of participants in the project activity: individual, collective (pairs, groups);

II. The nature of interaction: cooperative, emulative, competitive;

III. The level of implementation of interdisciplinary links: mono-disciplinary, inter-disciplinary, super-disciplinary;

IV. The nature of project coordination: direct, hidden;

V. Duration: short, medium, long;

VI. The purpose and nature of project activities (research, informational, introductory, artistic, and constructive).

We agree that "the most promising types of project activities, taking into account its potential psychological and pedagogical capabilities, are collective, interdisciplinary and super-disciplinary projects that not only perform the functions of integration and systematization of knowledge, but also ensure the maximum approximation of knowledge to the real needs of life, creative self-realization, and naturally corresponding development" (Stetsiuk, 2013, p. 295).

This opinion is confirmed by the project's authors, which is referred to as the interdisciplinary approach to project-based learning within the higher education system (Saher & Syhyd, n.d.). They emphasize the expediency of organizing and implementing complex interdisciplinary projects by learners of different instructional years. In this context, we proposed using an interdisciplinary approach to forming learners' environmental culture as part of a comprehensive practical training session with learners majoring in "Educational and Pedagogical Sciences." Such training sessions last three days. According to the developed project (scenario), first-year learners perform environmental tasks at their workplaces. Second- and third-year learners act as their supervisors. Moreover, the tasks themselves are interdisciplinary since to complete them; the learner must reveal the knowledge, skills, and abilities acquired during the study of various academic disciplines (Trifanina & Miroshnichenko, 2022).

During the research, we were convinced that learners' participation in the environmental mission in everyday activities and in the work of groups to combat poachers during training practice plays a vital role in forming their environmental culture. Environmental activities include local history expeditions, research projects, and others.

The essence of using project technology to form learners' environmental culture in professional training is the successful joint implementation of a training project by learners, that is, a sequence of planned actions to solve environmental problems (from local to global).

The main thing in project-based learning is not the project itself but the process of project development by learners—from modeling training exercises to formulating and researching environmental problems to building a defense of the optimal ways to solve them in the form of a project.

According to Karamushka (2019), the formation of learners' environmental culture is an educational process aimed at expanding theoretical knowledge about the relationship between professional and environmental activities, developing environmental awareness (beliefs based on critical assessments of the state of the natural environment and actions of individuals, the meaning of value orientations), self-reflection and motivation of readiness for environmentally oriented activities in the professional sphere.

The formation of learners' environmental cultures is a continuous process of gradual inclusion in environmental activities through the acquisition of experience in practical cases of preserving and improving the environment and environmentally significant personal qualities.

The formed environmental culture of the learner is characterized by the following features: comprehensive and in-depth knowledge of the environment around us, value orientations towards the natural environment, ecologization of thinking, responsible attitude towards natural resources, and participation in environmental activities (Korovina, 2016). We were guided by these features when determining the indicators and criteria of learners' environmental culture formedness.

Kachur's opinion is correct—an important aspect of the formation of environmental culture is the national component, which considers the ethnic group's historical experience in interaction with the environment and attitude to the environment. National environmental culture is the basis for environmental education and lifelong environmental education. The ecological component of the worldview, along with theoretical knowledge, may include everyday knowledge in the form of customs and traditions (Kachur, 2011).

In our research, we considered that since culture has the power to regulate and catalyze human existence, the environmental culture of a specialist should acquire an essential internal character. Therefore, the aspiration of an environmentally active learner is to be committed to a system of values, ideals, and interests that characterizes a highly organized motivational sphere and creative and culturally generative potential (Stetsiuk, 2013).

In determining the criteria for learners' environmental culture formedness, we considered Puzyr's scientific standpoint "regarding the determining role of the content and components of this culture" (Puzyr, 2016).

In assessing the level of learners' environmental culture formation, we relied on the criteria and indicators developed in the studies of Bilyk (2011) and Lukianova (2016) and our observations during the experimental work.

We have identified the following main criteria for learners' environmental culture formedness:

a. Motivational and value-based (environmental orientation of learners' attitudes; awareness of environmental values as the basis of environmental behavior);
b. Informational and cognitive (awareness of environmental processes and phenomena; assimilation of environmental knowledge);
c. Resultative and pragmatist (development of personal qualities necessary for environmental activities, ability to evaluate environmental phenomena, pro-active environmental attitude.

Indicators for each criterion and the logical sequence of using these indicators in the activities of learners were clarified.

The following characteristics of the levels were noted:

- High level of environmental culture formedness (learners are able to identify thematic and ideological ideas fully understand the essence of the process; there are and learners are aware of the environmental values of actions; there is a desire to create; learners are able to realize the goal; developed imagination);
- The average level of environmental culture formedness (learners have a partial factual understanding of the content, are not able to realize the environmental meaning or the purpose of the process; evaluative judgments are motivated mainly by the value of individual events, the importance of individual components of nature; insufficiently developed creative imagination);
- Low level of environmental culture formedness (the learnerhas a fragmented perception, he or she is not aware of the general environmental processes; judgments lack environmental motivation, criteria for evaluating attitudes).

The stages of implementation of the project technology for the formation of learners' environmental culture in the process of studying professional disciplines are as follows: diagnostic, prognostic, organizational, practical, and generalizing.

The quantitative assessment of the indicators of the levels of environmental culture formedness was carried out by experts, 10 of whom were selected from among the scientific and pedagogical staff of the Department of Pedagogy and the Department of Ecology, who have the necessary competence, experience in scientific and pedagogical activity for more than five years, a PhD or Doctor of Pedagogical Sciences and have previously had a positive attitude to working as part of a group of experts. The experts were asked to fill out specially designed cards that indicated the criteria of environmental culture formedness, its levels, and the parameters of quantitative assessment for each indicator. After that, the average value of the expert assessment was calculated for each criterion.

To use the criteria most efficiently and to ensure the possibility of comparing the work results at different stages, they are all systematized in a three-point system by level. The methodology for determining the effectiveness of environmental culture formation is as follows:

The overall performance indicator is derived from the average indicator of the level of environmental culture; the assessment of environmental culture formedness in learners is carried out on a three-point scale.

In our research, we introduced the following quantitative indicators:

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- 4 points – if the indicator is quite pronounced;
- 2 points –if the indicator is detected;
- 0 points –if the indicator is not detected.

The results of the experiment were analyzed using quantitative data processing methods. To evaluate the environmental awareness of each expert taking part in the educational experiment, the total of their assessments on the level of development of motivational and values, informational and cognitive, and result-oriented and pragmatic criteria were divided into three. Provided that the average value of the expert assessment for the relevant criterion did not exceed 1.33, the person was considered to have a low level of environmental culture formedness; those with scores of 1.34-2.66 were considered to have an average level; those with scores of at least 2.67 were considered to have a high level of environmental culture formedness.

At the initial stage of the experimental work, the sample was divided into the control (CG) and experimental (EG) groups. The CG group consisted of 115 learners, and the EG group consisted of 112 learners. The results of the research on environmental culture formation obtained before the formative experiment are presented in Table 1.

Table 1. Levels of learners' environmental culture formedness before the beginning of the formative stage of the experiment (in %)

Groups	**Number of people**	**Criteria of environmental culture formedness**									**The level of environmental culture formedness**		
		Motivational and value-based			**Informational and cognitive**			**Resultative and pragmatist**					
		High	Aver.	Low	High	Aver.	Low	High	Aver.	Low	High	Aver.	Low
EG	112	12.3	61.6	26.1	15.5	58.3	26.2	14.6	54.2	31.2	14.3	58.3	27.4
CG	115	14.2	57.3	28.5	16.1	59.1	24.8	16.1	53.1	30.8	15.5	56.5	28.0

During the formative pedagogical experiment, measures were taken to introduce project technology for environmental culture formation in the process of studying professional disciplines:

- Creation of an ecological environment surrounding a higher educational institution.
- Introduction of the environmental orientation of the content of professional training.
- Develop learners' interest in using various projects related to environmental activities.
- Optimize the individual implementation of project technology for learners' environmental culture formation.

The management of this process took into account: (i) application of project technology for the development of positive motivation of learners to perform environmental functions; (ii) project technology played a crucial role in our experiment, particularly in stimulating learners' social and value needs, with a primary focus on their environmental activity. This application was instrumental in fostering a sense of responsibility and commitment among the learners. When performing individual project tasks, the learner should consider the environmental characteristics of the region from which the learner came to study. According to the experiment's results, the most effective forms of participation in environmental projects are excursions and local history expeditions, visits to conservation areas, nature parks, and nature reserves, meetings with ecologists, creative work, written reports, and photo reports, and group discussion of the results and formulation of conclusions. By adjusting the leisure activities of the learners, we were able to cultivate their interest in environmental activities. This, coupled with the accumulation of skills to master various types of these activities and the inclusion of environmental knowledge in the educational process, led to a significant shift in their understanding and appreciation of the importance of project technology in environmental activities.

The results obtained at the end of the formative pedagogical experiment were compared with those recorded before the beginning of the formative stage of the experiment (Table 2).

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Table 2. Levels of learners' environmental culture formedness using project technologies at the end of the formative stage of the experiment (in %)

Groups	Number of people	Criteria of environmental culture formedness									The level of environmental culture formedness		
		Motivational and value-based			Informational and cognitive			Resultative and pragmatist					
		High	Aver.	Low	High	Aver.	Low	High	Aver.	Low	High	Aver.	Low
EG	112	27.2	61.2	11.6	26.7	62.2	11.1	23.1	58.7	18.2	25.7	60.7	13.6
CG	115	17.1	58.3	24.6	18.1	59.1	22.8	18.3	54.2	27.5	17.8	57.2	25.0

This study's theoretical propositions were confirmed during the experimental work. The changes in the levels of learners' environmental culture formedness demonstrate the feasibility of introducing project-based technology. The difference in the results of the experimental and control groups indicates that the use of project technology to form learners' environmental culture while studying professional disciplines has a qualitative impact on this process.

The advantages of using project technology in environmental education are compelling. They include:

1) Ensuring the actual use of environmental knowledge, the entry of the process of forming environmental culture into creative, personally meaningful, environmentally appropriate activities;
2) Project technology not only activates the learning activities of learners but also ignites the realization of their potential and self-improvement, inspiring a sense of transformation, actualizes motivation, and creating conditions for mastering the methodology of studying environmental issues;
3) Promoting individual mastery of forms of independent research and environmental protection activities.

Integrating project technology with other contemporary technologies enhances its effectiveness in forming environmental culture. Combining project-based learning with heuristic techniques allows students to explore problems creatively, encouraging them to generate innovative solutions to environmental issues. For instance, through exploratory learning sessions, students can utilize techniques such as brainstorming and guided discovery to understand the implications of their decisions on the environment. Additionally, case-based technology can provide insights into real-world scenarios where environmental challenges arise. By analyzing case studies of successful environmental interventions or failures, students can gain a nuanced understanding of the factors that influence sustainability in various contexts. This reinforces theoretical knowledge and emphasizes the complexity of environmental decision-making. Portfolio technology is a key component in the integration of project technology with other contemporary technologies. It enables students to document their learning journeys, reflect on their experiences, and assess their personal growth in environmental awareness. By including a variety of artifacts, such as project reports, reflections on case studies, and research on nanotechnology applications in sustainable practices, this multifaceted approach ensures that students develop a comprehensive environmental culture rooted in both knowledge and experience.

The integration of project technology and nanotechnology into the educational framework has yielded significant results in fostering an environmental culture among learners, particularly in relation to health issues. One of the most notable outcomes of employing project-based learning (PBL) in conjunction with nanotechnology is the increased engagement and motivation among students. Participants in the study reported a heightened interest in environmental health topics, driven by the hands-on nature of the projects. Students involved in projects focused on developing nanomaterials for water purification expressed enthusiasm about the potential real-world applications of their work. This aligns with findings from previous research, which indicates that active learning strategies, such as PBL, significantly enhance student motivation and commitment to learning (Hmelo-Silver, 2004). Moreover, the collaborative nature of PBL fostered a sense of community among students, encouraging them to share ideas and work together to solve complex health-related problems. This collaborative environment not only improved interpersonal skills but also reinforced the importance of teamwork in addressing public health challenges, a critical competency in professional settings.

The integration of project technology and nanotechnology facilitated a deeper understanding of the intricate relationships between environmental factors and health outcomes. Students engaged in projects that examined the impact of pollutants on community health demonstrated a marked improvement in their ability to analyze and interpret data related to environmental health risks. For example, students who investigated the effects of air quality on respiratory health were able to connect theoretical knowledge with practical implications, leading to a more nuanced understanding of how environmental conditions directly affect public health. The incorporation of nanotechnology into these projects allowed students to explore innovative solutions to pressing health issues. For instance, projects that focused on the development of nanotechnology-based drug delivery systems highlighted the potential for reducing side effects and improving treatment efficacy. This exposure to cutting-edge technology not only enriched students' learning experiences but also prepared them to think critically about the role of innovation in addressing health challenges.

The results of this study indicate that the combination of project technology and nanotechnology fosters the development of sustainable health practices among learners. Students were encouraged to consider the environmental impact of their professional decisions, leading to a greater awareness of the importance of sustainability in health-related fields. Projects that involved creating eco-friendly materials for medical applications prompted discussions about the lifecycle of products and their potential effects on both human health and the environment. Additionally, students reported a commitment to advocating for sustainable practices in their future careers. Many expressed intentions to incorporate environmental considerations into their professional decision-making processes, recognizing the interconnectedness of health and environmental sustainability. This shift in mindset is crucial for cultivating a generation of professionals who are not only skilled in their respective fields but also equipped to address the broader implications of their work on public health and the environment.

The findings from this study underscore the importance of integrating project technology and nanotechnology into professional education, particularly in disciplines related to health. By fostering an environmental culture among learners, educational institutions can prepare future professionals to navigate the complexities of health issues in an increasingly interconnected world. This holistic approach enhances students' understanding of their professional responsibilities and empowers them to become proactive advocates for sustainable health solutions.

Conclusion

The research confirms the feasibility of using project technology to form learners' environmental culture while studying professional disciplines. It is expedient to use project technology to form learners' environmental culture while studying professional disciplines in conjunction with other modern technologies. Prospects for further research on this issue are to substantiate the feasibility of using such technologies as heuristic, case technology, and portfolio technology in the educational process of a higher educational institution, taking into account the specifics of academic programs at different levels, and developing a model for learners' environmental culture formation.

The article underscores the critical need for educational approaches that integrate environmental health, project-based learning, and nanotechnology to cultivate an environmental culture among learners in professional disciplines. By equipping students with the knowledge and skills to address health issues linked to environmental factors, educational institutions can play a pivotal role in shaping a generation of environmentally conscious professionals. This holistic approach not only enhances students' understanding of their professional responsibilities but also prepares them to contribute meaningfully to sustainable health solutions in an increasingly complex world.

Future research should validate the efficacy of integrating various educational technologies (including heuristic methods, case technology, and portfolio technology) into the curriculum of various educational institutions at different educational levels, considering the unique educational characteristics of various academic programs. It needs to be developed to build learners’ environmental culture. Examples of how to create clear academic objectives, plan instruction, diagnose learners, and use instructional materials for learners need to be elaborated, serving as a guide for educational practices. Finally, based on these integrated programs, the outcomes will be examined, which will shed light on future developments in educational training in this changing world. Nanotechnology can be vital in project technology education and other modern teaching methods. It is also a valuable tool for environmental opportunities, helping to find new solutions to global problems such as energy efficiency, pollution management, and resource sustainability.

References

1. Akram, M., Rashid, A., Anwar, H., Khan, F. S., Zainab, R., Kausar, S., & Egbuna, C. (2023). Exploring the Frontiers of green nanotechnology: Advancing biomedicine,

Herbonanoceuticals, environment, and sustainability. Scicom Journal of Medical and Applied Medical Sciences, 2(1), 18-30.
2. Aparicio, J. D., Raimondo, E. E., Saez, J. M., Costa-Gutierrez, S. B., Alvarez, A., Benimeli, C. S., & Polti, M. A. (2022). The current approach to soil remediation: a review of physicochemical and biological technologies, and the potential of their strategic combination. Journal of Environmental Chemical Engineering, 10(2), 107141.
3. Asil, S. M., Ahlawat, J., Barroso, G. G., & Narayan, M. (2020). Nanomaterial based drug delivery systems for the treatment of neurodegenerative diseases. Biomaterials science, 8(15), 4109-4128.
4. Bilyk, L. I., Tarasenko, H. S., & Chemeres, I. A. (2011). Environmental education: Theory and practice: A textbook. Book 1. Cherkasy: Vertical.
5. Boichuk, Yu. D. (2013). Theoretical and methodological aspects of formation of ecological and valeological culture of the future teacher. New Colloquium, 2, 44–49.
6. Burkovska, O., & Pampura, S. (2022). Using the case method in professionally oriented foreign language teaching. ViaeEducationis: Studies of Education and Didactics, 1(1), 117–124.
7. Chang, Y., Choi, J., & Şen-Akbulut, M. (2024). Undergraduate Students' Engagement in Project-Based Learning with an Authentic Context. Education Sciences, 14(2), 168.
8. Daud, A. M., & Uwe, F. G. (2016). Project-management in practice: A guideline and toolbox for successful projects. Springer-Verlag CMBH Germany.
9. Dunlop, L., & Rushton, E. A. (2022). Education for environmental sustainability and the emotions: Implications for educational practice. Sustainability, 14(8), 4441.
10. Henziora, T. M., & Horbatiuk, N. M. (2015). Innovative teaching technologies in teaching chemical and biological cycles. In Natural Sciences and Education: A collection of scientific papers of the Faculty of Natural Sciences and Geography (pp. 179–182). Uman: VPC "Vizavi" ("Sochinskyi" Publisher).
11. Hindle, R. L. (2023). Y02A as Praxis: An innovation Model for Coastal Resilience and Adaptation (Doctoral dissertation, University of Technology Sydney, Australia).
12. Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16(3), 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3
13. İpek, Z., Atik, A. D., Tan, S., & Erkoç, F. (2020). Awareness, exposure, and knowledge levels of science teachers about nanoscience and nanotechnology. Issues in Educational Research, 30(1), 134-155.
14. Kabak, O. M. (2023). Ecological competence of an educational applicant as an integral part of the environmental culture of a modern person. Qualification work [Candidate of Biological Sciences]. Kryvyi Rih, 86 p.
15. Kachur, I. V. (2011). Problems of forming ecological culture in the educational environment. Science. Religion. Society, 2, 209–213.
16. Karamushka, V. I. (2013). On the criteria for the formation of ecological competence of the individual. Actual Problems of Psychology, 1(38), 379–382.
17. Kligler, B., Pinto Zipp, G., Rocchetti, C., Secic, M., & Ihde, E. S. (2021). The impact of integrating environmental health into medical school curricula: a survey-based study. BMC Medical Education, 21, 1-6.
18. Kopnina, H. (2018). Education for sustainable development (ESD): The turn away from 'environment' in environmental education? In Environmental and sustainability education policy (pp. 135–153). Routledge.
19. Korovina, V. A. (2013). The project method as a form of organizing learners' independent work in the process of studying the course of "Ecology." In Actual problems of training future primary school teachers in the context of humanization of higher education. Institutional repository of Borys Hrinchenko Kyiv University.
20. Kozyar, M., Dziuba, P., Tyurina, V., Miroshnichenko, V., & Romanyshyna, L. (2023). The role of project-based learning in the training of future officers. Eduweb, 17(4), 213–224. https://doi.org/10.46502/issn.1856-7576/2023.17.04.19 https://revistaeduweb.org/index.php/eduweb/article/view/592
21. Lukianova, L. B. (2016). Organization of knowledge control in ecology: Study guide for teachers. Kyiv: DSK-Center LLC.
22. Nanni, A., & Allan, L. (2020). PBL and the new ecological paradigm: fostering environmental awareness through project-based learning. Journal of Asia TEFL, 17(3), 1085.

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23. Obrecht, M., Feodorova, Z., & Rosi, M. (2022). Assessment of environmental sustainability integration into higher education for future experts and leaders. Journal of Environmental Management, 316, 115223.
24. Petrovska, M. (2013). Environmental culture: Methodical recommendations for independent work of learners. Lviv: Ivan Franko National University of Lviv.
25. Ponomarenko, S. I. (2020). Interdependence of environmental culture and ecological education. Psychological and pedagogical problems of the modern school, 2(4), 119–128. https://doi.org/10.31499/2706-6258.2(4).2020.223057
26. Ponomariova, H. F. (1997). Pedagogical conditions for the formation of environmental culture of learners of a pedagogical college. PhD Thesis: 13.00.01 “Theory and history of pedagogy". Kirovohrad, 19 p.
27. Prokhorova, L. A. (2019). Formation of ecological outlook of youth in the system of secondary school–higher educational institution. In Ecology – the philosophy of human existence: A collection of scientific papers (pp. 147–151). Melitopol: “Color Print” LLC.
28. Pustovit, N. A., Kolonkova, O. O., Prutsakova, O. L., Solobai, Yu. V., Tarasiuk, H. P., & Kopylets, Ye. V. (2014). Formation of the culture of ecological behavior of basic school learners: Methodological guide. Kirovohrad: Imex Ltd.
29. Puzyr, T. M. (2016). Formation of ecological culture of future environmental technicians in the process of professional training in colleges: Dissertation for a Candidate of Pedagogical Sciences. Zhytomyr.
30. Saher, L. Yu., & Syhyda, L. O. (n.d.). Interdisciplinary approach to project-based learning within the higher education system. Retrieved from https://crkp.sumdu.edu.ua/uk/ped-innovations/2-uncategorised/265-mizhdistsiplinarnij-pidkhid-do-proektno-orientovanogo-navchannya-v-ramkakh-sistemi-vishchoji-osviti.html
31. Singha, R., & Singha, S. (2024). Application of Experiential, Inquiry-Based, Problem-Based, and Project-Based Learning in Sustainable Education. In Teaching and Learning for a Sustainable Future: Innovative Strategies and Best Practices (pp. 109-128). IGI Global.
32. Sovhira, S. V. (2007). Methods of teaching ecology. Kyiv: Scientific World.
33. Stephenson, A., Lastra, L., Nguyen, B., Chen, Y. J., Nivala, J., Ceze, L., & Strauss, K. (2023). Physical laboratory automation in synthetic biology. ACS Synthetic Biology, 12(11), 3156-3169.
34. Stetsiuk, K. V. (2013). Ecological pedagogy of higher education: A textbook. Luhansk: “Elton-2” Publishing House.
35. Trifanina, L. S., & Miroshnichenko, V. I. (2022). An interdisciplinary approach to the formation of professional readiness of future border guard officers for project management. Innovative Pedagogy, 50(2), 104–107. https://doi.org/10.32782/26636085/2022/50.2.21
36. Volobuiev, V. (2023). Formation of professional readiness of future border guard officers for project management (Doctoral dissertation). Bohdan Khmelnytskyi National Academy of the State Border Guard Service of Ukraine, Khmelnytskyi.
37. World Health Organization (WHO) (2018). Air quality, energy and health. Retrieved from https://www.who.int/teams/environment-climate-change-and-health/air-quality-energy-and-health/health-impacts
38. Zeidmane, A. (2006). Science education problems in Latvia. In Problem-based learning in engineering and science – Development of facilitator: Book of abstracts of the 35th International IGIP Symposium (pp. 87). Tallinn.