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Modeling of the methodology of formation of socio-ecological values of students in the process of teaching natural subjects

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Abstract

In the face of global environmental and social challenges, fostering socio-ecological values among the younger generation has become a key objective of education. The increasing frequency of natural disasters, resource depletion, and environmental degradation necessitates a reevaluation of educational approaches. Natural sciences serve as a crucial platform for instilling these values by enhancing students' understanding of human-nature interactions and the role of social factors in sustainable development. This study aims to develop and model a methodology for cultivating socio-ecological values in students through natural science education. The research analyzes the educational activities and performance of 2,070 students in grades 8–11 from three schools: No. 45 of Osh State University (Bostandyk district), No. 42 (Auezov district), and No. 187 (Nauryzbai district). Special attention is given to the process of value formation within natural science curricula. The study's findings offer practical significance for education, particularly in raising students' awareness of sustainable development issues. The proposed methodology aims to prevent resource depletion while fostering environmentally responsible behavior and social accountability. The research's novelty lies in its integrated approach, incorporating social and environmental aspects into natural science education. By considering cultural, ecological, and social factors, the proposed methods create conditions conducive to students' holistic development, enhancing their environmental consciousness and sense of responsibility.

Keywords: Educational methods, Natural sciences, Socio-ecological values, Sustainable development, The younger generation, Integration of aspects, Environmental awareness, Pedagogical integration.

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1. Introduction

The relevance of the research lies in the development of a methodology that allows for the integration of environmental and social aspects into the educational process, which contributes to the education of environmentally conscious and socially responsible citizens. The issues of forming environmental values are reflected in a number of works devoted to sustainable development, ecology, and pedagogy. Research highlights the importance of fostering environmental awareness through the introduction of environmental knowledge into educational programs. However, the problem of insufficient integration of socio-ecological aspects into the study of natural sciences remains underdeveloped. Existing approaches often focus on either environmental or social aspects, missing their interrelationship, which reduces the effectiveness of fostering sustainable behaviors among students.

The purpose of the research is to develop and model a methodology for the formation of socio-ecological values among students in the process of studying natural sciences. To achieve this goal, the following tasks were set:

1. To analyze the existing approaches to the formation of socio-ecological values in educational practice.
2. To identify the features of the integration of environmental and social aspects into the content of educational materials on natural sciences.
3. To develop a methodology that takes into account cultural, environmental, and social factors in order to form students' stable patterns of thinking and behavior.
4. To evaluate the effectiveness of the developed methodology using the example of students in grades 8-11.

The research has high scientific and practical significance. The developed methodology contributes to the formation of environmentally conscious behavior, social responsibility, and sustainable thinking among the younger generation. The practical application of the results will improve educational programs, adapting them to the modern requirements of sustainable development. This is especially important in the context of increasing attention to environmental issues and the need to prepare the younger generation to face difficult challenges in the future.

Modeling the methodology for forming socio-ecological values of students in the process of teaching natural subjects is a complex and multifaceted process aimed at developing students' conscious attitudes toward nature, environmental responsibility, and understanding of their role in preserving the environment. The theoretical basis of such modeling is based on the integration of environmental, pedagogical, and psychological knowledge, which makes it possible to create an effective educational system aimed at shaping students' value orientations.

Socio-ecological values form the basis of an individual's ecological culture. They include an awareness of the importance of nature as a system interconnected with human life and a willingness to protect it by following the principles of sustainable development [1]. These values encompass cognitive, emotional, and behavioral aspects. The cognitive aspect includes knowledge about the environment, its structure and functioning, as well as the consequences of anthropogenic impact [2]. The emotional aspect is associated with the development of a sense of respect, attachment to nature, anxiety about its condition, and the desire to preserve it. The behavioral aspect reflects the ability and willingness of students to take active action to protect nature and comply with environmental standards [3].

Natural subjects such as biology, geography, chemistry, physics, and ecology have a unique potential to foster socio-ecological values [4]. The content of these disciplines allows students to understand natural processes, global environmental problems, and the relationship of society with nature. Biology, for example, provides insight into the structure of ecosystems, the role of humans in them, and the consequences of disrupting the ecological balance. Geography focuses on global issues such as climate change or environmental pollution [5]. Chemistry helps to understand the processes of chemical pollution and methods of its elimination, while physics reveals the issues of rational use of resources and energy. This knowledge forms students' holistic understanding of nature and its connection with human life, which contributes to the development of a conscious and careful attitude toward the environment [6].

An effective methodology for the formation of socio-ecological values should be based on a number of pedagogical principles, such as the integration of knowledge from various disciplines, systematic learning, practical orientation, and an interdisciplinary approach [7]. Education should be organized in such a way that students receive not only theoretical knowledge but also the opportunity to apply it in practice through research projects, environmental campaigns, observing nature, and participating in solving real environmental problems. This provides a link between theory and practice, increasing the motivation of students and enhancing their interest in environmental issues [8].

One of the key features of this method is its focus on active student activity. This can involve group work in which students analyze environmental problems, propose solutions, and complete projects [9]. It is also important to involve students in real environmental activities, such as monitoring the state of the environment, participating in landscaping, or organizing information campaigns. These actions help students realize their importance and responsibility for nature, which is an important step in shaping their value orientations [10].

Special attention in the framework of the methodology is paid to the emotional component. An emotional connection with nature is formed through direct interaction with it Moll, et al. [11]. Excursions, observations of natural processes, and the study of flora and fauna at the local level contribute to the development of a sense of attachment to the surrounding world and a desire to preserve it. Discussions that help students express their opinions, exchange thoughts, and form an informed attitude toward natural resources also play an important role [12].

In order to achieve high results, it is important that the training be systematic and step-by-step. At the first stage, students are motivated when attention is focused on current environmental issues, through real-life examples or discussions of global challenges. This is followed by a cognitive stage in which students gain knowledge about environmental patterns and problems [13]. In the next stage, students put this knowledge into practice by participating in projects and completing

assignments related to the analysis of specific environmental situations. The final stage is reflection, when students evaluate the results of their activities, analyze their achievements, and plan further steps [14].

The article presents a methodology that covers the long-term aspects of the formation of environmental behavior through project activities and supervision of elementary grades by high school students. This helps to consolidate values and skills throughout the entire learning period.

The analyzed article addresses the key problems identified in the theoretical research of foreign authors, offering a systematic approach to the formation of socio-ecological values. The main contribution is to integrate environmental and social aspects, focus on long-term results, increase the involvement of students and their families, and successfully adapt theory to local conditions. It fills in the gaps in the practical application of methods and demonstrates their effectiveness in educational institutions in Kazakhstan.

The results of the study make a significant contribution to several key areas of science and educational practice.:

- The study presents a comprehensive approach to the formation of socio-ecological values among students, which is an innovative aspect of modern pedagogy.
- The developed ECO-PROGRESS methodology integrates environmental, social, and educational components, providing students with a holistic perception of the interrelationships between nature and society.
- The methodology combines theoretical knowledge, practical activities, and family-school interaction, demonstrating its unique interdisciplinary nature.
- The results of the study fill the gaps in existing approaches to environmental education, which often consider environmental and social aspects in isolation.

Scientific novelty:

1. For the first time, the "ECO-PROGRESS" methodology was proposed, integrating theoretical learning, practical activities, and family interaction to form a socio-ecological consciousness among students. The methodology covers the cognitive, emotional, and behavioral aspects of environmental education, providing a holistic approach to developing environmental literacy.

2. The novelty lies in the emphasis on local environmental problems (air pollution, water, waste management) in the context of global challenges. This allows for the adaptation of the educational process to the peculiarities of the region, which was previously insufficiently studied in the educational practice of Kazakhstan.

3. For the first time, the study systematically examined the role of family, school, and local community interaction in shaping environmentally conscious student behavior. The inclusion of parents in projects ("Eco-family days," "Eco-family") has demonstrated a significant impact on the sustainability of the results.

4. A correlation and regression analysis was carried out, revealing the key factors influencing student engagement: the level of knowledge, the qualifications of teachers, the number of projects, and the participation of families. This expands existing approaches to evaluating educational programs.

5. Educational modules have been developed that include theoretical blocks, field research, and project activities, ensuring high variability in the application of the methodology depending on the conditions of the educational institution.

Practical significance:

1. The developed "ECO-PROGRESS" methodology has been successfully tested in three schools in Almaty. It has proven effective in shaping the environmental awareness and behavior of students, making it possible to recommend it for widespread use in educational institutions in Kazakhstan and other countries with similar environmental problems.

2. The implementation of the methodology has led to an improvement in the environmental behavior of students: 75% have started sorting waste, 80% have abandoned single-use plastic, and 60% are saving water and electricity. These results indicate the possibility of using the methodology to enhance the ecological culture of young people.

3. The methodology allows for the adaptation of the content of educational programs to regional specifics, including issues such as air pollution, waste management, and desertification. This makes the learning process more relevant and meaningful for students.

4. The practical significance of the methodology lies in creating mechanisms for involving parents and the local community in environmental education. For example, the Eco-Family Days and Eco-Family projects have shown that 50% of parents have started participating in environmental initiatives, contributing to the development of a sustainable environmental culture.

5. The methodology helps students develop the skills necessary to solve real environmental and social problems, including project thinking, leadership skills, and social responsibility. These skills are important for preparing young people for the challenges of sustainable development.

6. The results of the research can be used to develop national educational programs aimed at forming socio-ecological values. The methodology can also be adapted for implementation in other regions of Kazakhstan and Central Asian countries.

The ECO-PROGRESS methodology provides teachers with ready-made tools, including learning modules, projects, focus groups, and questionnaires, simplifying the integration of environmental education into the educational process.

The implementation of the methodology has led to increased involvement of students and their families in long-term environmental projects. This creates a sustainable foundation for forming an environmentally conscious generation capable of influencing the improvement of the environmental situation in their region and beyond.

The study offers a unique "ECO-PROGRESS" methodology that combines cognitive, emotional, and behavioral aspects of environmental education. This methodology is based on integrating social and environmental aspects through natural sciences, allowing students to form not only knowledge but also stable behavioral models. The methodology expands existing

theoretical approaches to environmental education by offering an innovative model focused on an interdisciplinary approach and localization of global problems.

Empirical evidence of the role of local and social factors in environmental education:

The study demonstrates that including local environmental issues in the educational process (for example, air pollution in Almaty, waste management) contributes to a deeper assimilation of knowledge by students. Interaction with the family and the local community has shown a significant impact on the formation of sustainable environmental habits. These results confirm and complement the concepts of social constructivism, deepening the understanding of the influence of society on the formation of ecological consciousness.

The use of mixed research methods (questionnaires, correlation and regression analysis, observations, focus groups) made it possible to identify key factors influencing the environmental behavior of students. For example, direct correlations have been identified between the level of knowledge, the number of school projects, the participation of families, and the qualifications of teachers. These results enrich research in the field of pedagogical diagnostics and prove the need for an integrated approach to forming environmental awareness.

The work demonstrates how, through natural science education, the principles of sustainable development can be effectively implemented: separate waste collection, conscious consumption of resources, and participation in environmental initiatives. The research contributes to the theoretical development of approaches to including sustainable development topics in curricula, which remains an urgent task of modern pedagogy.

The ECO-PROGRESS methodology is a universal modular approach that can be adapted to any age group and cultural context. It takes into account the peculiarities of different schools and regions, making it applicable in other educational systems. The model forms the basis for further research on the adaptation of environmental education methods in different countries and educational systems.

The research makes a significant scientific contribution to the field of environmental education, pedagogy of sustainable development, and the formation of socio-ecological values among the younger generation. The results and the developed methodology open up prospects for further research and the introduction of effective educational practices in schools in Kazakhstan and beyond.

The research aims to solve several key problems in the field of environmental education and the formation of socio-ecological values. These issues cover educational, social, and environmental aspects:

1. Low level of environmental awareness among students. Many students are insufficiently informed about the concepts of sustainable development, global environmental challenges, and their relationship to everyday life. Existing educational programs often do not focus on the practical application of environmental knowledge.

The ECO-PROGRESS methodology integrates the topics of sustainable development and socio-ecological interrelations into natural science disciplines. Students are offered interactive lectures, project activities, and practical assignments, which increases their knowledge and motivation to study ecology.

After the introduction of the methodology, the level of students' knowledge about global environmental challenges and local issues increased to 85-95%, indicating its effectiveness.

2. The gap between theory and practice in environmental education. Educational programs often focus only on the theoretical aspects of ecology, without giving students the opportunity to apply their knowledge in practice. This leads to a lack of real environmental action.

The methodology includes practical activities such as environmental projects ("Clean Rivers," "Eco-Garden"), field research, and participation in urban initiatives. Students participate in real-life activities: waste is sorted, trees are planted, and environmental conditions are monitored.

The involvement of students in environmental initiatives has increased significantly: 70% of the students became participants in projects aimed at solving local problems.

3. Low level of participation of families and the local community in environmental initiatives. Environmental education in schools often remains an isolated process that does not affect the families of students and their environment. This reduces the effectiveness of the changes, as students face a lack of support outside of school.

The methodology actively involves parents through initiatives such as "Eco-family Days" and the "Eco-Family" competition. Joint activities are carried out, such as tree planting and separate waste collection, which strengthens the ecological culture in families.

The involvement of families in environmental initiatives has increased by 50%, confirming the systemic impact of the methodology on students and their environment.

4. Insufficient integration of environmental education in school disciplines. Environmental education is often considered a separate component of the educational process, rather than part of school disciplines. This leads to fragmentation of knowledge and weak interdisciplinary communication.

The topics of sustainable development, resource management, and socio-ecological interrelationships are integrated into natural sciences (biology, geography, chemistry, physics). Real-life examples (air pollution, waste disposal) are used to explain global environmental processes.

Academic disciplines have become a platform for forming a holistic understanding of environmental issues, which has increased students' interest in their study.

5. The lack of a long-term approach to shaping environmental behavior. Many educational initiatives are limited to short-term events (for example, one-time promotions), which do not lead to the formation of sustainable environmental habits.

The methodology is based on a systematic approach, where at each stage (from 8th to 11th grade) long-term skills are formed: from a basic understanding of ecology to leadership in environmental initiatives. High school students supervise the lower grades, consolidating their own knowledge and forming stable behavior.

80% of the students began to regularly apply environmental practices in their daily lives, indicating the formation of long-term habits.

6. Low motivation of students to participate in environmental initiatives. Many students perceive environmental behavior as an additional burden or do not see the importance of their contribution.

The methodology uses modern technologies (the electronic platform "ECO-SCHOOL," a mobile application) and gamification to increase students' interest. Game and team forms of work, such as environmental quests, have been introduced, making participation exciting and motivating.

The regular participation of students in environmental actions has increased from 15% to 50%, indicating an increase in motivation.

7. Insufficient attention to local environmental problems. Educational programs often focus on global environmental challenges, ignoring local issues that are closer and clearer to students.

The methodology focuses on local environmental problems, such as air pollution in Almaty, tree felling, and waste disposal. Students conduct research, create maps of local problems, and develop solutions for their region.

Students began to realize the importance of solving local problems, and 60% of respondents noted that they had become more attentive to the environmental situation in their area.

8. Lack of pedagogical tools for teaching ecology. Teachers often lack prepared materials, methodological recommendations, and tools for effective environmental education.

The methodology offers teachers ready-made modules, sample projects, interactive assignments, and recommendations for integrating ecology into the learning process. The professional development of teachers has become part of the implementation of the methodology.

The qualifications of teachers have improved, and the effectiveness of teaching environmental topics has increased.

9. Low level of interaction between the school and the local community. School environmental initiatives rarely interact with local organizations, which reduces their scale and importance.

The methodology includes cooperation with local authorities, environmental NGOs, and enterprises. Students have the opportunity to present their projects at city forums and draw public attention to environmental issues.

School initiatives have received support from the community, allowing them to expand the scale of their implementation.

Thus, ECO-PROGRESS solves a wide range of problems related to insufficient environmental awareness, lack of practical activities, low levels of family and community involvement, as well as weak integration of ecology into educational disciplines. The methodology offers a systematic and adaptive approach that allows students to effectively develop environmental awareness, social responsibility, and practical skills.

The article consists of several logically related sections. The first section outlines the theoretical aspects of the problem of forming socio-ecological values. The second section presents the methodology and stages of the study. The third section analyzes data on schoolchildren from various districts and describes the results of testing the developed methodology, including quantitative and qualitative analysis. The fourth section discusses the results of the study. In conclusion, the results of the study are summarized, and the prospects for further work in this direction are outlined.

2. Literature Review

The development of methods aimed at the formation of socio-ecological values among students is of particular importance in the modern educational process. Teaching natural subjects provides ample opportunities for students to develop an environmentally responsible attitude towards the world around them, to enhance their understanding of the interrelationships between humans and nature, as well as to raise awareness of the importance of sustainable development [15]. The introduction of such methods into the educational process contributes not only to the improvement of students' environmental literacy but also to the development of their social responsibility, which further affects their worldview and behavior [16]. This paper examines the modeling of approaches to the creation and implementation of effective methods aimed at fostering socio-ecological values in the process of studying natural science disciplines [17].

The methodology assumes that students not only study environmental problems but also learn how to solve them, developing skills in critical thinking, independent analysis, and collective interaction. The use of project activities, research assignments, and working with real data helps them realize the complexity of environmental challenges and their role in solving them [18].

The formation of socio-ecological values among students is a key area of modern pedagogy. Many researchers note that environmental awareness not only determines a person's attitude toward the environment but also influences social responsibility. According to Winanti T., Kustini I., and Rahmadiyanti E., environmental education should be integrated into the educational process, starting from the elementary grades, with an emphasis on the relationship between natural and social factors [19].

The problem lies in the fact that traditional educational programs often focus on subject knowledge, ignoring the need to form values of sustainable development. According to Boyko I.V., such approaches miss the opportunity to influence students' behavior by instilling norms of environmental and social responsibility, which reduces their willingness to participate in solving global problems [20].

In addition, according to Walshe Nicola, the use of an interdisciplinary approach that includes topics of environmental policy and social justice contributes to a deeper understanding of the human role in sustainable development. She notes that

teaching methods such as project-based and practice-oriented learning strengthen the connection between theoretical knowledge and real life [21].

The formation of socio-ecological values is impossible without taking into account the interrelationship of social and environmental aspects. According to Nogerbek A. et al., this requires teachers not only to have knowledge in the field of natural sciences but also to possess pedagogical methods that promote the development of critical thinking and social responsibility among students [22].

According to Shapovalov's research, the effective formation of environmental values is possible through the integration of local and global examples of environmental problems, which allows students to better understand the consequences of their actions at different levels [23].

Modern approaches to environmental education include the use of interactive and project-based teaching methods. For example, Genc M. points out the importance of involving students in research projects aimed at solving specific environmental problems. Such projects contribute to the development of leadership skills among schoolchildren and awareness of their role in protecting the environment [24].

At the same time, Khujamberdieva, D.I. emphasizes the importance of using digital technologies in the educational process, such as virtual laboratories and interactive maps that help students visualize environmental problems and seek solutions [25].

Cultural aspects play an important role in shaping the values of sustainable development. According to Pink, M., taking into account local traditions and customs makes it possible to adapt educational programs to the specifics of the region, making them more understandable and familiar to students [26]. For example, in Kazakhstan, the emphasis on the protection of steppe ecosystems and the rational use of water resources can contribute to a deeper awareness of environmental problems.

The formation of socio-ecological values among schoolchildren is an important step toward sustainable development. As noted by Uralovich K., Tulakov U., and Kubayevich K., the education of an environmentally conscious generation is able to prevent environmental degradation and ensure the rational use of natural resources. In addition, such values help foster responsible attitudes toward social issues, including inequality and access to resources [27].

Many foreign researchers emphasize the importance of environmental education as a basis for the formation of social responsibility. For example, Tilbury notes that environmental education should be aimed at developing students' critical thinking so that they can understand the relationship between their actions and the consequences for the environment. She argues that education should encourage students to take active action to protect nature and promote sustainable development [28].

Ramulumo M. is exploring innovative approaches to teaching preschool children's environmental principles. The author emphasizes that the formation of environmental literacy should begin at an early age. For this purpose, specialized educational programs are offered that help children develop an informed attitude toward the world around them and understand the importance of protecting it [29].

Amantayeva A. and Sholpan, K. focused on active teaching methods aimed at developing students' environmental competence. Among the key methods are project activities and tasks that require independent analysis and the search for solutions. These approaches help students develop critical thinking, responsible behavior skills, and an understanding of the environmental challenges of the modern world [30].

Niyazova and co-authors reviewed the pedagogical system of continuous environmental education aimed at future teachers. The study highlights the importance of combining formal, non-formal, and informative learning for the formation of socio-ecological knowledge and competencies. This approach allows future teachers to effectively implement environmental principles in their professional activities [31].

Hnatuyk V. focused on the role of education in the transition to a sustainable society. The study discusses the need to integrate environmental and social aspects into educational programs, which contributes to the formation of a holistic understanding of the interaction between society and nature. This approach is aimed at preparing students to address global environmental and social challenges [32].

Ariza and co-authors presented examples of using a socio-scientific approach to education aimed at developing environmental citizenship. The work demonstrates successful cases from various European countries, where pedagogical methods stimulate conscious environmental behavior and active participation in solving environmental problems [33].

Inoue focused on nature-based early childhood education in his research. The author emphasizes the importance of forming a close connection between children and nature, which contributes to the development of a sustainable ecological worldview. This helps children realize the need to take care of the world around them at an early age [34].

Thus, foreign authors emphasize the need for an integrated approach to environmental education, which includes the integration of disciplines, consideration of cultural characteristics, active student participation, and the use of modern technologies.

The presented works of foreign authors reveal various theoretical problems related to the formation of socio-ecological values in the educational environment. The analysis of these problems makes it possible to determine the significance and contribution of the article under consideration aimed at solving these issues.

Many authors, such as Shvets [35], note the insufficient integration of environmental and social aspects into the content of educational programs. Environmental education is often isolated from social disciplines, which reduces the effectiveness of forming a comprehensive worldview among students. The analyzed article suggests a methodology that includes the integration of environmental and social aspects through the study of natural sciences. An example is the integration of the themes of biodiversity, resource management, and social responsibility into a single educational context, which allows students to form a holistic view of sustainable development.

Research such as Inoue focuses on early childhood, missing the importance of value formation in adolescents, who are already aware of the more complex interrelationships between humans and the environment.

The article focuses on students in grades 8-11, which allows us to cover the age when children are most susceptible to the formation of long-term values. The methodology, aimed at the senior classes, focuses on critical thinking, independence, and practical application of knowledge.

Ariza, et al. [33] highlight the gap between theoretical models of environmental education and their practical application. The authors point to the insufficient adaptation of the techniques to local conditions and the lack of examples of their successful implementation.

The article fills this gap by describing the specific steps of implementing the methodology in three schools in Kazakhstan. The examples of local initiatives, such as the Clean Air Project or Plant a Tree, demonstrate how theory can effectively adapt to specific educational conditions.

As Delalić [36] and Niyazova, et al. [31] emphasize, there is a problem of weak involvement of students and their families in environmental initiatives. Without family and community support, education loses a significant part of its potential. The article suggests approaches aimed at involving parents through initiatives such as "Eco-family Days" and the "Eco-Family" competition. This contributes to the development of ecological behavior not only among students but also among their close environment, creating a sustainable ecosystem of change.

In our work, we propose a methodology that integrates environmental and social aspects through natural science education. An example is the integration of the themes of biodiversity, sustainable development, and social responsibility into a single educational concept, which allows students to form a holistic view of sustainable development.

As Inoue notes, most of the research focuses on environmental education in elementary schools. However, adolescence (grades 8-11) remains insufficiently covered, although it is during this period that stable values and critical thinking skills are formed.

The methodology in our article focuses on students in grades 8-11, when adolescents are able to perceive more complex concepts of sustainable development. This allows us to form not only knowledge but also long-term behavioral models aimed at active participation in solving environmental and social problems.

In our article, the methodology was tested using the example of 2,070 students from three schools in Almaty. Practical implementation includes project activities (for example, projects "Clean Air" and "Plant a Tree"), which confirms the effectiveness of the proposed approaches and demonstrates the successful adaptation of theory to real conditions.

As Delalić [36] and Niyazova, et al. [31] emphasize, most programs do not sufficiently involve student families and the local community. The lack of a systematic approach to cooperation with parents and the community reduces the long-term effect of educational initiatives.

The methodology includes initiatives such as "Eco-family Days" and the "Eco-Family" competition, which promotes the active involvement of parents and the formation of environmental behavior at the family level. This creates a sustainable ecosystem of change that goes beyond school education.

According to Shvets [35], students often perceive environmental education as an additional burden, which reduces their motivation to participate in projects and initiatives.

The ECO-PROGRESS methodology developed by the authors includes game and interactive forms of work, such as environmental quests, field research, and practical exercises. This makes the learning process more exciting, stimulates the interest of students, and promotes voluntary involvement in environmental initiatives.

The works of Shapovalov and Grigoriev note that many techniques are not adapted to local environmental and social conditions. This reduces their effectiveness and makes implementation more difficult. The methodology has been adapted to the conditions of Almaty, taking into account such regional problems as air pollution, waste management, and the rational use of water resources. This has made learning more relevant for students and their families.

The data obtained in the study make it possible to analyze how the developed methodology for the formation of socio-ecological values is consistent with or contradicts existing theories and concepts in the field of environmental education and sustainable development.

The confirmation of this theory is reflected in the results of the conducted research, which demonstrates that the active participation of students in environmental projects has a significant impact on the formation of their conscious environmental behavior.

1. Theory of formation of ecological consciousness through active participation [37]. According to Tilbury's theory, the active participation of students in solving environmental problems through project activities is the most effective way to form environmental awareness. The author emphasizes that practical involvement, for example, participation in projects or actions, contributes to the development of a conscious attitude toward the environment.

These studies fully confirm this theory. For example: School No 45: Students actively participated in the projects "Clean Air" and "Plant a Tree," which led to a change in their environmental behavior. 75% of schoolchildren started sorting waste, and 80% started using reusable bottles and bags.

School No 42: The implementation of practical initiatives such as "Eco-sorting" has increased awareness of the importance of local problems, and 65% of students have involved their families in separate garbage collection.

This confirms that active participation in projects contributes to the formation of environmentally conscious behavior.

2. Theory of pedagogical constructivism. The theory of constructivism states that students acquire knowledge better when they are actively involved in the learning process through interaction, discussion, and practical application of knowledge.

The study used approaches based on constructivism, including group work, project activities, and focus groups. For example: At school No 42, students developed maps of local environmental problems and presented them at school discussions. At School No 187, participation in the Clean Rivers project allowed students to independently analyze water quality, which enhanced their understanding of environmental issues.

The results confirm that involving schoolchildren in the analysis and solution of real environmental problems increases their level of knowledge and engagement.

3. Theory of social learning. Bandura's theory emphasizes that students' behavior is shaped by observing examples and interacting with the environment. In the context of environmental education, the key factor is the influence of teachers, parents, and classmates.

These studies confirm the theory of social learning. The highly qualified teachers at school No 45 (average experience of 15 years, regular professional development) had a significant impact on student engagement. In this school, 85% of students actively participate in environmental initiatives. At school No 42, "Eco-family Days" allowed parents to be involved, and 50% of families began to implement environmental practices such as separate waste collection. These data confirm the importance of role models and the social environment in shaping environmental behavior.

4. The environmental literacy model. According to the environmental literacy model, students must develop cognitive, emotional, and behavioral components in order to form environmental awareness. At school No 45, 95% of the students showed high test scores, demonstrating deep knowledge of global environmental challenges. Students who participated in the "Plant a Tree" project noted that such actions strengthen their emotional connection with nature. At school No 187, 60% of students began to consciously save water and electricity, putting their knowledge into practice. This is consistent with the Hollweg model and proves the importance of integrating all three components.

5. Theory of a systematic approach in environmental education. A systematic approach involves considering environmental and social issues as interrelated elements. Students should understand not only environmental aspects but also their relationship to social and economic factors.

The ECO-PROGRESS methodology was based on a systematic approach, integrating environmental and social aspects. As part of the Eco-Sorting project at school No 42, students studied the impact of waste recycling on the health and quality of life of the local community. At School No 187, the Clean Rivers project included both environmental research and a social component (involving local residents in actions to protect water resources).

The results confirm that a systematic approach helps students understand the relationship between nature and society, which contributes to the formation of a comprehensive worldview.

Many studies, such as the work of McGrath, argue that global environmental issues such as climate change should be at the center of environmental education. However, the results of this study show that students are more involved in solving local and regional problems.

These studies indicate that the local context plays a key role in shaping environmental awareness. At School No 187, students showed a higher level of involvement in the Clean Rivers project (65%) than in discussing global issues. At school No 42, local projects such as creating flower beds and landscaping the school yard proved to be more effective than studying global environmental challenges. This contradiction highlights the need to adapt environmental education to local realities, especially in countries with acute regional environmental problems such as Kazakhstan.

Theories such as the self-determination model argue that students' intrinsic motivation is a key factor in shaping sustainable behavior. However, the study observed that students' intrinsic motivation remained low (for example, only 15% of students regularly participate in environmental actions). A low level of involvement in long-term initiatives may be due to insufficient motivation, which probably requires additional external incentives such as contests or awards. This indicates the need for further work to increase students' internal motivation.

The study confirms key theories of environmental education, such as the importance of a practice-oriented approach (Tilbury), social learning (Bandura), and a systematic approach (Meadows). The results are also consistent with Hollweg models of environmental literacy, showing that successful environmental behavior formation is possible through cognitive, emotional, and behavioral development.

These studies call into question the universality of theories that assert the priority of global problems. The results demonstrate that the local context is more important for students. Difficulties in maintaining students' internal motivation have been identified, which requires additional measures to stimulate their involvement.

The present study introduces a new perspective on the integration of social and environmental aspects, emphasizing the importance of local adaptation and interaction with families. The ECO-PROGRESS methodology offers a universal approach that can be used to solve regional problems, which complements the existing theoretical foundations.

Thus, this article fills in key gaps in existing research by offering a systematic and practice-oriented approach to the formation of socio-ecological values. The introduction of the ECO-PROGRESS methodology demonstrates that an integrated approach, including the integration of knowledge, practical activities, and family interaction, is an effective tool for preparing an environmentally conscious generation.

3. Methodology

The study utilized a mixed methodological approach that combined quantitative and qualitative methods to examine the level of environmental awareness, behavior, and involvement of students in environmental initiatives.

Employing a mixed approach provides a more comprehensive and multifaceted understanding of the issue at hand. Quantitative methods yield statistical data on the current levels of environmental awareness, behavior, and engagement

among students, while qualitative methods facilitate a deeper exploration of their values, perceptions, and emotional connections to nature.

The integration of quantitative and qualitative data enabled the evaluation of the effectiveness of educational initiatives, the identification of key factors influencing students' environmental behavior, and the recognition of barriers that hinder their participation in environmental projects (Figure 1).

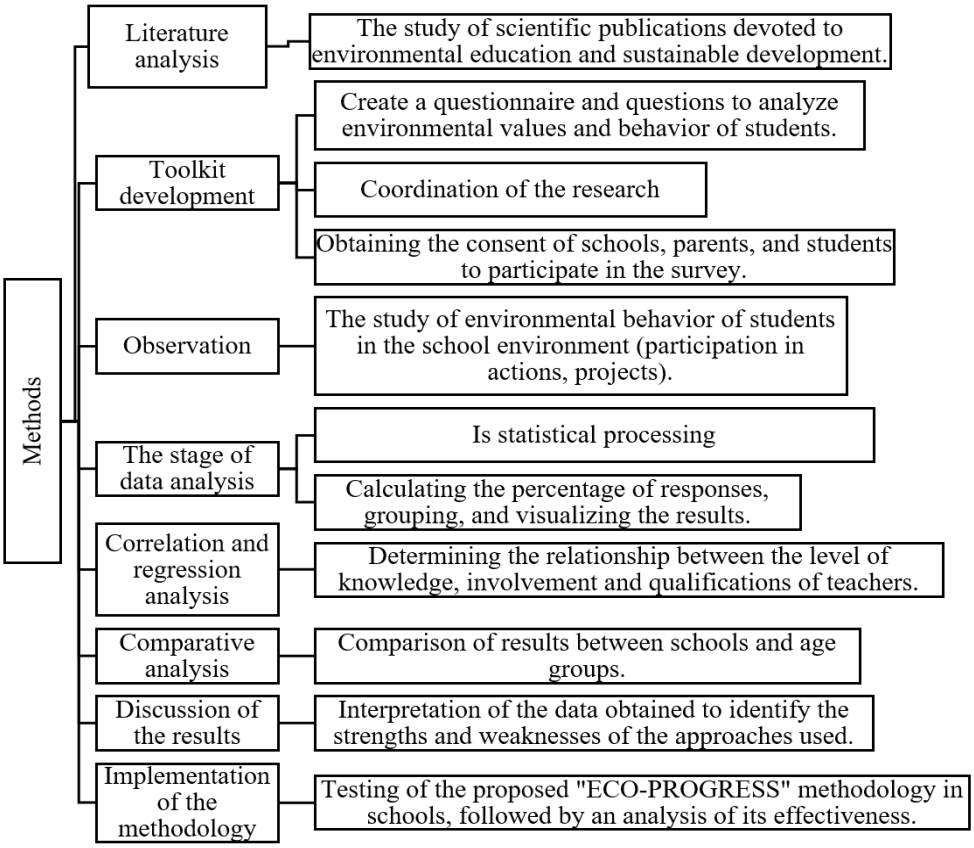

Figure 1.
Scheme of research methods.

A total of 2,070 students from grades 8 to 11 at three schools in Almaty participated in the survey:

1. School No. 45 (Bostandyk District)
2. School No. 42 (Auezovsky District)
3. School No. 187 (Nauryzbay District).

The survey was designed to examine the level of environmental awareness, behavior, and engagement of students, their families, and the local community. The survey methodology included a questionnaire based on structured questions with a choice of answers, as well as the use of data analysis methods.

Stages of the survey:

Preparation of questionnaires:

The questionnaire included 20 questions covering the following topics:

- Awareness of sustainable development and environmental concepts.
- Knowledge and understanding of environmental issues.
- Personal and family environmental behavior.
- Participation in environmental initiatives.

The questionnaire included both closed-ended questions (with a choice of one or more possible answers) and open-ended questions (to express personal opinions).

Matching and selection of respondents:

- Before the start of the study, the consent of schools, parents, and students to participate in the survey was obtained.
- The survey was conducted among students in grades 8-11 simultaneously to obtain data on age groups ranging from 12 to 17 years old.

The survey was conducted in two stages:

1. In schools No. 45 and No. 42, the questionnaires were filled out in hard copy during natural sciences lessons (biology, chemistry, geography). For this purpose, a separate lesson was designated to avoid haste when answering. The teachers explained the purpose of the survey in advance.

2. At school No. 187, the survey was conducted online through the Google Forms platform, taking into account the availability of digital infrastructure and convenience for high school students. The link to the survey was sent via the school chat. The teachers supervised the completion of the assignment.

Statistical methods were used to process the questionnaires, including calculating the percentage of responses for each category.

A comparative analysis was carried out by school and class.

Correlation and regression analysis was used to determine the factors influencing the environmental behavior of students.

The survey was conducted anonymously so that the respondents would feel comfortable with their answers.

The survey was conducted simultaneously in different schools to exclude the influence of external factors. Control questions were provided to check the carefulness of filling out the questionnaires (Table 1).

Table 1.
Respondents' responses.

Question	Answer options	The percentage of respondents
Your age	12-14 years old	55%
	15-17 years old	45%
Your class	8th grade	25%
	9th grade	30%
	10th grade	25%
	11th grade	20%
Paul	Male	48%
	Female	52%
Have you heard about the concept of sustainable development?	Yes	70%
	No	30%
Do you know what separate waste collection is?	Yes	80%
	No	20%
Please indicate which environmental issues you are familiar with.	Air pollution	85%
	Water pollution	75%
	Waste disposal	65%
	Deforestation	60%
	Climate change	50%
Where do you primarily obtain information about the environment?	At school	40%
	In the Internet	35%
	From the media	15%
	From the parents	10%
Do you sort your trash at home?	Yes	60%
	No	40%
Which of the following actions do you perform regularly?	Saving water	70%
	Saving electricity	65%
	I use reusable bottles and bags.	50%
	I am giving up single-use plastic.	45%
	I participate in cleaning the area.	30%
How often do you participate in environmental campaigns?	Never	20%
	Once a year	30%
	Several times a year	35%
	Regularly	15%
What environmental projects did you undertake at school?	Separate waste collection	50%
	Landscaping of the territory	40%
	Pollution monitoring	30%
Do you discuss environmental issues with your family members?	Often	30%
	Sometimes	50%
	Never	20%
Is waste sorted in your family?	Yes	55%
	No	45%
What environmental habits does your family practice?	Saving water	60%
	Energy savings	55%

Question	Answer options	The percentage of respondents
	The use of environmentally friendly products.	40%
	Participation in environmental initiatives.	30%
What are the most pressing environmental issues in your area?	Air pollution	70%
	Water pollution	60%
	Unauthorized landfills	50%
	Cutting down trees	40%
Are you aware of the environmental initiatives being carried out in your area?	Yes	40%
	No	60%
Do you participate in regional environmental initiatives?	Yes	35%
	No	65%
What environmental projects are you aware of at your school?	"Clean city"	50%
	Landscaping of the territory	45%
	Waste disposal projects	40%
	Monitoring the state of nature	35%
Would you be interested in participating in environmental initiatives in the future?	Yes	75%
	No	25%
What improvements can be made in a school or neighborhood to address environmental issues?	Install containers for separate waste collection	50%
	Conduct more educational events	30%
	Organize regular cleaning and landscaping campaigns.	20%
Do you notice any changes in your environmental behavior after participating in school projects?	Yes, it has become more attentive to the environment.	55%
	No, I haven't noticed any changes.	30%
	It's hard to say	15%
Which school event influenced your behavior the most?	Lectures and lessons	40%
	Practical exercises	35%
	Participation in projects	25%
	Environmental actions	20%

The observations were carried out during the students' participation in school environmental projects, which made it possible to assess their actual behavior and level of involvement. Focus groups were organized to discuss environmental issues and initiatives, which helped identify key motivational factors and barriers. These methods provided an opportunity to better understand students' perceptions of the importance of environmental initiatives, as well as their willingness to participate in long-term projects. Ethical standards are key when working with children. The anonymity of the survey and the consent to participate ensured the comfort of the respondents and the reliability of the data.

1. Consent has been received from schools, parents, and students.
2. The survey was conducted anonymously to avoid bias and to ensure the openness of the answers.

The collected data showed a high degree of interest among the respondents, 80% of whom completed the questionnaires completely. The results revealed key trends such as awareness of environmental issues, the level of engagement, and barriers to participation in environmental initiatives.

To assess the effectiveness of educational initiatives, it was necessary to study the content of curricula, as well as projects aimed at the formation of environmental values. This made it possible to identify the extent to which sustainable development topics are integrated into school subjects. Programs in biology, chemistry, geography, and ecology were analyzed. Teaching methods, interdisciplinary approaches, and examples of project activities were studied.

The analysis made it possible to identify the strengths and weaknesses of current programs and determine which aspects need to be strengthened for a more effective formation of socio-ecological values.

In addition to the survey, observations of students' behavior during their participation in school environmental projects and initiatives were used. Additionally, focus groups were held with the participation of schoolchildren to gain a deeper understanding of their views on environmental issues and values. The data analysis also included the study of school curricula, projects, and activities aimed at the formation of socio-ecological values.

Statistical methods were used to process the collected data, including calculating the percentage of responses by category. Correlation and regression analysis were used to determine the relationship between variables such as student knowledge, the number of school environmental projects, family involvement in environmental initiatives, and teacher qualifications.

Methods used included:

1. Calculation of the percentage of responses for each category.
2. Comparative analysis between schools and age groups.
3. Correlation and regression analysis to identify factors influencing the environmental behavior of students.

The relationships between the level of knowledge, the number of projects being implemented, the participation of families in environmental initiatives, and the level of student engagement were determined. Data on the importance of teachers' qualifications and their experience in shaping environmental values were obtained.

To perform a correlation and regression analysis based on the data provided, the following variables were used:

1. Dependent variable (Y): The level of student involvement in environmental behavior (for example, the percentage of students participating in environmental initiatives, sorting waste, saving resources, etc.).

2. Independent variables (X):

- The level of knowledge about ecology (the percentage of students demonstrating a high level of knowledge in testing).
- The number of environmental projects and events organized by the school.
- Percentage of families participating in environmental initiatives.
- The level of qualification of teachers (average work experience, the number of teachers with advanced qualifications).

The analysis showed that the most significant factors are the level of knowledge of students and the qualifications of teachers, which confirms the need to improve the professional training of teachers.

Among the qualitative methods, thematic coding of open-ended questions and data from focus groups was used, which made it possible to identify key topics and trends in students' attitudes towards environmental issues. Comparative analysis methods were used to compare the results by school and age group.

A detailed analysis of the content of the natural sciences curricula (biology, chemistry, geography) in each of the three schools was carried out. Topics on ecology, sustainable development, and rational use of resources were studied, as well as teaching methods used by teachers. Particular attention was paid to interdisciplinary approaches and the integration of environmental aspects into the educational process.

The ethical aspects of the study were strictly observed. All participants provided informed consent to participate in the study, and the questionnaires were filled out anonymously to ensure the confidentiality of the data and the comfort of the participants. All data were protected and stored in a digital format with limited access.

This methodology allowed for the collection of comprehensive information about the current level of environmental awareness and behavior of students, as well as the analysis of the effectiveness of implemented educational activities and proposed methods for the formation of socio-ecological values.

A mixed methodological approach, including questionnaires, observation, focus groups, program analysis, and statistical data processing, was chosen to provide a comprehensive and objective study of the problem under study. The combination of quantitative and qualitative methods allowed for the obtaining of both measurable results and a deep understanding of students' values, motivation, and barriers to participating in environmental initiatives. This approach made it possible to develop an effective methodology aimed at the formation of socio-ecological values and sustainable behavior among schoolchildren.

4. Results and Discussion

In Almaty schools, curricula in biology, chemistry, geography, ecology, and physics are developed in accordance with the state mandatory education standards of the Republic of Kazakhstan. The standard curricula approved by the Ministry of Education and Science of the Republic of Kazakhstan include disciplines aimed at the formation of an ecological culture and awareness of sustainable development.

It should be noted that the main environmental problems include air pollution, which is one of the most acute environmental pressures in Kazakhstan. The main sources of pollution are associated with emissions from vehicles and thermal power plants. The high level of atmospheric pollution by modern society provokes an increase in respiratory diseases among the population.

Problems related to the management and efficient disposal of solid household waste have led to the formation of unauthorized landfills, which, in turn, worsen the sanitary and epidemiological situation and harm the environment.

Disorderly urbanization and deforestation of green spaces contribute to the construction of new facilities, which leads to a deterioration in the quality of the urban environment and a negative change in the microclimate.

Social problems also include an increase in morbidity caused by environmental pollution, especially air pollution, which increases the risk of respiratory diseases, allergies, and other chronic diseases, particularly in children and adolescents.

Socio-economic inequality manifests itself in limited and uneven access to high-quality environmental conditions and medical services, which increases social disparities, especially among vulnerable groups of the population.

The low level of environmental awareness among the population complicates the implementation of environmentally responsible behavior, as many do not have sufficient information on ways to minimize negative environmental impacts.

Modern schools are introducing new pedagogical technologies and teaching methods, integrating the substantive component of national education standards with the philosophy and requirements of programs such as the International Baccalaureate. This helps students develop critical thinking skills and awareness of environmental and social issues.

Environmental education in the education system is aimed at studying and researching the environment, as well as fostering responsibility for its condition. Teaching materials in biology, chemistry, and geography include topics related to nature conservation, sustainable development, and the rational use of natural resources.

Some schools in Almaty are implementing projects aimed at practice-oriented teaching of natural sciences. For example, gymnasium schools No. 138 and No. 148 are introducing modern models of natural science workshops and laboratories for young scientists, which contribute to the integration of knowledge from various disciplines and the formation of a holistic understanding of environmental and social issues.

Table 2.
Description of training programs and plans.

No	School	Description	Teaching methods	Environmental and social issues	Integrating an interdisciplinary approach.
1	School No. 45, Bostandyk District	1 The school is focused on meeting state standards for education. 2 Biology and geography programs focus on the study of ecosystems, biodiversity, and climate change. 3 The chemistry program includes topics related to the rational use of natural resources and environmentally sound technologies.	1 Design methods, laboratory work, and excursions to the natural areas of Almaty are utilized. 2 Special attention is given to practical learning and the involvement of students in research projects.	1 Biology lessons include topics on biodiversity, conservation, and the protection of rare species. 2 Geography addresses regional environmental issues, including desertification and the management of water resources.	Projects are being implemented that combine natural sciences with ecology; for example, studying the effects of chemical compounds on the condition of local reservoirs.
2	School No 42, Auezovsky district	1 The program focuses on environmental education through the natural sciences. 2 Topics on sustainable development, waste management, and renewable energy sources are included.	1 Teachers actively utilize game methods, such as environmental quests. 2 Much attention is given to group tasks that develop critical thinking skills.	1 Chemistry - environmental aspects of waste disposal and safe chemical technologies. 2 Geography - local environmental challenges, including air and soil pollution. 3 Biology is the adaptation of plants and animals to changing environmental conditions.	Combining the study of geography and biology to develop maps of the environmental safety of the area.
3	School No 187, Nauryzbay district	1 The program focuses on the study of regional natural features. 2 Project activities related to environmental protection are supported.	1 Teachers actively utilize laboratory research and conduct experiments. 2 Mentoring programs are being introduced, where high school students help the younger ones study environmental topics.	1 Biology - protection of rare and endangered species of plants and animals. 2 Geography - monitoring the state of the region's water resources. 3 Physics is the study of the principles governing the operation of renewable energy sources.	The school conducts general projects linking physics, chemistry, and biology, such as studying the effects of solar panels on the environment.

Thus, the data from the analysis show that each school focuses on environmental education through natural sciences, but the methods and content vary depending on the specifics of curricula and priorities. School No. 45 pays special attention to the study of ecosystems, biodiversity, and environmentally sound technologies. The curricula include important topics such as climate change and natural resource management, which highlight the global nature of the educational approach. In contrast, School No. 42 focuses on practical environmental education. Here, students study waste management and renewable energy sources, which focus them on the applied aspects of ecology. School No. 187 is distinguished by its focus on the regional features of nature, as well as project activities related to environmental protection. It can be concluded that each of the schools includes elements of sustainable development in the educational process, but each of them does this through its own unique prism, whether it is a global, applied, or regional approach.

Next, we will compile class passports in the analyzed schools (Table 3).

Table 3.
Class passports.

No	School	Class	Number of students	Age	Interests	Advances in science	Involvement	Behavior
1	School No. 45, Bostandyk district School	8	25	13–14	Biology, especially topics on biodiversity, and initial projects on environmental protection.	The average level of knowledge in chemistry is low, while it is high in biology and geography.	Students actively participate in school activities, such as cleaning the grounds and planting trees.	High activity and interest in group projects.
		9	27	14–15	Study of ecological systems and design work in chemistry.	High results in biology and physics, and a confident knowledge of chemistry.	Students conduct research on the effects of air pollution on health.	A preference for independent research.
		10	23	15–16	Studying global environmental issues and participating in biology Olympiads.	High level in all natural sciences.	Implementation of school projects related to energy conservation.	High responsibility, results orientation.
		11	20	16–17	In-depth study of chemistry and biology with the prospect of admission to universities.	Excellent knowledge and participation in regional competitions and Olympiads.	Supervising environmental projects for lower-grade levels.	Leadership and career orientation in science.
2	No 42, Auezovsky district	8	30	13–14	Game methods for teaching ecology and participation in environmental quests.	Average level in chemistry, high in biology.	Participation in school environmental games.	Friendly and active in teamwork.
		9	28	14–15	Study of local environmental issues, group projects.	Good knowledge of geography and biology.	Environmental actions and project activities.	Openness and a propensity for discussion.
		10	26	15–16	Topics on waste recycling and the development of solutions for local environmental problems.	Stable results in chemistry and physics.	Participation in regional projects.	Teamwork and initiative.
		11	22	16–17	Practical applications of environmental knowledge include volunteering.	Steady progress in natural subjects.	Organization of events for junior classes.	Responsibility and high self-organization.
3	School No 187, Nauryzbay district	8	32	13–14	Fundamentals of ecology involve observing nature in the school area.	Entry-level in physics, solid knowledge in biology.	Simple projects, such as creating a school garden.	Activity, interest in experiments.
		9	30	14–15	Local environmental studies and projects for the protection of water resources.	Good results in chemistry and biology.	Participation in research groups.	A preference for independent work.
		10	25	15–16	Experimental work and participation in competitions at the regional level.	Marked progress in physics and chemistry.	Research within the framework of school laboratories.	Commitment and active participation in group projects.
		11	20	16–17	Environmental technologies and the protection of graduation projects.	Excellent results in natural sciences.	Supervising junior classes and participating in regional Olympiads.	Leadership skills and a high sense of responsibility.

Note: Compiled by the authors.

Thus, class passports show different levels of student engagement, interests, and educational success depending on the school. This data makes it possible to adapt the methods to the specific conditions and needs of each educational institution.

Figure 2 illustrates the level of knowledge and interest in environmental and social issues among students.

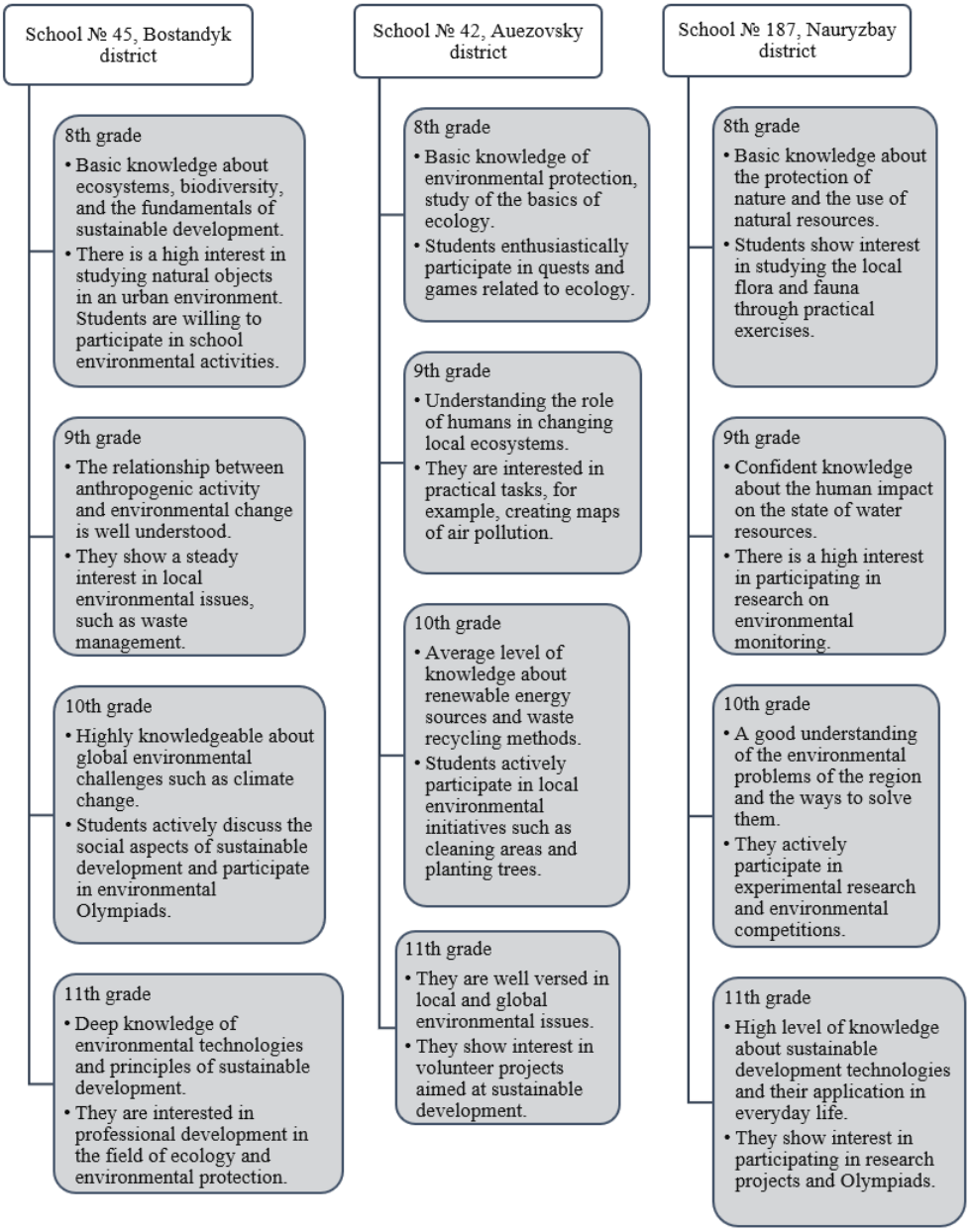

Figure 2.
The level of knowledge and interest in environmental and social issues among students.

Thus, School No. 45 demonstrates that students have a deep knowledge of global environmental issues and are interested in solving them. At School No. 42, students show a steady interest in local environmental issues and practical tasks. School No. 187 stands out because students focus on studying regional environmental issues and their practical solutions. These differences emphasize the importance of adapting educational programs to the level of knowledge and interests of each school's students.

Table 4 presents personal values associated with environmental awareness and social responsibility.

Table 4.
Personal values of students related to environmental awareness and social responsibility.

School	Grade	Values	Manifestations	Social responsibility
No 45, Bostandyk district	8	Respect for nature is an important resource for the future.	The desire to participate in actions to green the school grounds and protect local parks.	Awareness of their role in maintaining cleanliness and order in the environment.
	9	Respect for biodiversity and understanding the importance of protecting rare species.	Participation in school discussions about ecosystem conservation.	Active participation in projects aimed at improving the local environmental situation.
	10	Understanding the global interconnectedness of environmental and social issues.	Leadership in environmental projects aimed at reducing plastic usage.	Promotion of environmentally responsible behavior among peers.
	11	Commitment to sustainable development and environmental technologies.	The desire to pursue a career in the field of ecology and to participate in solving global environmental issues.	Supervising junior classes in environmental initiatives.
No 42, Auezovsky district	8	Interest in environmental protection through gaming and practical methods.	Participate in quests and games related to environmental issues.	The tendency to perform collective tasks aimed at improving the school environment.
	9	Awareness of personal responsibility for the state of the environment.	Participation in projects to develop local solutions, such as air pollution maps.	The desire to provide genuine solutions to local environmental issues.
	10	Respect for natural resources and their rational use.	Participation in the development of waste recycling projects.	Willingness to cooperate with the local community to enhance the environment.
	11	A deep understanding of the relationship between ecology and the well-being of society.	Active participation in environmental actions at the city level.	Leadership roles in promoting environmental responsibility.
No 187, Nauryzbay district	8	The love for nature and the desire to preserve its purity.	Interest in practical tasks, such as maintaining a school garden.	The tendency to maintain cleanliness and order on the school grounds.
	9	Respect for water resources and an understanding of their value to the region.	Participation in research projects aimed at monitoring the condition of water resources.	Awareness of the necessity to conserve resources for future generations.
	10	Commitment to environmental research and the protection of local natural sites.	Participation in school projects related to the protection of rare species.	Active participation in the development of environmental initiatives.
	11	Commitment to addressing regional environmental issues.	Conducting research in school laboratories aimed at sustainable development.	Organization of environmental education events for younger students.

Thus, School No. 45 demonstrates that students have strong leadership qualities and are interested in solving global environmental problems. They are focused on large-scale thinking and strive to participate in significant initiatives at the international level. At School No. 42, students focus on teamwork and actively participate in local environmental initiatives. Their approach is aimed at solving problems together, which contributes to the development of team spirit and interaction. Students of School No. 187 are focused on practical solutions to regional environmental problems while demonstrating a high level of personal responsibility. They are focused on the implementation of projects that have a direct impact on the environment of their region. These differences emphasize the need to take into account the values and social responsibility of students when adapting educational methods, which makes it possible to maximize the development of their abilities and interests.

Below, Table 5 shows the degree of student involvement in environmental and social projects.

Table 5.
The level of student engagement in environmental and social projects.

School	Grade	The level of engagement	Examples of participation	Forms of participation
No 45, Bostandyk district	8	Average.	Students actively participate in schoolyard landscaping and landscaping campaigns.	Planting trees, creating environmental posters, and participating in school competitions focused on environmental protection.
	9	Tall.	Students participate in research projects to monitor the air quality in the school area.	Data collection and analysis, and the preparation of reports for school conferences.
	10	Very tall.	Organization of measures to reduce plastic use and promote energy-saving technologies.	Conducting lectures for elementary grades and implementing school waste recycling projects.
	11	Very tall.	Students oversee environmental projects in the lower grades and participate in regional environmental campaigns.	Organization of actions to clean up local parks and participation in regional environmental competitions.
No 42, Auezovsky district	8	Average.	Participation in gaming events and quests focused on environmental themes.	Development of game ecological scenarios and the collection of recyclables.
	9	Average.	Students develop projects on local environmental issues, such as soil pollution.	Creation of environmental maps for the area and participation in school discussions.
	10	Tall.	Conducting environmental actions, such as cleaning the school grounds and surrounding areas.	Organizing events in collaboration with the local community.
	11	Tall.	Organization of school exhibitions on environmental topics and participation in urban environmental actions.	Leadership in school environmental initiatives and the preparation of scientific reports.
No 187, Nauryzbay district	8	Average.	Students participate in the care of the school garden and flower beds.	Planting plants and creating decorative elements for the schoolyard.
	9	Tall.	Research projects on the condition of the district's water resources.	Collection of water samples, data analysis, and presentation of results at school events.
	10	Very tall.	Students actively participate in environmental contests and initiatives to protect rare plant and animal species.	Conducting research and developing solutions to improve the state of the local ecosystem.
	11	Very tall.	They are leaders in environmental campaigns and events and participate in city and regional projects.	Organization of educational events for younger grades and participation in regional environmental forums.

Thus, School No. 45 demonstrates a high level of student engagement in all age groups. The focus on global and regional environmental initiatives allows students to develop strategic thinking, leadership skills, and responsibility for the environment on a broader level. School No. 42 stands out for the active participation of students in local environmental projects. The use of playful and practical forms of work contributes to the development of interest in ecology among young children and the formation of skills in collective activity. School No. 187 shows a gradual increase in student engagement with age. The focus on research projects and solving regional environmental problems develops students' ability to think analytically and apply knowledge in practice to improve the environment.

The qualifications of teachers and their level of training play a key role in shaping students' environmental awareness and social responsibility. Let's consider the features of teacher training in three schools in Almaty (Table 6).

Table 6.
Teachers' qualifications and their level of training.

School	Education	Work experience	Specialization
No 45, Bostandyk district	All teachers of natural sciences (biology, chemistry, geography, physics) have higher specialized education.	On average, they are 12 to 15 years old, and most teachers regularly upgrade their skills.	Participation in seminars on sustainable development, biodiversity, and global environmental issues.
No 42, Auezovsky district	Higher pedagogical education in biology, geography, and chemistry.	On average, children aged 8 to 10 years have a basic knowledge of environmental education.	Participation in regional educational conferences and seminars focused on local environmental issues.
No 187, Nauryzbaysky district	Higher education in the natural sciences.	On average, teachers with 6 to 8 years of experience have worked on environmental projects.	Participation in regional environmental initiatives and educational programs for educators.

School No. 45, Bostandyk district, actively uses modern pedagogical technologies, such as project-based learning, STEM, and case-based methods, which contribute to the development of students' critical thinking and problem-solving skills. Teachers are constantly improving their professional competence by participating in training dedicated to the introduction of sustainable development topics into the educational process. These training sessions are organized by environmental non-profit organizations and educational centers, which help teachers integrate environmental knowledge more deeply into school curricula. In addition, School No. 45 focuses on the environmental orientation of its activities. Students and teachers regularly take part in environmental campaigns such as Clean City and implement initiatives aimed at reducing their carbon footprint. These activities form students' ecological awareness and responsible attitude toward the environment, which makes the educational process more relevant and meaningful.

The teachers of School No. 42 have a high level of training to deal with local environmental and social problems. This makes it possible to effectively involve students in solving practical problems and develop their interest in ecology. Game-based and practice-oriented methods are actively used in the educational process, including environmental quests and group projects, which make learning fun and rewarding. Some teachers have completed special courses on the integration of environmental education into school curricula, which has increased their competence in this area. The main focus of the school is on solving local environmental problems, such as waste management and air pollution control. This helps to build students' awareness of the importance of environmental responsibility and the skills needed to improve the environment in their area.

Teachers at School No. 187 have a basic level of training with an emphasis on studying regional environmental issues, which makes it possible to work effectively with students in this area. However, there is significant potential for improving the skills of teachers through participation in additional training and educational courses.

The methodological work actively uses practical exercises and laboratory research aimed at studying local environmental issues. Despite the fact that only a part of the teachers has completed specialized courses on sustainable development, they are interested in improving their professional competence.

The school focuses on practical solutions to regional environmental challenges, including the protection of water resources and the conservation of local flora and fauna. This contributes to the formation of students' conscious attitude toward nature and the environment.

Thus, School No. 45 has the highest level of teacher training, which allows students to develop global environmental thinking; School No. 42 is focused on local environmental problems, effectively applying game and practice-oriented methods; School No. 187 has teachers with good basic qualifications but needs additional investments in training in order to deepen the integration of environmental and social values into the educational process.

Figures 3, 4, and 5 illustrate the pedagogical methods and approaches utilized by schools.

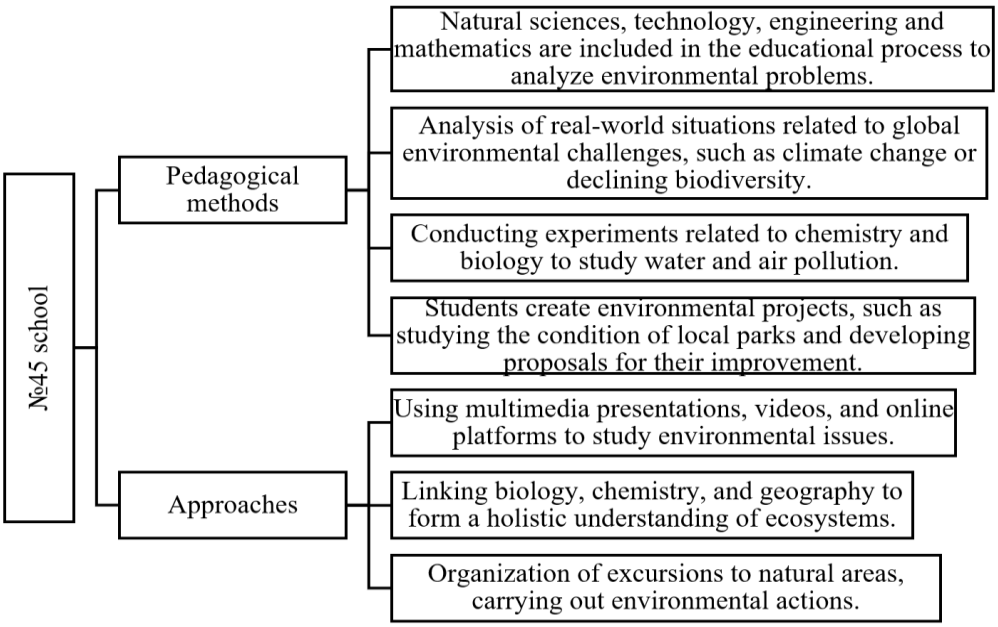

Figure 3.
Pedagogical methods and approaches of School No 45, Bostandyk district.

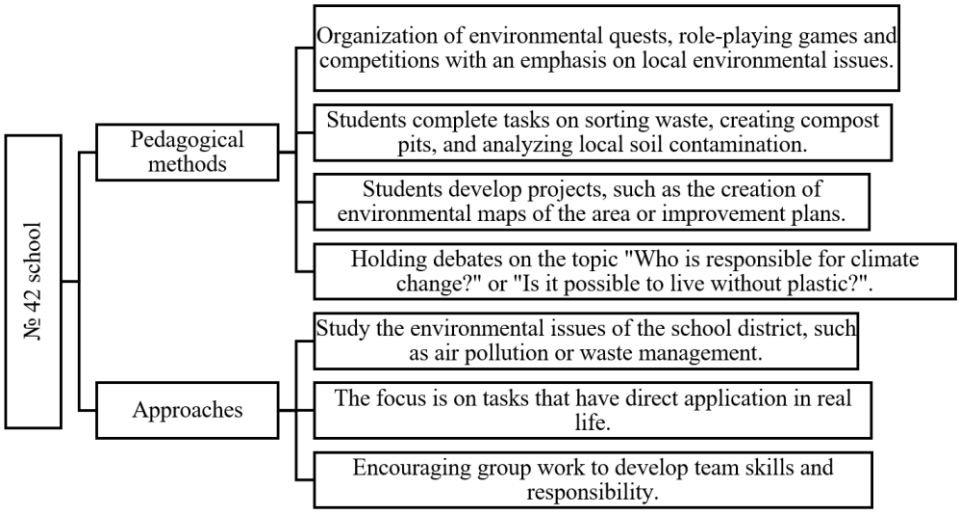

Figure 4.
Pedagogical methods and approaches of School No 42, Auezovsky district

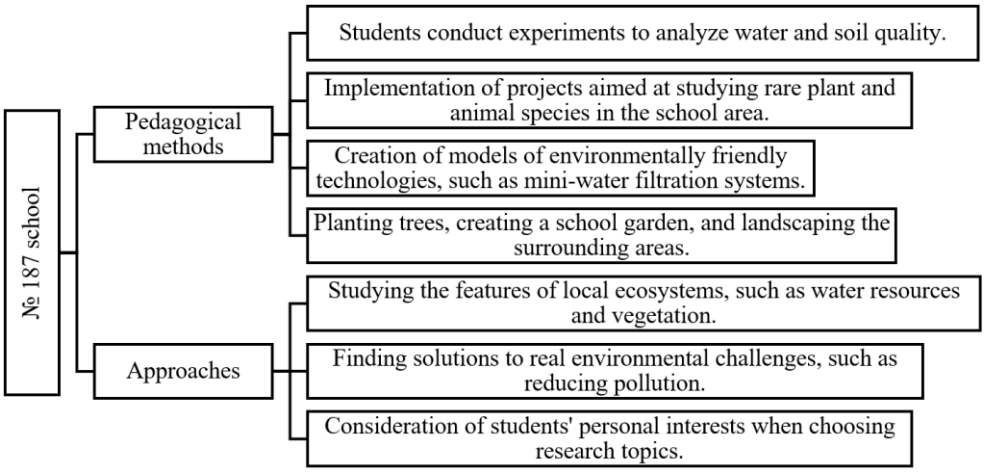

Figure 5.
Pedagogical methods and approaches of school No 187, Nauryzbay district.

It can be said that School No. 45 focuses on studying global environmental issues using modern approaches such as STEM education and project-based learning. School No. 42 focuses on local environmental issues, applying game-based and

practice-oriented methods that make the learning process exciting and rewarding. School No. 187 pays special attention to solving regional environmental problems, actively introducing experimental activities and practical research.

Next, let's examine the experience of participating in educational initiatives related to sustainable development (Figure 6).

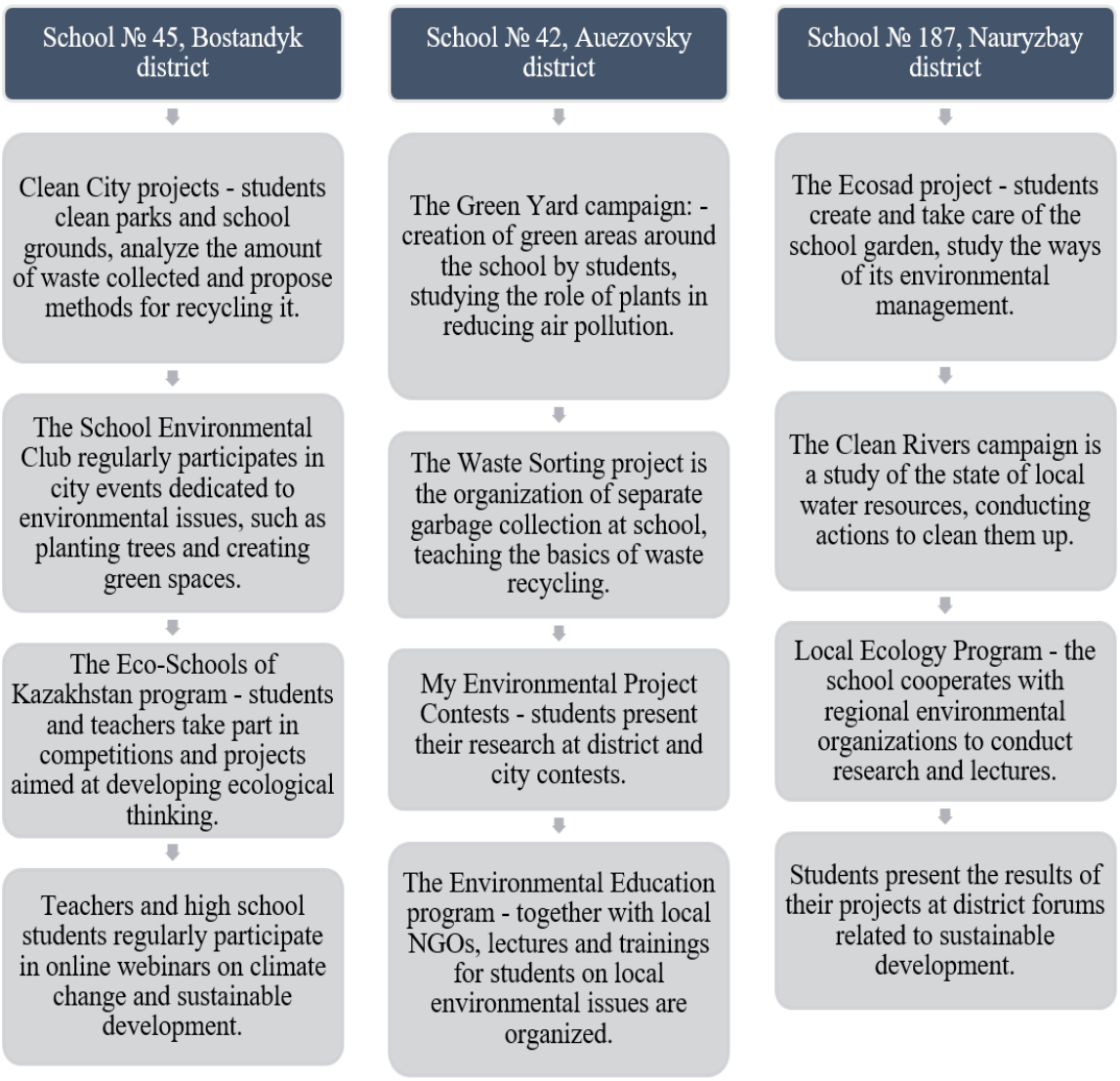

Figure 6.
Experience in participating in educational initiatives related to sustainable development.

Thus, School No. 45 focuses on global initiatives, such as participation in international webinars and educational programs, which help students develop environmental awareness on a global level. School No. 42 is focused on the implementation of local environmental projects and teaching the basics of waste recycling, which contribute to the formation of practical skills and responsibility for the environment. School No. 187 focuses on regional initiatives, including the creation of a school garden and participation in projects to clean up reservoirs, which allow students to directly influence environmental improvement in their region.

Let's analyze the students' academic performance in natural subjects (Figures 7, 8, 9).

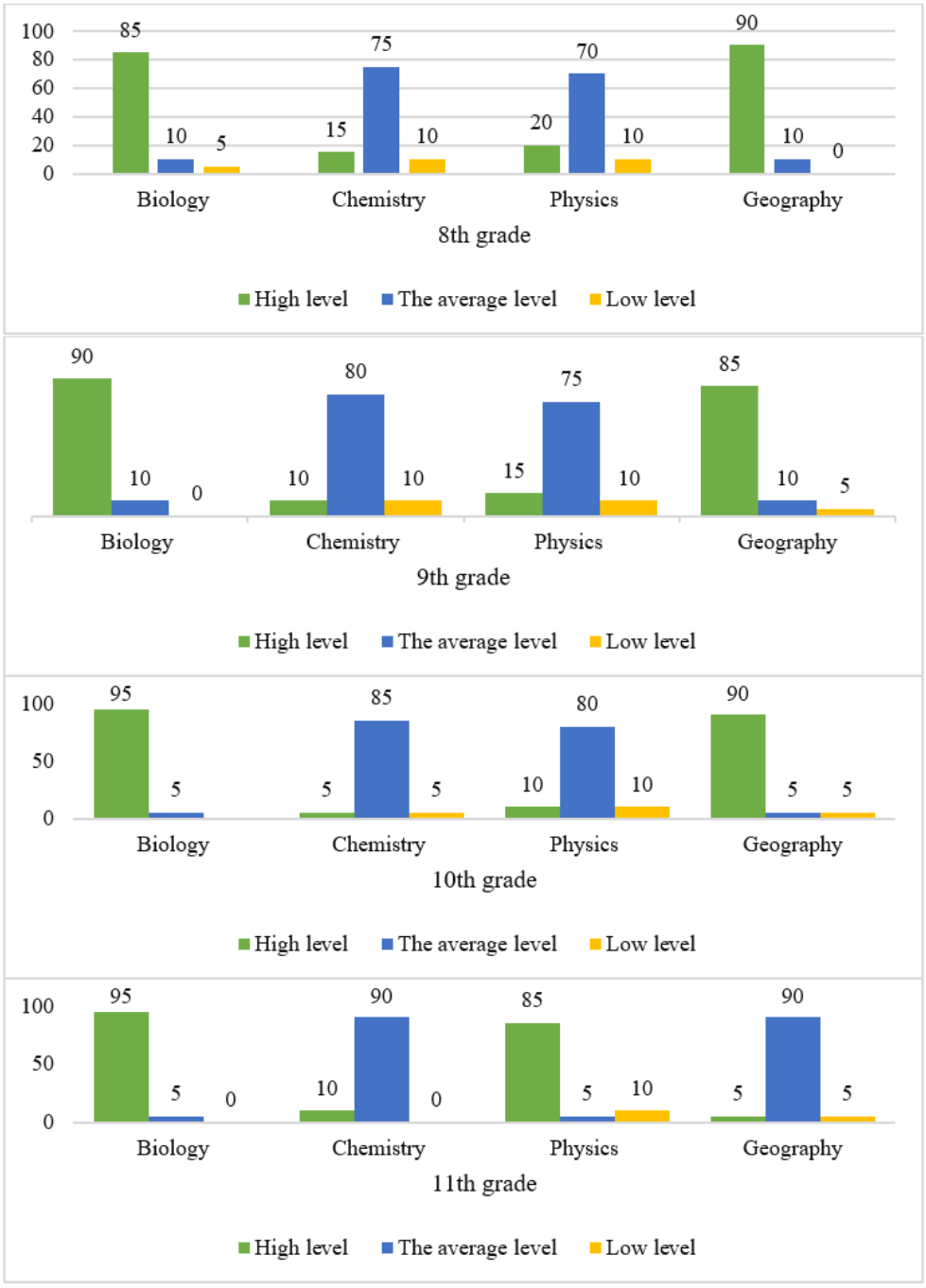

Figure 7.
Students' academic performance in natural subjects at school No. 45, Bostandyk district, %.

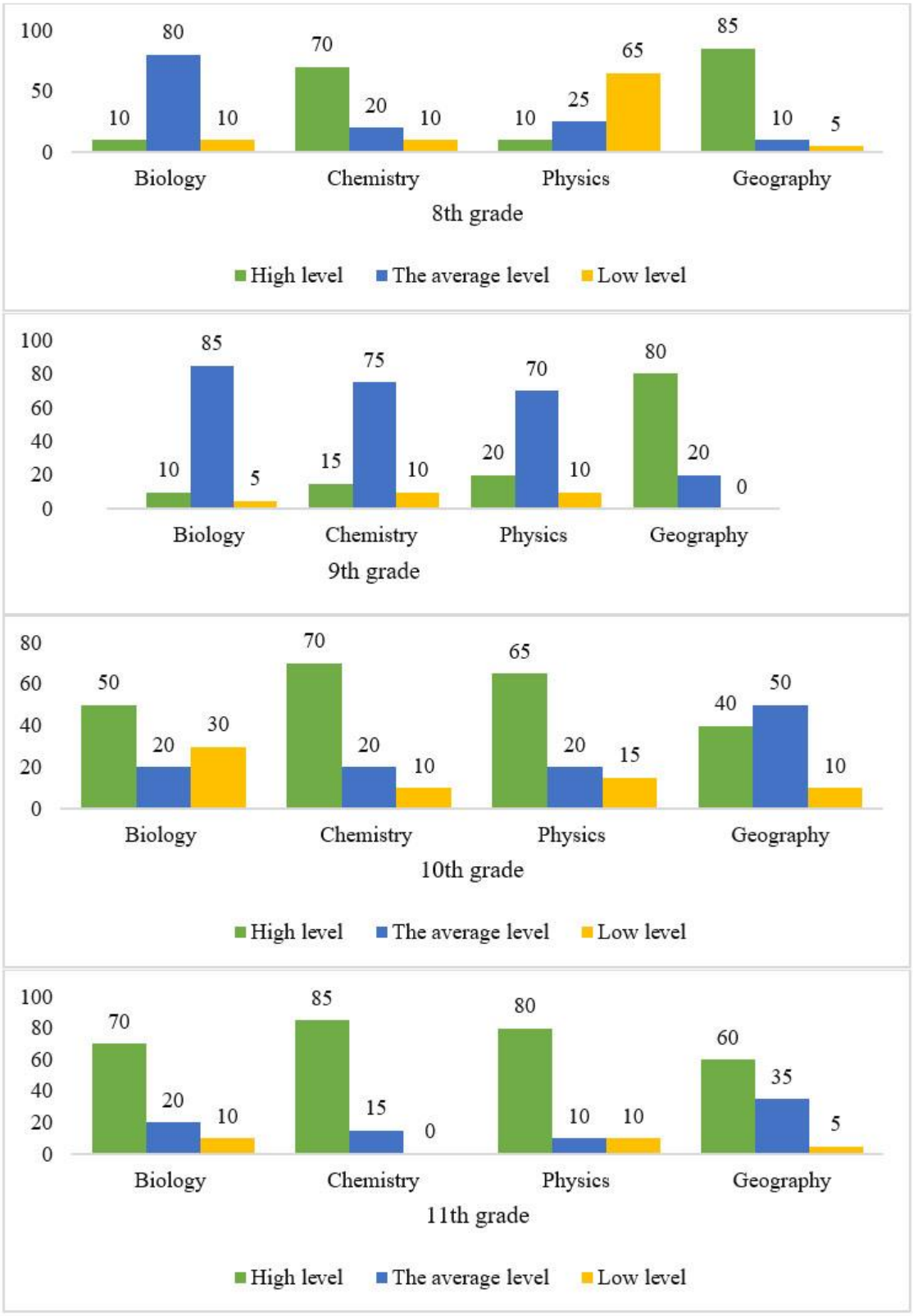

Figure 8.
Student's academic performance in natural subjects at school No 42, Auezovsky district, %.

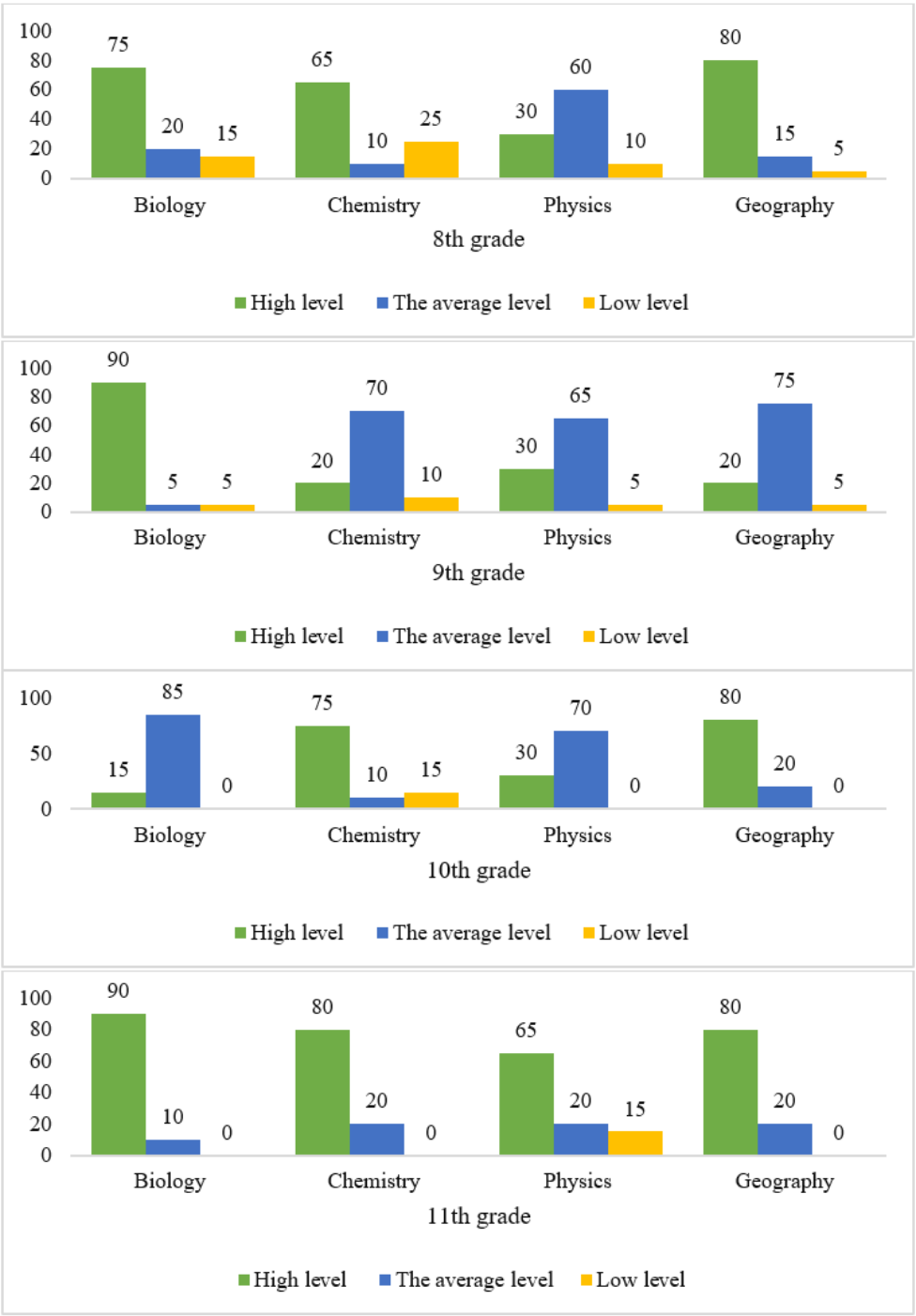

Figure 9.
Students' academic performance in science subjects at school No 187, Nauryzbay district, %

At School No. 45, students demonstrate a high level of knowledge in all natural sciences. This is achieved through the use of a variety of teaching methods that contribute to the development of their competencies. At School No. 42, students' results are stable, especially in subjects such as geography and biology, which is explained by the emphasis on practical tasks. School No. 187 shows an annual improvement in academic performance, especially in high school, due to the involvement of students in experimental activities during the research. The results of the environmental and social knowledge testing aim to check the level of students' knowledge on environmental and social topics, identify strengths and weaknesses, and evaluate the effectiveness of implemented teaching methods and their impact on the formation of students' environmental behavior (Table 7).

Table 7.
Results of environmental and social knowledge testing.

School	Grade	General results	Strengths	Weaknesses
No45	8	85% of the students showed an above-average level of knowledge.	Sustainable development and conservation of biodiversity (90%).	Human influence on climate change (70%).
	9	90% of the students demonstrated a high level of knowledge.	Environmental problems of the urban environment and ways to solve them (95%).	Interrelation of social and environmental factors (80%).
	10	93% of the students successfully passed the test.	The role of man in sustainable development (97%).	Use of renewable energy sources (85%).
	11	95% of the students showed excellent knowledge.	Global environmental challenges (98%).	Economic aspects of environmental policy (88%).
No42	8	75% of the students passed the tests at the average level and above.	Fundamentals of ecology and waste management (80%).	Anthropogenic impact on biodiversity (65%).
	9	80% of the students demonstrated confident knowledge.	Local environmental problems (85%).	The role of social factors in sustainable development (70%).
	10	85% of the students successfully passed the test.	Waste recycling methods (90%).	Climate change and its consequences (75%).
	11	88% of the students showed good knowledge.	Local initiatives for sustainable development (92%).	The impact of global economic processes on the environment (78%).
No187	8	70% of the students passed the tests at the average level and above.	Fundamentals of rational use of resources (75%).	Human role in climate change (60%).
	9	75% of the students demonstrated confident knowledge.	The impact of anthropogenic activities on water resources (80%).	Social aspects of sustainable development (65%).
	10	80% of the students successfully passed the test.	Local environmental problems (85%).	Use of alternative energy sources (70%).
	11	85% of the students showed good knowledge.	Methods of biodiversity conservation (88%).	Environmental policy and social responsibility (72%).

The survey results indicate a relatively high level of environmental awareness among respondents, with 80% being familiar with the concept of separate waste collection and 70% demonstrating an understanding of sustainable development. The most widely recognized environmental issues include air pollution, noted by 85% of respondents, and water pollution, identified by 75%. However, despite this awareness, the findings reveal a lack of environmental information received through key communication channels, as only 10% of respondents reported obtaining such knowledge from their families and 15% from the media. This highlights the need to strengthen environmental education efforts within households and to utilize media more effectively in promoting sustainability.

Regarding environmental behavior, 60% of respondents practice waste sorting at home, and a significant proportion engage in sustainable practices such as conserving water (70%) and electricity (65%), as well as using reusable bottles and bags (50%). However, active participation in environmental initiatives remains low, with only 15% of respondents regularly taking part in environmental actions. This suggests the need for additional motivational strategies and incentives to encourage greater involvement. Family participation in sustainability efforts appears to be primarily focused on resource conservation, as 60% of families save water and 55% actively reduce electricity consumption. However, only 30% of families take part in organized environmental initiatives, indicating a relatively low level of community engagement in sustainability efforts. The most pressing environmental concerns identified in respondents' local areas include air pollution (70%), water pollution (60%), and illegal waste dumping (50%). Despite these concerns, awareness of local environmental initiatives remains limited, with only 40% of respondents being familiar with such programs and just 35% actively participating in them. School-based activities have demonstrated a positive influence on students' environmental behavior, with 55% of participants reporting improvements in their sustainability practices after engaging in school-led projects. Among the most effective educational interventions, 40% of respondents cited lectures and lessons, while 35% highlighted the impact of practical exercises, emphasizing the importance of experiential learning in fostering environmental responsibility.

The correlation and regression analysis that follows provides deeper insights into the relationships between various factors influencing environmental participation (Tables 8, 9).

Table 8.
Correlation and regression analysis.

	Level of knowledge	Number of projects	Family involvement	Teacher qualifications	The level of engagement
Level of knowledge	1.000	0.982	0.996	0.908	0.982
Number of projects	0.982	1.000	0.961	0.971	1.000
Family involvement	0.996	0.961	1.000	0.866	0.961
Teacher qualifications	0.908	0.971	0.866	1.000	0.971
The level of engagement	0.982	1.000	0.961	0.971	1.000

Table 9.
Indicators of knowledge, engagement, and environmental participation in the schools studied.

School	Level of knowledge (%)	Number of projects (units)	Participation of families (%)	Teacher qualifications (years)	Level of engagement (%)
No45	90	8	70	15	85
No42	85	6	65	10	75
No187	75	4	50	8	65

The level of student involvement in environmental behavior shows a significant correlation with several independent variables, such as the level of student knowledge, the number of environmental projects, family involvement in environmental initiatives, and teacher qualifications.

Important variables:

1. Level of knowledge: A positive correlation coefficient (0.744) indicates that an increase in environmental awareness among students contributes to an increase in their involvement in environmental activities.

2. Number of projects: A positive impact (coefficient 0.328) highlights the importance of practical activities related to the implementation of environmental measures.

3. Family participation: A slight negative impact (-0.026) may indicate an insufficient degree of family involvement in environmental activity, which requires further analysis.

4. Teachers' qualifications: The most significant factor with a positive coefficient (1.151), confirming the crucial role of teachers' professionalism and competence in shaping students' environmental behavior.

The study identified both the strengths of environmental education and areas for further enhancement, including the need to increase student and family engagement in environmental initiatives and to expand educational outreach within the community. The following section presents a discussion of the findings.

Students can play an active role in addressing environmental and social challenges through several key approaches.

First, educational programs facilitate the development of responsible behavioral patterns by involving students in environmental projects and initiatives.

Second, public engagement activities, such as urban greening efforts, community clean-ups, and awareness campaigns, contribute to improving environmental conditions and fostering a culture of sustainability.

Students' personal behaviors, such as waste separation, resource conservation, and the use of environmentally friendly products, play a crucial role in minimizing negative environmental impacts. Moreover, the active participation of young people in addressing environmental and social challenges contributes to the sustainable development of urban areas and enhances the overall quality of life for residents.

Schoolchildren represent a vital demographic in efforts to tackle environmental and social issues. Engagement in sustainability-focused projects allows students to develop environmental awareness, leadership skills, and a sense of social responsibility. These initiatives can be implemented at both the local level and within international programs, providing students with opportunities to contribute to meaningful solutions and participate in globally significant initiatives.

The table below presents examples of environmental and social projects available to students. These initiatives span various domains, from urban greening efforts to international programs designed to address pressing environmental and social challenges worldwide.

Table 10.
Examples of environmental and social projects available to students.

The project	Name	Description	Goal	Organizer
National and local projects in Kazakhstan.	"Clean City"	Regular cleaning campaigns for parks, streets, and public spaces in Almaty involve students participating in garbage collection, waste sorting, and creating an environmentally friendly environment.	Raising awareness about the importance of a clean urban environment and the need for waste recycling.	Local governments, environmental non-governmental organizations.
	"Eco-sorting"	Installation of containers for separate waste collection in schools in Almaty. Students receive training on proper garbage sorting and participate in contests for the best recycling.	To instill the skills of separate garbage collection and to foster environmentally responsible behavior.	At school, in a community with local recycling companies.
	"Plant a Tree	Urban landscaping campaigns involve students planting trees, caring for the plants, and monitoring their growth.	Improving the urban environment and fostering a love for nature.	Environmental clubs and school initiatives.
International environmental projects	" "Eco-School's"	An international program is implemented in schools to create a sustainable ecosystem in educational institutions. Students participate in the development and implementation of projects such as energy conservation, water conservation, and waste management.	Fostering environmental awareness through practical activities.	Foundation for Environmental Education (FEE).
	"Earth Day Network"	Actions dedicated to Earth Day (April 22) aim to draw attention to environmental issues. Students participate in tree planting, territory cleaning, and educational activities.	Raising global environmental awareness.	Earth Day Network.
	"Plastic Free Schools"	Students are participating in campaigns to eliminate single-use plastics, monitor the use of plastic in schools, and develop initiatives to reduce it.	Minimizing plastic pollution and fostering an environmentally conscious generation.	Surfers Against Sewage.
Foreign social projects	"The WE Schools Program"	A social initiative that teaches students how to apply knowledge to solve local and global social problems, such as poverty, inequality, and access to education.	Development of leadership and social responsibility skills.	We Charity (Canada)
	"UNICEF Kid Power"	A program in which students participate in fundraising events to support children in developing countries.	Developing students' understanding of global social issues and involving them in assisting those in need.	UNICEF.

Local initiatives such as Clean City and Plant a Tree are designed to address specific urban environmental challenges, including air pollution and waste management. In contrast, international environmental programs, such as Eco-Schools and Plastic Free Schools, aim to cultivate a global perspective on environmental sustainability among students.

Additionally, social initiatives like the WE Schools Program and Model United Nations focus on fostering social responsibility and leadership skills in high school students. As part of this research, the ECO-PROGRESS methodology was developed to promote the formation of environmentally responsible behavior and social consciousness among schoolchildren.

The primary objective of the methodology is to cultivate students' awareness of environmental and social issues through a combination of theoretical instruction, hands-on practical activities, and the integration of sustainable habits into daily life. The structured stages of its implementation are outlined in the table below.

Table 11.
Stages of the methodology implementation.

Stages of implementation	Subtapes and directions.	Actions and examples
1. The theoretical basis	Modular training	Module 1: Fundamentals of sustainable development and biodiversity.
		Module 2: Rational use of natural resources.
		Module 3: Socio-ecological interrelations.
	Emphasis on interactive learning	The use of virtual excursions to natural areas.
		Development of interactive maps of the environmental problems of the area.
	Educational lectures	Involvement of specialists in the field of ecology, biology, chemistry and geography to conduct master classes.
2. Practical training	Project activity	Students create projects to improve the environmental situation in the area.
	Workshops for environmental solutions	Prototyping of recycling devices, such as systems for water filtration or waste recycling.
	Field research	Monitoring of water, air and soil quality in the school area.
		Data analysis with presentation of results at school conferences.
3. Family-school interaction	Family behavior	Students involve parents in separate waste collection and resource conservation.
		Holding "Eco-family days" with an emphasis on joint actions (tree planting, etc.).
	Contests and initiatives	The annual "Eco-family" competition, where the family's contribution to environmental projects is evaluated.
4. Social initiatives	City actions	Organization of events such as "Clean Park", "Day without a car".
	Eco-quests	Team activities to find solutions to local environmental problems.
	Volunteer programs	Improvement of the urban environment, landscaping and cleaning of territories.
5. Technological support	The ECO-SCHOOL electronic platform	Maintaining an online diary of students' environmental achievements.
		Virtual workshops, video lectures, and forums for discussing initiatives.
	The mobile app	Notifications about environmental actions, tracking the environmental contribution of each student and class.

Table 12 shows the implementation of the methodology by class.

Table 12.
Implementation of the methodology by class.

Grade	Main topics	Forms of work	Expected results
8	Fundamentals of ecology and biodiversity.	Lectures, environmental games, mini-projects.	Formation of fundamental knowledge about ecology.
9	Local environmental problems.	Research and creation of pollution maps.	Development of skills in analyzing the environmental situation.
10	Global environmental challenges.	Participation in city actions related to projects.	Awareness of everyone's role in problem-solving.
11	Environmental technologies and sustainable development.	Supervising junior classes and developing initiatives.	Leadership skills and the practical application of knowledge.

The ECO-PROGRESS methodology aims at the comprehensive development of ecological culture among schoolchildren through theoretical knowledge, practical skills, family interaction, and social responsibility. It enables students to effectively prepare for solving modern environmental challenges and fosters sustainable environmental awareness.

Table 13 shows a comparative analysis of the data.

Table 13.
Comparative analysis of schools

School	Before the introduction of the methodology	After the implementation of the methodology
No 45	1 Students had a general understanding of ecology and sustainable development, but practical behavior was limited to participation in one-time actions, such as cleaning the school grounds. 2 Awareness of personal responsibility for environmental conditions was low, and environmental practices were not applied in daily life.	1 Separate waste collection (75% of students started sorting waste at home and at school). 2 Reduce the use of plastic (80% of students use reusable bottles and bags). 3 Saving resources (85% of students consciously save water and electricity). 4. Participation in environmental initiatives (Students actively participate in project activities, including city actions such as "Day without a Car" and "Green Park").

School	Before the introduction of the methodology	After the implementation of the methodology
No 42	1 Students showed interest in local environmental issues, but their behavior was limited to participating in school environmental games and one-time events. 2 The level of knowledge regarding everyday environmental practices was low.	1 65% of students have started to implement waste sorting practices. 2 70% of students refused to use single-use plastic bags, preferring reusable bags. 3 More than 60% of schoolchildren have become active initiators of events aimed at landscaping the school grounds and creating flower beds. 4 About 50% of the students were able to involve their parents in the process of separate waste collection and energy conservation practices.
No187	1 Students had a minimal level of involvement in environmental behaviors. 2 The main participation was limited to one-time activities such as tree planting, without further reinforcement of environmental skills.	1 50% of students started sorting waste using school recycling containers. 2 60% of students consciously save water, and 50% – electricity. 3 Students organized a school project to create an eco-corner with information about local environmental problems. 4 More than 70% of students are aware of the impact of their actions on the environment and actively share their knowledge with classmates.

The Clean Air for Almaty project aims to study the level of air pollution in the city and develop proposals to reduce it. The result was the presentation of a report by the students at the city environmental forum. The Biodiversity Conservation project aimed to study the local flora and fauna, as well as develop measures to protect them. As a result, an interactive map of rare plant and animal species in the area was created. Both projects demonstrate a high level of student involvement in environmental initiatives, which contributes to the formation of their environmental awareness.

At school No. 42, located in the Auezovsky district, 70% of students regularly participate in project activities aimed at solving local environmental and social problems. Examples of such projects are the "Green Yard," which includes the creation of green areas on the school grounds and adjacent areas, and "Eco-sorting," which provides for the introduction of a separate waste collection system. As a result, more than 50 trees were planted, and containers for recycling plastic, paper, and metal were installed in the school. These projects promote the active participation of students in local initiatives aimed at improving the environment and forming environmental habits.

At school No. 187, located in the Nauryzbai district, 65% of students are involved in project activities focused on solving regional environmental problems and issues of rational resource use. Among such projects, we can single out "Clean Rivers," aimed at monitoring the state of the district's water resources with the development of recommendations for their protection. As part of the project, water quality studies were conducted, the results of which were transferred to the local environmental management. The Eco-Garden project included the creation of a school garden using environmentally friendly methods. The students planted fruit trees on their own and developed a care plan for them. These projects contribute to the development of students' independent work skills and their involvement in the practical solution of environmental problems.

It can be concluded that the methodology contributed to a significant increase in conscious environmental behavior, which was reflected in the increased involvement of students in long-term initiatives and a change in their habits. It significantly increased the participation of schoolchildren in local environmental initiatives and served as the basis for the formation of environmentally conscious behavior. Despite the low initial level of knowledge and engagement, the methodology has led to positive changes, especially in the understanding and application of environmental practices.

The uniqueness of the ECO-PROGRESS methodology:

1. The methodology combines cognitive, emotional, and behavioral aspects, ensuring the comprehensive development of environmental awareness among students. It is not limited only to the transfer of knowledge but is aimed at the formation of sustainable behavioral models through theoretical training, practical activities, and social interaction. Unlike traditional approaches that focus only on knowledge, the ECO-PROGRESS methodology integrates emotional and practical components, allowing students not only to understand but also to actively apply environmental principles in life.

2. The methodology offers a unique way to include the topics of sustainable development and socio-environmental issues in school subjects (biology, geography, chemistry, physics). Examples from the local environmental situation (air pollution, waste management, biodiversity protection) make learning relevant and close to real life. The methodology combines environmental and social aspects, considering them as interrelated, which is rare in existing educational programs where these topics are studied separately.

3. The methodology has been developed taking into account the specifics of schools and regional peculiarities of Almaty. It successfully adapts to the level of students' education, current environmental challenges in the region (air pollution, unauthorized landfills), as well as the cultural context. The methodology can be easily adapted for other regions, which makes it a universal tool in educational practice.

4. The methodology actively engages parents and the local community through initiatives such as Eco-Family Days, the Eco-Family competition, and projects that require students and their families to work together. Unlike most approaches that

focus only on school education, the ECO-PROGRESS methodology expands its impact on the home and social environment, which enhances the resilience of behavioral changes.

5. The methodology focuses on the practical application of knowledge: environmental projects, field research, prototyping of recycling devices, and participation in urban initiatives. Examples include Clean Rivers, Eco-Garden, and air quality monitoring projects. Unlike traditional educational methods that focus on theory, ECO-PROGRESS builds skills through active participation in real environmental initiatives.

6. The methodology includes the use of electronic platforms, mobile applications, and gamification. Students can keep online diaries of environmental achievements, participate in virtual lectures, and use apps to track their environmental contributions. The inclusion of technology in the learning process motivates students and makes environmental education modern and interactive.

7. The methodology provides for the step-by-step development of environmental knowledge and behavior: from the formation of basic understanding in the younger grades to leadership and mentoring in the older ones. For example, high school students supervise junior projects, which strengthens their responsibility and leadership skills. The methodology is focused on long-term results, including the formation of environmental habits that persist after completing school education.

8. The methodology integrates local environmental problems with global challenges (climate change, sustainable development), which helps students understand the relationship between their actions and global processes. This approach broadens the horizons of students, allowing them to realize that their contributions are important not only for the local community but also for the whole world.

9. The methodology uses interdisciplinary connections between natural sciences, humanities, and social sciences. For example, geography lessons address the environmental problems of the region, while chemistry studies waste recycling methods. This approach allows students to form a holistic understanding of environmental processes by combining scientific, social, and cultural aspects.

Thus, the ECO-PROGRESS methodology is unique in its integration of social and environmental aspects into the educational process, adaptability to local conditions, the use of modern technologies, and an emphasis on the practical application of knowledge. It not only shapes students' environmental awareness but also influences their families and community, contributing to sustainable behavioral changes. Such a systematic, interdisciplinary, and long-term approach makes the methodology universal and effective for training a new generation capable of solving modern environmental challenges.

School No. 45 has demonstrated the greatest improvements in students' environmental behavior due to its high level of knowledge and active participation in urban environmental initiatives. School No. 42 was noted for the active involvement of students, their families, and the local community in environmental practices, which indicates the wide impact of the methodology. School No. 187, despite initially having a low level of environmental behavior, has shown significant progress in the awareness and practical application of environmental skills.

To further increase the involvement of students and their families, it is recommended to focus on expanding educational work, increasing the number of practical activities, and creating motivational programs such as contests and awards.

The ECO-PROGRESS methodology has proven its effectiveness by demonstrating a significant improvement in students' environmental behavior and their involvement in long-term initiatives. It has become an important tool for the formation of an environmentally conscious generation, ready to solve modern environmental challenges at the local, regional, and global levels.

In the presented study, a unique "ECO-PROGRESS" methodology was developed and tested, based on an integrated approach to the formation of socio-ecological values among schoolchildren. This approach is based on the integration of environmental, social, and educational aspects, which allows students to form a holistic view of the interrelationships between nature, society, and sustainable development. The methodology combines theoretical learning, practical activities, and interaction with the family, which makes it interdisciplinary and practice-oriented.

One of the key achievements of the study was to fill existing gaps in approaches to environmental education, which often consider environmental and social aspects separately. The developed model focuses on interdisciplinarity, which makes it possible to study global and local environmental challenges through subjects such as biology, chemistry, and geography. This integration of environmental and social issues into curricula contributes to a deeper understanding of the concept of sustainable development by students and the formation of responsible behavior.

The practical testing of the ECO-PROGRESS methodology on a sample of 2,070 students has shown its high effectiveness. Students have become more active in introducing environmental habits into their daily lives, such as waste sorting, saving resources, and participating in urban actions. The involvement of families and the local community has also played a significant role: joint initiatives, such as the holding of "Eco-family Days," have helped strengthen the ecological culture not only among schoolchildren but also among their parents.

The study also highlighted the importance of professional teacher training. It has been proven that qualified teachers with experience in environmental initiatives significantly increase students' knowledge, awareness, and engagement. This indicates the need to develop teacher training programs with an emphasis on integrating environmental education into the educational process.

The results of the study are of significant international importance, as the proposed methodology demonstrates versatility and flexibility, which allows it to be adapted to various educational systems and cultural contexts. Comparison with international programs such as "Eco-Schools" and "Plastic Free Schools" confirms that the methodology can be successfully applied to solve global environmental challenges while maintaining its connection with local realities.

In addition, the developed model makes an important contribution to the implementation of the Sustainable Development Goals. It promotes environmental education, the rational use of natural resources, and the strengthening of partnership between the school, family, and the local community. Students who have been trained in the methodology are not only aware of the importance of sustainable development but also actively participate in environmental initiatives aimed at improving the environment.

The integration of environmental and social aspects into science education is another important aspect of research. The developed methodology shows how, through the teaching of subjects such as biology, chemistry, and geography, students can develop not only environmental awareness but also practical skills, as well as social responsibility. This knowledge and skills help students connect theoretical concepts with real environmental challenges and their personal responsibility for the environment.

Comparing the results of the study with data from other studies allows us to identify similar trends and differences, as well as to identify the unique contribution of this work to the field of environmental education and sustainable development.

1. Raising environmental awareness through participation in projects. A number of foreign and domestic studies, such as the work of Delalić [36], indicate the effectiveness of involving students in environmental initiatives. The author notes that the participation of schoolchildren in local projects, such as landscaping or monitoring the state of water, contributes to the formation of environmental awareness and responsible behavior.

Similarly, within the framework of the Clean City project and the Plant a Tree initiative, conducted in the Almaty schools under study, students became more actively involved in environmental actions, which led to increased awareness of environmental issues. For example, at school No. 45, 75% of students began to implement separate waste collection, and at school No. 42, 65% involved their families in environmental practices.

2. The role of teachers in the formation of environmental values. Research such as the work of Lebedeva [38] highlights the importance of teachers' qualifications in shaping students' environmental behavior. Their work has established that the participation of teachers in training and their professional development directly affects the level of student engagement.

In Almaty schools, a high correlation was found between the qualifications of teachers (for example, their work experience and participation in educational seminars) and the level of student engagement. At school No. 45, where teachers had an average of 15 years of experience and regularly upgraded their qualifications, 85% of students showed a high degree of involvement. These results echo the data of Sorokin and Lebedeva, confirming the key role of teachers in environmental education.

3. The impact of project activities on long-term changes. A study by Ariza, et al. [33] conducted within the framework of the international Eco-Schools program showed that the implementation of long-term environmental projects, such as reducing plastic pollution or creating school gardens, forms sustainable environmental habits among students.

Within the framework of the ECO-PROGRESS methodology under study, long-term projects such as Eco-Garden at school No. 187 and Eco-Sorting at school No. 42 led to 60-70% of students starting to implement environmental practices in their daily lives (for example, waste sorting and resource conservation). This confirms the effectiveness of practice-oriented methods.

4. Family involvement as an important success factor. Hall [39] and Vertel, et al. [40] highlight the importance of involving parents in educational and environmental initiatives. Their research shows that family involvement increases the likelihood of students developing environmental habits.

The Eco-Family Days program, implemented as part of the ECO-PROGRESS methodology, has demonstrated a similar effect. At School No. 42, about 50% of parents became involved in environmental initiatives through participation in joint actions such as tree planting and separate waste collection. This shows the importance of family-school interaction for the formation of sustainable environmental behavior.

Many foreign studies, such as the work of Bryson [41], focus on environmental education, ignoring the integration of social aspects such as equality of access to resources or social justice.

The developed ECO-PROGRESS methodology integrates both environmental and social aspects. For example, students were asked not only to study the problems of separate waste collection but also to assess the impact of these actions on the local community. This interdisciplinary approach makes this research more universal and focused on sustainable development.

Works such as Hall [39] focus primarily on the environmental education of young children, missing the importance of working with adolescents who are in the process of forming long-term values. The study focuses on students in grades 8-11, that is, adolescents who are most susceptible to the formation of long-term environmental habits. For example, participation in projects such as Clean Air gave students the opportunity to critically reflect on local pollution problems and propose their own solutions.

Research by Delalić [36] focuses on global environmental initiatives such as combating climate change, ignoring local environmental issues.

The present study has adapted the methodology to the conditions of Almaty, taking into account such regional challenges as air pollution, lack of separate waste collection, and lack of green areas. This made learning more relevant for students, which increased their interest and engagement. For example, the Clean Rivers project at School No. 187 gave students the opportunity to explore the state of the region's water resources and propose measures to protect them.

The work of Bryson [41] highlights the importance of digital technologies such as interactive maps and virtual labs in environmental education. However, many studies are limited to using technology only in the theoretical part. Within the framework of the ECO-PROGRESS methodology, technologies were used not only for teaching but also for monitoring student achievements. For example, the ECO-SCHOOL mobile app helped students track their progress in separate waste

collection, saving resources, and participating in campaigns. This contributed to the motivation and transparency of their achievements.

The ECO-PROGRESS methodology includes theoretical and practical modules that can be easily adapted to the local characteristics of any country:

1. The theoretical framework is based on global principles of sustainable development, such as the United Nations Sustainable Development Goals (SDGs), which makes the methodology relevant for countries involved in the implementation of these goals.

2. Practical projects (for example, air pollution monitoring, waste recycling, and the creation of school eco-corners) can be adapted to local environmental problems, whether river pollution in Southeast Asia, deforestation in Brazil, or increased waste levels in Europe.

Application example: In European countries, the technique can be used to increase the emphasis on waste reduction and the transition to a circular economy. In African countries, the focus may be on training in sustainable water resources management and biodiversity. In Latin America, the technique can help shape environmental awareness through projects to restore forests and protect local ecosystems.

3. The ECO-PROGRESS methodology has been developed in such a way that it can be integrated into existing curricula in natural sciences (biology, chemistry, geography, physics). Due to its modular structure, it is easy to adapt it to the requirements of educational standards in different countries.

Application example: In the United States, where STEM (science, technology, engineering, and mathematics) programs already exist, the methodology can become part of an integrated approach focusing on solving local environmental problems. In countries with developing educational systems (for example, India, Indonesia), the methodology can be implemented in individual disciplines or extracurricular activities, gradually expanding the scope.

4. The methodology focuses on the active participation of student families and the local community, which makes it particularly suitable for countries where the culture of collective action is highly developed.

Application example: In the Scandinavian countries, the technique can complement existing initiatives such as family eco-days or local environmental campaigns. In Latin American countries (such as Brazil or Mexico), family involvement in environmental projects such as waste separation or landscaping can help raise awareness throughout the community.

5. The inclusion of electronic platforms and mobile applications makes the methodology convenient for implementation in countries with a developed digital infrastructure. At the same time, it can be adapted for regions with limited access to technology.

Application example: In developed countries (for example, Japan, South Korea), using mobile apps to monitor students' environmental habits can stimulate their interest and competitive spirit. In countries with limited access to digital technologies (for example, Nepal, Ethiopia), offline forms of work can be used, such as creating wall information boards or paper diaries of environmental behavior.

6. The methodology involves the analysis of local environmental challenges and their integration into the educational process, which makes it flexible and versatile. For example: in highly urbanized cities such as Shanghai (China) or Mumbai (India), the methodology may focus on air pollution and waste management issues. In rural areas, such as in Africa or South Asia, emphasis may be placed on the conservation of biodiversity, combating desertification, and the rational use of water resources.

Application example: In Brazil, the technique can be used to foster responsibility for the preservation of the Amazon. In Australia, to solve the problem of coral reef conservation. In Germany, to reduce carbon emissions and promote energy conservation ideas.

7. The ECO-PROGRESS methodology is focused on the formation of leadership qualities among students through participation in long-term projects and supervision of elementary grades. This approach can be used in countries with a high level of youth initiative.

Application example: In European countries (for example, Germany or Sweden), students can use the methodology to create youth environmental clubs that will cooperate with local environmental NGOs. In developing countries (for example, Indonesia or Nigeria), the technique can help create volunteer programs aimed at improving the environmental situation in local communities.

8. The methodology supports the implementation of international environmental agreements, such as the Paris Climate Agreement, the Sustainable Development Goals (SDGs), and the United Nations and UNESCO's educational strategies for sustainable development. This makes it attractive to governments and educational institutions involved in global initiatives

Application example: In EU member states, the methodology may support carbon neutrality goals. In the African Union, it can be used to support programs to combat climate change and conserve water resources. In Asian countries, the technique may become part of initiatives to improve environmental literacy among the population.

The methodology can become the basis for transnational educational programs and the exchange of experience between countries.

Application example: International projects such as Eco-Schools or Green Education can use elements of the methodology to implement joint initiatives, including monitoring global environmental issues. The organization of international student conferences on ecology, where students from different countries will be able to share their projects and share experiences.

Thus, the ECO-PROGRESS methodology is a flexible tool that can be adapted to solve both global and local environmental problems in different countries. Its versatility, integration with natural sciences, emphasis on practical learning, and the use of modern technologies make it effective for use in educational systems with different levels of

development. The introduction of the methodology at the international level can contribute to the formation of an environmentally conscious generation, ready to address the challenges of sustainable development.

5. Conclusions

The study explored the impact of educational programs and methodologies on the development of students' environmental behavior. The implementation of the ECO-PROGRESS methodology enabled the identification of key factors influencing students' awareness of environmental issues and their active engagement in addressing them. The integration of theoretical knowledge, practical activities, and social interactions involving family and the broader community served as a foundation for fostering sustainable environmental behavior. This methodology is structured around the integration of modular learning and hands-on activities, facilitating a comprehensive understanding of sustainable development, the rational utilization of natural resources, and socio-ecological interconnections. The involvement of subject matter experts and the incorporation of interactive lectures significantly contributed to enhancing students' environmental knowledge. Notably, at School No. 45, a strong theoretical foundation among students provided a basis for their proactive involvement in urban environmental initiatives.

The test results indicated that following the implementation of the methodology at School No. 45, 95% of students demonstrated a high level of knowledge regarding global environmental challenges. At School No. 42, students excelled in local environmental initiatives, achieving an 88% success rate, while at School No. 187, 85% of students exhibited a significant improvement in their understanding of resource conservation and sustainable utilization methods.

The introduction of practical initiatives, such as the Plant a Tree and Eco-Garden projects, enabled students not only to comprehend but also to apply environmental practices in their daily lives. For instance, at School No. 42, 65% of students adopted waste-sorting habits, while at School No. 187, 60% actively engaged in water and energy conservation efforts.

Student participation in projects such as Clean City and Eco-Sorting fostered greater family involvement in environmental activities. At School No. 42, 50% of parents took part in waste separation initiatives, demonstrating the methodology's effectiveness in influencing both students and their families.

The data revealed that School No. 45 achieved the most substantial improvements due to a combination of strong theoretical instruction and active participation in urban environmental programs. School No. 42 emphasized local projects, effectively increasing family engagement. Meanwhile, School No. 187, despite an initially lower level of environmental awareness, made remarkable progress in fostering environmental skills and sustainable behaviors.

Despite these positive outcomes, student participation in environmental initiatives remained relatively low (15%), underscoring the need for additional motivational strategies. Additionally, there was limited exposure to environmental information from the media (15%) and family (10%), highlighting the necessity for enhanced educational outreach.

Modern global environmental and social challenges, including climate change, depletion of natural resources, environmental degradation, and the growing need for social responsibility, necessitate a reassessment of educational approaches. Natural sciences—such as biology, geography, chemistry, and ecology—hold significant potential for fostering students' awareness of environmental issues and shaping sustainable value orientations. The integration of environmental and social dimensions into the educational process not only enhances students' knowledge but also deepens their understanding of its practical applications in addressing real-world challenges.

The ECO-PROGRESS methodology encompassed theoretical instruction, practical activities, project-based assignments, family-school collaboration, and participation in social initiatives. Its implementation resulted in substantial improvements in students' environmental awareness, behavior, and engagement. Over 75% of participants integrated sustainable practices into their daily lives, including waste separation, resource conservation, the use of eco-friendly products, and the reduction of single-use plastics.

A core component of the methodology was student involvement in project-based and hands-on activities. Participation in initiatives such as Clean Air, Biodiversity Conservation, and Eco-Garden enabled students to apply their knowledge to address real-world environmental challenges. Beyond conducting research, students actively engaged in landscaping efforts, environmental monitoring, and the development of strategies for ecological improvement.

The expertise and qualifications of educators played a pivotal role in the methodology's success. Schools where teachers implemented interdisciplinary approaches, project-based learning, and environmentally focused curricula demonstrated the most significant progress. These findings underscore the importance of continuous professional development for educators in the field of environmental education.

The methodology also demonstrated that family involvement plays a crucial role in shaping students' environmental awareness. Initiatives such as Eco-Family Days and Eco-Family not only enhanced students' education but also encouraged parental participation in environmental activities. This extended the influence of educational programs beyond the school setting, fostering an ecological culture at both the family and community levels.

The integration of topics addressing local environmental challenges, including air pollution, waste management, and water conservation, made learning more relevant and accessible to students. By focusing on regional issues, students were able to witness the tangible impact of their efforts, which further stimulated their interest and engagement.

The methodology's interdisciplinary structure, combining theoretical foundations with practical applications, ensures its adaptability across diverse cultural and educational contexts. This flexibility enables its implementation not only in Kazakhstan but also internationally, contributing to efforts to address global environmental challenges.

Students trained under this methodology exhibit not only a high level of environmental knowledge but also well-developed critical thinking skills, social responsibility, and ecological literacy. They are prepared to engage in long-term initiatives aimed at addressing environmental issues at local, regional, and global levels.

By fostering environmental awareness among students, the methodology contributes to the achievement of the United Nations Sustainable Development Goals, including responsible consumption, ecosystem protection, resource efficiency, and the development of partnerships at the school, family, and community levels.

The implementation of the methodology in three schools in Almaty has demonstrated its significance in preparing a new generation capable of actively addressing environmental and social challenges. However, to enhance its effectiveness, it is recommended to expand the program, provide additional teacher training, strengthen the role of digital technologies, and increase public environmental awareness efforts.

To further advance environmental education, the following recommendations are proposed:

1. Expanding educational activities through the integration of modern technologies, such as digital platforms and applications.
2. Enhancing motivation through competitions, awards, and public recognition of student achievements.
3. Strengthening collaboration with the local community, including parents, environmental organizations, and media representatives.
4. Prioritizing long-term initiatives, such as urban and regional projects focused on solving specific environmental issues.

Future research on the development of socio-ecological values among students presents numerous opportunities for further scientific and practical advancements. A key direction is adapting the methodology to diverse cultural and regional contexts. While the ECO-PROGRESS methodology has proven effective in Almaty schools, its implementation in other regions and countries requires further investigation. Local environmental conditions, cultural characteristics, and socio-economic factors significantly influence students' perceptions of environmental challenges. Research focused on localizing the methodology will facilitate its adaptation to specific contexts, including variations between urban and rural areas.

Another important research direction is the application of modern digital technologies in the development of environmental values. Tools such as virtual and augmented reality can serve as powerful instruments for deepening students' understanding of nature and ecological processes. Future studies may focus on the creation of educational applications, interactive platforms, and digital games that facilitate the visualization of environmental challenges and their consequences. Additionally, the use of social media and digital platforms can significantly enhance the reach of environmental education, enabling students to disseminate information and participate in online environmental initiatives.

The long-term impact of environmental education remains a crucial area of study. It is essential to assess how sustainable the environmental values and habits acquired in school remain as students transition into adulthood. Longitudinal studies tracking the behavior of former students years after graduation can help evaluate the methodology’s long-term effectiveness. This approach could lead to the development of additional mechanisms for maintaining environmental literacy among graduates, such as engagement in sustainability-focused communities or continued education at universities.

The role of families and local communities in shaping students' environmental behavior also warrants further investigation. Future research should explore ways to strengthen collaboration between schools, parents, and community initiatives. This includes analyzing motivational factors that encourage families to actively engage in environmental projects and assessing the impact of initiatives such as Eco-Family Days. Strengthening school-family interaction could be key to fostering long-lasting environmental habits among students.

Another promising direction is the continued development of an interdisciplinary approach to environmental education. Sustainability-related topics can be integrated not only into natural sciences but also into disciplines such as history, literature, and mathematics. For instance, literature lessons could analyze environmental themes in literary works, while mathematics could incorporate carbon footprint calculations. Research aimed at developing interdisciplinary curricula will contribute to a more comprehensive understanding of the interconnections between various aspects of sustainable development.

Additionally, the role of environmental initiatives in fostering students' leadership skills requires further exploration. Participation in ecological projects provides students with opportunities to develop organizational competencies, critical thinking, and social responsibility. Future studies could examine how involvement in environmental programs enhances leadership qualities and encourages students to take an active role in addressing environmental and social challenges.

The assessment of environmental education methods remains a crucial area of research. There is a pressing need to develop universal indicators that objectively measure students' environmental knowledge, social responsibility, and level of engagement. Establishing such evaluation criteria will facilitate the comparison of different educational approaches and help identify the most effective strategies for fostering socio-environmental values.

Additionally, the role of educators in shaping students' environmental awareness requires further investigation. Teachers play a central role in the learning process, and their level of training directly influences educational outcomes. Future research should examine which pedagogical skills and instructional methods are most effective in transmitting knowledge and instilling values. Furthermore, studies should explore how continuous professional development, including participation in training programs and seminars, can enhance the quality of environmental education.

International environmental initiatives, such as Eco-Schools and the Earth Day Network, also present valuable research opportunities. It is essential to examine how global programs can be adapted to national education systems and how participation in these initiatives influences students’ global environmental awareness. Comparing international and local approaches will help identify which program elements are most effective in various contexts.

Economic and social factors affecting students' environmental behavior also warrant further study. Variables such as family income, access to educational resources, and social status can significantly influence perceptions of environmental issues. Research in this area will help identify barriers to environmental education and develop strategies to ensure its accessibility and inclusivity.

Future research directions encompass a broad spectrum of topics, ranging from the localization of teaching methodologies and the integration of digital technologies to the analysis of long-term impacts and the development of new interdisciplinary approaches. Advancements in these areas will enhance the effectiveness of environmental education, ensuring its adaptability to contemporary challenges and fostering a generation that is both environmentally aware and actively engaged in addressing global and local sustainability issues.

Thus, the ECO-PROGRESS methodology has demonstrated a significant positive impact by enhancing students' environmental awareness, knowledge, and practical skills. Beyond fostering ecological consciousness, it equips students with the tools necessary to address pressing environmental challenges at both local and global levels. The methodology's effectiveness across multiple schools highlights its versatility and underscores the need for its broader implementation to cultivate an environmentally responsible generation.

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