ГЛАСНИК Српског географског друштва 105(2) 89-114
BULLETIN OF THE SERBIAN GEOGRAPHICAL SOCIETY 2025

Original scientific paper
UDC 37:502/504
https://doi.org/10.2298/GSGD2502089A

Received: March 17, 2025
Corrected: April 24, 2025
Accepted: June 11, 2025

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ENVIRONMENTAL EDUCATION IN THE CONTEXT OF GLOBALIZATION: PSYCHOLOGICAL AND PEDAGOGICAL ASPECTS

Abstract: The study was conducted to identify the key psycho-pedagogical aspects that influence the effectiveness of environmental education of students in a globalized environment. In the study, surveys were conducted to assess the influence of psycho-pedagogical factors on environmental education and experiments were conducted to identify their impact on the educational outcomes of learners. During the study, it was found that students using different levels of cognitive skills such as knowing, understanding, applying, analysing, synthesizing and evaluating performed well in the experiments, highlighting the importance of applying this methodology to improve the quality of learning. Students participating in Science, Technology, Engineering, and Mathematics (STEM) projects showed a higher interest in environmental topics, as well as more active participation in discussions, indicating a high level of engagement in the learning process. The use of innovative technologies such as virtual laboratories and simulations significantly improved students' performance in practical environmental tasks. Participation in international projects was found to enrich knowledge of global environmental issues. However, the study revealed a low level of students' awareness of Kyrgyz environmental and educational legislation, which underlines the need to introduce it into the curriculum to enhance active citizenship.

Keywords: STEM-projects, educational environment, innovative technologies, international projects, safety

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Introduction

In the context of climate change on the planet, the issues of environmental education become a priority. The multitude of contemporary environmental problems, such as global warming, environmental pollution, disappearance of biodiversity and depletion of natural resources, emphasizes the need for the formation of environmental culture in humans (Hassan et al., 2022). The problem of the study is that globalization creates new challenges for environmental education, which require an adaptation of traditional methods to the changed conditions. These changes can make it difficult for students to develop environmental awareness, as traditional pedagogical approaches often fail to take into account the impact of cultural differences and modern technologies.

The media environment can significantly influence the environmental education of young people, as it shapes perceptions of environmental problems and promotes or, on the contrary, hinders the formation of environmental responsibility (Ramankulov et al., 2015; Abduvalieva et al., 2024). Taylakova and Alymkulov (2021), Hottekke and Allchin (2020), and Ahmed et al. (2021) demonstrate that youth who actively consume environmental content via social media show higher interest in environmental issues. However, they are also exposed to misinformation and fake news, making it difficult for them to understand real environmental threats. The results of their research show that active engagement in environmental initiatives is associated with positive content, whereas negative information can induce apathy and indifference. But their research did not take into account psychological and pedagogical aspects such as motivation, emotional engagement and critical thinking that may influence the perception of environmental content in the media environment.

Insufficient integration of an interdisciplinary approach in environmental education, can lead to fragmentation of knowledge and incomplete understanding of complex environmental issues among students (Yeraliyeva et al., 2016; Ibrayeva et al., 2018). Studies by Asykulov and Esenbaeva (2022), Dillon and Herman (2023), and Iftikhar (2024) showed that isolated instruction in single subjects, such as biology or ecology, impedes the integration of knowledge and skills needed for a comprehensive understanding of environmental issues. They found that students involved in interdisciplinary projects demonstrated a higher level of understanding of the interrelationships between environmental, social and economic aspects of sustainable development. The authors noted that the introduction of programmes that integrate ecology and sociology fosters a deeper understanding of environmental responsibility and social justice among students. Their research emphasized that traditional unidisciplinary approaches not only reduce environmental literacy, but also limit the development of critical thinking and systemic analysis in students. What has been overlooked is how the use of innovative technologies such as virtual laboratories, simulations and Science, Technology, Engineering, and Mathematics (STEM) projects can facilitate the effective adoption of an interdisciplinary approach in educational processes.

The family can play a key role in the formation of basic values and attitudes that determine attitudes towards the environment (Efremov, 2025). Research by Hermino and Arifin (2020), Kariyapperuma and Collins (2021), and Davari et al. (2024) show that families in which environmental values are part of everyday life significantly increase the likelihood that children will take an interest in environmental issues. The authors emphasize that positive parental example in environmental practices, such as recycling and saving resources, contributes to children's sustainable environmental habits and higher awareness of climate change.

They also note that family discussion of environmental issues and participation in joint environmental actions increases youth involvement in environmental initiatives. An omission in the research is the lack of attention to intercultural communication, which can have a significant impact on the ways in which environmental values are transmitted.

Globalization can promote consumer values such as materialism, brand cult, disposable society, affordability and convenience, which are contrary to the principles of sustainable development and environmental responsibility (Lleshi et al., 2024; Aviv et al., 2024). Studies by Abykeeva-Sultanalieva et al. (2023), Xu et al. (2020) and Sanchez-Jiménez et al. (2021) show that the dominance of consumer culture has a negative impact on the formation of environmental responsibility among young people. The authors note that despite growing awareness of environmental issues, young people are often influenced by advertising and cultural norms that point out material values. Their research emphasizes that consumer culture promotes a "disposable culture", which leads to increased waste and resource inefficiency. Furthermore, Shahzad et al. (2022) noted that educational programmes aimed at building sustainable habits do not always compete effectively with consumer attitudes. What is missed is that globalization can also create opportunities to positively influence environmental responsibility through the spread of sustainable practices and initiatives such as international environmental cooperation and access to clean technologies.

The analysis of the authors' works emphasizes the importance of media, interdisciplinary approach and family factors in the formation of environmental responsibility among young people. Studies show that these elements have a significant impact on the level of awareness and participation in environmental initiatives. However, how innovative technologies such as STEM projects and virtual laboratories can contribute to the development of a comprehensive understanding of environmental issues in a globalized world remains under-researched.

The aim of the study is to examine how globalization influences the perception of environmental values through psychological and pedagogical lenses. The main hypothesis is that the application of modern psychological and pedagogical methods in environmental education positively affects students' environmental awareness, motivation, and commitment, even amid globalizing influences. Supporting hypotheses include: (1) Bloom's Taxonomy enhances cognitive engagement with environmental issues; (2) the STEM model increases practical understanding and involvement; (3) Maslow's theory explains motivational dynamics in environmental learning; and (4) student awareness of national environmental legislation remains low, highlighting a curricular gap.

Materials and Methods

The study was conducted from January to June 2024. Four educational institutions of Kyrgyzstan participated in the study: Issyk-Kul State University named after K. Tynystanov (2024), Kyrgyz National University named after J. Balasagyn (2024), International University in Central Asia (2024) and American University in Central Asia (2024). The sample of study participants was not random and was formed according to clearly defined parameters: number by gender, age, and attitude to one of the two groups into which they were allocated. A survey was used to collect data. To select participants, an initial survey (Appendix A) was distributed via email to potential participants at the institutions where they

study or work. Participants were required to complete this survey to be considered for inclusion in the study. The selection process took place in January and February, while the main survey (Appendix B) and experiments (Appendix C) were conducted from March to May. Data processing and analysis were performed in June.

According to the results of Appendix A, the sample included 600 respondents (two groups). Group I – students of higher education institutions – 480 people (240 men and women each), Group II included teachers, researchers, and experts – 40 representatives each, in total – 120 participants (60 representatives of each gender). They were directly related to environmental sciences – 240 representatives and pedagogy, psychology, and innovative technologies – 120 representatives each. The respondents were divided into three age categories: I – from 18 to 30 years, II – from 31 to 42 years, III – from 43 to 55 years. The maximum number in each age category is 200 people. By educational institutions: Issyk-Kul State University named after K. Tynystanov – 144 respondents, Kyrgyz National University named after J. Balasagyn – 171 participants, International University in Central Asia – 152 participants and American University in Central Asia – 133 respondents. Participation in international projects related to ecology – 311 people.

The Appendix B survey was conducted using the SurveyMonkey platform. Block I of the survey was concerned with identifying key psychological and pedagogical aspects that influence environmental education. There were different survey options for the two groups in this block. II block was to understand the awareness of the country's laws that relate to education and ecology. For this purpose, the Constitution of the Kyrgyz Republic (2021) and Resolution of the Government of the Kyrgyz Republic No. 200 "On Approval of the Programme for the Development of Education in the Kyrgyz Republic for 2021-2040" (2021) were considered, on the basis of which questions for respondents were formulated. After completing the survey, links to these documents were sent to respondents for further reading.

The experiments with Appendix C were conducted using innovative technologies (PhET Interactive Simulations, EcoBeaker) and live on the basis of educational institutions. Only 120 students out of 480 (30 students from each institution, 60 women and men of the first age category – 18 to 30 years old) participated. They were discussed through online meetings. The Taxonomy of Educational Objectives (Bloom, 1956), Theory of Human Motivation (Maslow, 1943), STEM and additional materials for the first experiment (Onoh et al., 2024) were used to create the experiment scenarios. Participant information is confidential. Data processing was performed using the Statistica 13.3 program. Descriptive statistics were used to summarize and analyse the survey data, including frequency distributions, means, and standard deviations. Inferential statistics, such as t-tests and chi-square tests, were applied to assess the significance of differences between groups and to test hypotheses related to the impact of psychological and pedagogical factors on environmental education outcomes.

Results

Analysing the activities of the most common environmental projects

When completing the survey, 311 respondents indicated that they were involved in international and local environmental projects. Information about the projects is presented in the form of a table (Table 1), with numerical data indicating the number of participants in each project.

Table 1. Project information

Project	Objectives	Activities	Results
Landscape Management and Climate Adaptation Project (World Bank Group), 151 participants	Improved natural resource management and adaptation to climate change	Trainings for local communities, mechanisms for monitoring and evaluation of ecosystems, co-operation with governmental bodies	Increased area of restored forests, increased awareness of climate change
World Wide Fund for Nature (United Nations Development Programme), 234 participants	Protecting biodiversity and improving the environmental situation	Developing a legal framework for nature conservation, financing ecosystem restoration projects, and supporting sustainable agriculture	Creation of new protected areas, improvement of ecosystems
Green Economy Investment Opportunities in the Kyrgyz Republic, 123 participants	Maintaining biodiversity and sustainable development of mountain ecosystems	Development of ecotourism, training of local residents in sustainable use of resources, creation of jobs	Increased flow of tourists, increased income of local population, improved ecosystems
Moving Towards Zero Waste (United Nations Environment Programme), 278 participants	Reducing waste and improving waste management at the community level	Training in separate waste collection and recycling, introduction of recycling and disposal systems at the municipal level	Reduction of waste volumes in landfills, improvement of environmental quality
Multi-Partner Trust Fund Office Annual Programme, 196 participants	Restoration of degraded ecosystems to improve their productivity and sustainability	Restoration of natural landscapes, introduction of sustainable land tenure practices, workshops for local farmers	Increasing biodiversity, improving the condition of water bodies, supporting sustainable agriculture
Food Security and Nutrition and Sustainable Agriculture (Sustainable Development Knowledge Platform), 92 participants	Improving food security and sustainable agriculture	Training farmers in ecological practices, improving soil quality, conserving water resources	Increasing agricultural productivity, reducing the negative impact on the environment

Source: compiled by the authors based on Global Practice on Water Resources (2019), United Nations Development Programme (2024), Partnership for Action on Green Economy (2017), United Nations Environment Programme (2024), Multi-Partner Trust Fund Office (2024), Sustainable Development Knowledge Platform (2024)

Analysis of the activities of these international and local projects shows that they are aimed at a comprehensive solution to Kyrgyzstan's environmental problems through sustainable management of natural resources, protection of biodiversity and adaptation to climate change. Each project contributes to the improvement of the environment, which is important for the further development of the country.

Analysing the articles of the Constitution of the Kyrgyz Republic on education and the environment

In Articles 46-49 of the Constitution of the Kyrgyz Republic (2021), natural and educational rights are set out in law. These articles make sure everyone has access to education, support the growth of young people, cultural and artistic freedom, and the right to a healthy environment for the environment, along with the responsibilities that come with that. This set of rules shows that the state wants to teach its people about the environment and how to live in a way that doesn't harm it.

However, the survey data (Appendix B, Block II) show that there is a gap between what students know about the law and what the constitution says. Only 151 of the people who answered said they knew everything there was to know about the Constitution's key environmental and educational protections. Another 230 said they knew some things, and 219 said they had only heard of them. These results show that even though the Constitution strongly supports environmental and educational rights, they are still not fully incorporated into educational practices. This highlights the need to improve students' legal knowledge in environmental education.

Analysing legal and regulatory acts that relate to the environment

Law of the Kyrgyz Republic No. 53 "On Environmental Protection" (1999) lays out basic rules for protecting the environment, such as how to handle trash and keep ecosystems in balance. Its 2024 change, which focused on protecting natural areas, shows that the law is still changing to meet new environmental problems. The survey results show that 269 people know about this rule, making it the most well-known among the participants. This suggests that it is partially used in schools and workplaces.

Kyrgyzstan signed the Paris Agreement (UN, 2015), which requires the country to come up with plans to deal with and respond to climate change. However, only 142 of the respondents said they knew about this international promise. This shows that there is a big knowledge gap between global frameworks and national education. The Convention on Biological Diversity (1992), which promotes conservation and the equitable use of resources, is known to 163 respondents. Even though there are national biodiversity programs, not many people know about them, which means that they are not being used to their full educational potential. Also, 113 people know about the United Nations Framework Convention on Climate Change (1992), which is the basis for global climate cooperation. On the other hand, only 105 people know about the Montreal Protocol (1987), which deals with chemicals that damage the ozone layer. It's clear from these results that international environmental responsibilities aren't being taught enough in schools.

The Kyrgyz Republic's Cabinet of Ministers Resolution No. 11 (2021) lays out the main rules for environmental policy, which includes protecting the air and water. Awareness among 168 responders shows that it is not deeply ingrained in the curriculum, even though it is very important in real life.

Collectively, these results show that Kyrgyzstan has a strong legal base for environmental governance, as shown by its active international involvement and up-to-date national policies. However, students and teachers still don't fully understand these frameworks. This shows how important it is to make sure that basic legal documents like the Law of the Kyrgyz Republic No. 53 "On Environmental Protection" (United Nations, 2015; 1992; 1987; 2021) are not only easy to find but also systematically included in school programs to encourage students to become well-informed environmental citizens.

Analysing the results of the survey

Survey results from Appendix B (Block I, students) show that students demonstrated varied levels of knowledge on ecology and sustainable development, with a predominance of high and very high levels. These findings are presented in Figure 1, which illustrates the overall distribution of knowledge levels among respondents.

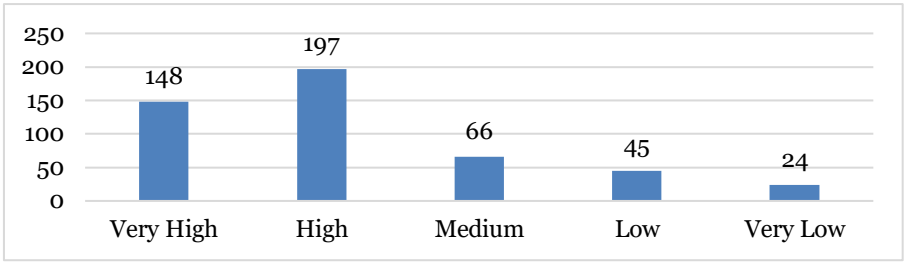

Fig. 1. Students' knowledge levels on environmental issues. Source: Compiled by the Authors

Out of the 148 students with very high knowledge, 77 were males and 71 were females. For the 197 students with a high level of knowledge, 102 were males and 95 were females. Among those with medium knowledge (66 students), 35 were males and 31 were females. In the low knowledge category (45 students), responses were nearly even – 22 males and 23 females. Lastly, the very low category included 24 students (12 males and 12 females). These figures demonstrate that males slightly outnumber females in the highest knowledge categories, suggesting a marginal gender disparity favoring males in environmental and sustainable development awareness.

Respect for nature and the ability to think critically were ranked highest among the qualities associated with environmental responsibility, followed by teamwork, emotional connection to nature, and self-discipline. The frequency of each response is visualized in Figure 2.

Among the 142 students who identified respect for the environment as the most important quality, 75 were males and 67 were females. For critical thinking and analysis (118 total), 61 were males and 57 were females. In terms of valuing teamwork (102 total), 50 were males and 52 were females. The quality of emotional connection to nature was emphasized by 75 students (36 males, 39 females), and self-organization and discipline was noted by 43 students (18 males, 25 females). These responses indicate a relatively balanced gender perception of key traits, with a slightly higher female emphasis on emotional and organizational attributes.

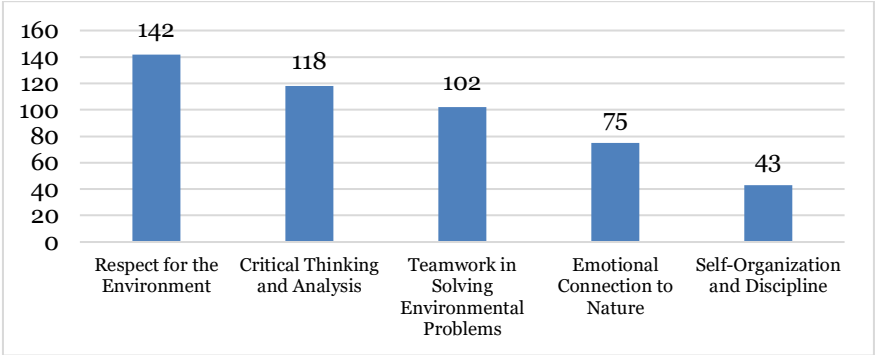

Fig. 2. Important qualities for environmental responsibility. Source: Compiled by the Authors

In terms of effective teaching practices, students expressed strong preferences for project-based learning and discussion-based formats. These methods were seen as most conducive to fostering responsibility and analytical skills. The breakdown of these responses is provided in Figure 3.

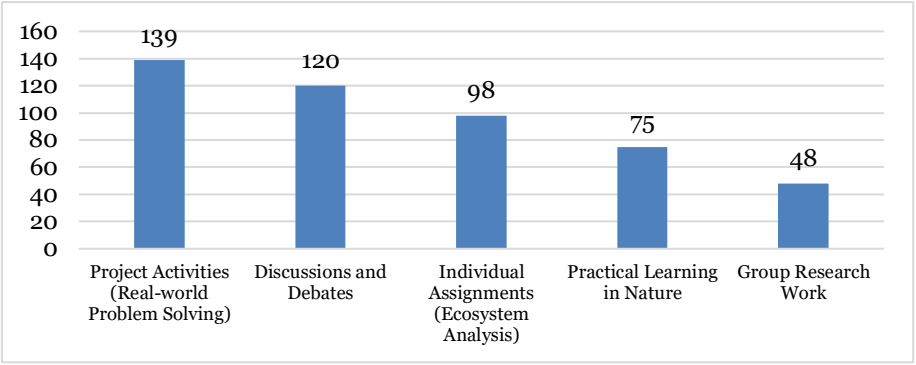

Fig. 3. Effectiveness of teaching methods. Source: Compiled by the Authors

In identifying project activities as effective (139 total), 68 males and 71 females responded affirmatively. Discussions and debates were favoured by 60 males and 60 females (120 total). For individual assignments (98 total), 47 were males and 51 were females. Practical learning in nature was chosen by 75 students (34 males, 41 females), and group research work by 48 students (23 males, 25 females). These data suggest a consistent appreciation of active and practical methods across genders, with females showing slightly greater preference for immersive and collaborative formats.

The importance of the emotional component in environmental education was affirmed by 270 respondents (137 men and 133 women), who indicated that emotional involvement motivates them to take more active care of nature. In contrast, 96 respondents (46 men and 50 women) stated that the emotional component is not particularly important to them, as they prefer a more analytical approach to ecology. Additionally, 54 students (29 males and 25 females) reported that emotions do not influence their environmental decisions, and therefore, this aspect holds little significance for them. These results point out the importance of the emotional component in the process of environmental education and the formation of responsibility for the environment.

The belief that globalization fosters awareness of the need for global cooperation was expressed by 139 respondents (70 males and 69 females). An increase in personal responsibility for the environment as a result of globalization was noted by 121 students (63 males and 58 females). Additionally, 102 respondents (50 males and 52 females) reported that globalization heightened their interest in international environmental initiatives. At the same time, 118 students (57 males and 61 females) indicated that globalization weakens their motivation due to an overemphasis on consumption and industrialization. These results underscore the complex impact of globalization on students' environmental values and attitudes towards environmental issues.

Interactive workshops and group discussions were identified by 142 respondents (70 males and 72 females) as effective in fostering the development of critical thinking. Project-based learning and problem-solving were considered the most effective for building analytical skills by 129 students (62 males and 67 females). A preference for lectures focused on analysing scientific data was expressed by 93 participants (48 males and 45 females). These results show that students value active learning methods that engage them in the process of analysis and discussion.

The study among teachers, researchers, and experts (Block I) analysed the significance of psychological and pedagogical principles for the formation of environmental culture in students (Figure 4). Numerical data correspond to the number of answers from 120 respondents.

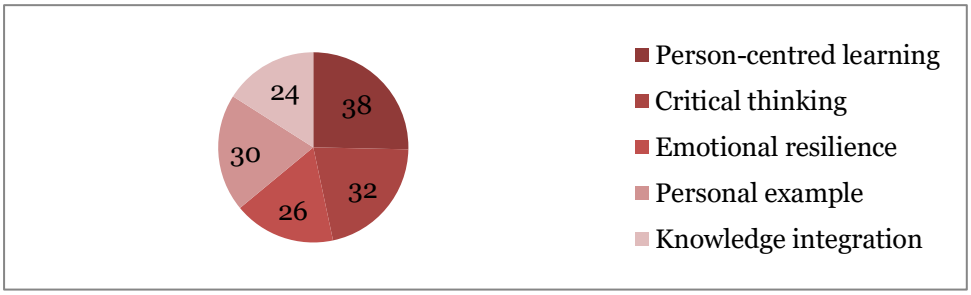

Fig. 4. Psycho-pedagogical principles. Source: Compiled by the Authors

Person-centred learning, critical thinking, and motivation through the personal example of teachers proved to be the key principles for the development of environmental culture in students. Person-centred learning is an approach that takes into account the individual characteristics and interests of each student, encouraging their active participation in learning (Goodwin, 2020; Spaska et al., 2025). Critical thinking – the ability to analyse and objectively evaluate information, which helps students make informed decisions and understand the consequences of their actions (Sandoval-Rivera, 2020; Spytska, 2024b). Emotional resilience – developing the ability to cope with stress and emotional difficulties, which is important for long-term motivation for environmental responsibility (Parker & Prabawa-Sear, 2020; Efremov, 2024). Personal example – teaching behaviours that motivate students by showing in practice the importance of environmental awareness (Sukma et al., 2020). Knowledge integration – an interdisciplinary approach that combines knowledge from different fields to better understand environmental issues (Zhang et al., 2022). The results emphasize the need for a variety of approaches in educational practice to build an environmental culture.

Among teachers, researchers and experts, 45 men and 39 women noted a high level of emotional involvement of students, which is manifested in their active participation and strong interest in discussing environmental issues. The medium level, in which students show interest but are not always emotionally involved, was chosen by 12 men and 15 women. The low level of involvement, characterized by weak interest in the majority of students, was noted by 3 men and 6 women. Students mostly show a high level of emotional involvement in environmental issues.

To increase students' emotional involvement in environmental issues, 23 teachers and 18 researchers among men use direct interaction with nature, while 20 teachers and 22 researchers among women use this method. Visualizing the effects of environmental disasters through films and videos is used by 15 male and 19 female experts, as well as 17 teachers among men and 16 among women. Discussions and reflection on personal environmental responsibility are practised by 14 men and 11 women among researchers and 19 men and 17 women among teachers. Working in environmental projects where students can see the results of their activities is common among 20 teachers and 15 researchers among men, and 18 teachers and 21 researchers among women use this method. Using methods such as direct interaction with nature and visualizing the effects of environmental disasters is the

most common among teachers and researchers to increase students' emotional involvement in discussing environmental issues.

The key features of students' psychological development influencing their perception of environmental problems were identified (Figure 5). Numerical data indicate the number of responses of 120 participants.

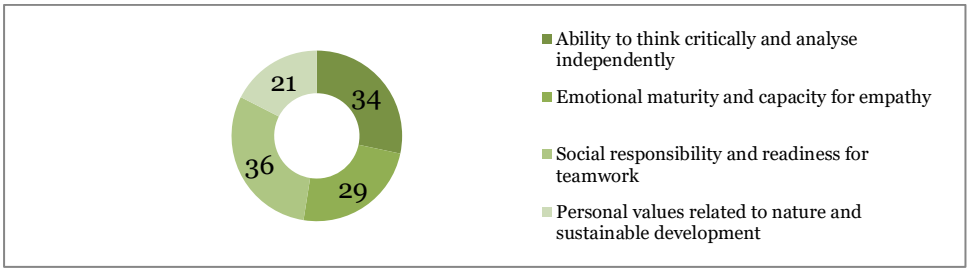

Fig. 5. Aspects of students' psychological development. Source: Compiled by the Authors

Social responsibility (the obligation of individuals and organizations to act in the interests of society and the environment (Suki et al., 2020)) and willingness to work collectively have the greatest impact on perceptions of environmental issues.

The need for an intercultural approach in teaching as a result of globalization was indicated by 42 respondents. An increased emphasis on environmental education through international projects was noted by 38 participants. Additionally, 29 respondents agreed that globalization generates ambivalence by simultaneously stimulating environmental awareness and reinforcing consumer values. No significant impact of globalization was reported by 11 participants. Overall, most respondents perceived globalization as an important factor that necessitates the incorporation of an intercultural approach in environmental education.

Digital technologies and online platforms for global discussions were identified by 41 respondents as the most effective pedagogical tools for integrating global environmental issues into the classroom. Intercultural learning through international environmental projects was highlighted by 36 participants, while 30 respondents mentioned project-based learning focused on both local and global environmental issues. Additionally, the involvement of students in real research and projects aimed at sustainable development was considered an important tool by 13 participants. These results demonstrate the high importance of digital and project-based technologies in education for effective discussion of environmental issues at the global level.

The survey among 600 respondents, which included 480 higher education students and 120 teachers, researchers and experts, provided data on the degree of familiarity with the Constitution of the Kyrgyz Republic (2021) and the legal acts regulating environmental studies. Regarding familiarity with the Constitution of the Kyrgyz Republic in terms of the rights to education and environmental protection, 151 respondents are fully familiar with the main articles, 230 respondents are familiar with the main provisions, and 219 have heard about these provisions.

Among respondents, 269 know the Law of the Kyrgyz Republic No. 53 "On Environmental Protection" (1999), 142 are familiar with the Paris Agreement under the United Nations Framework Convention on Climate Change (2015), 163 – with the Convention on Biological Diversity (1992), 113 – with the United Nations Framework Convention on Climate Change

(1992), 105 – with the Montreal Protocol on Substances that Deplete the Ozone Layer (1987) and 168 – with the Resolution of the Cabinet of Ministers of the Kyrgyz Republic No. 11 "On Issues of the State Committee on Ecology and Climate of the Kyrgyz Republic" (2021).

Regarding Resolution of the Government of the Kyrgyz Republic No. 200 "On Approval of the Programme for the Development of Education in the Kyrgyz Republic for 2021-2040" (2021), 165 respondents know the main objectives, stages and strategies, 256 respondents know about the existence of the programme and its directions, while 179 respondents do not know about its existence. These results underline the need to raise awareness of the Constitution of the Kyrgyz Republic (2021) and related regulations, as well as the importance of educational programmes for environmental education.

The legal framework of the Kyrgyz Republic fully promotes the development of environmental education in educational institutions for 122 respondents, partially promotes for 280 respondents, 135 respondents believe that it does not promote enough, and 63 respondents do not see a link between legislation and environmental education. The view that the existing legal and regulatory framework stimulates the development of environmental science was strongly supported by 115 respondents. Another 249 respondents expressed moderate agreement, while 162 respondents rather disagreed, and 74 respondents strongly disagreed.

As recommendations for improving environmental education and research, 197 respondents suggested increasing funding for environmental research, 161 respondents favoured strengthening international cooperation, 218 respondents supported the introduction of compulsory environmental education, 136 respondents called for a clearer definition of environmental standards, 178 respondents noted the need to improve mechanisms for controlling the implementation of environmental projects, and 157 respondents favoured the development of an environmental policy framework. The need to amend existing documents was not recognized by 72 respondents. These results emphasize the importance of legislative support and active use of the legal framework in environmental education and research.

Analysing the results of the experiments

In the "Assessment of Understanding of Environmental Concepts" experiment, in the first phase, students answered questions testing their knowledge of key environmental concepts. Correct explanations of the greenhouse effect were provided by 72 students, indicating that this phenomenon is associated with an increase in the concentration of greenhouse gases in the atmosphere and its consequences, such as increased temperatures and changing climate patterns. Also, 65 respondents mentioned the importance of biodiversity, giving examples: loss of species, which can disrupt ecosystem functions, and the impact of biodiversity decline on food security. Regarding sustainable development, 58 students emphasized the need for a balanced approach that takes into account economic, environmental and social aspects.

In the second stage, participants proposed a number of solutions to environmental challenges. The implementation of efficient production technologies and a shift to renewable energy sources was recommended by 90 participants. The use of green technologies, including electric vehicles and waste management systems, was discussed by 78 students. Environmental awareness campaigns and training on waste minimization were suggested by 82 participants. The need to install energy-efficient lighting and adopt smart technologies for energy

management was highlighted by 66 students. Finally, 70 participants emphasized the importance of rainwater harvesting systems and the restoration of water body ecosystems.

In the synthesis and evaluation phase, students developed recommendations to improve the environmental situation. The creation of green areas was suggested by 66 participants, including the greening of wastelands and the development of recreational facilities. Educational programmes were advocated by 54 students such as environmental workshops and the integration of environmental topics into school courses. Reducing plastic waste, including banning single-use plastics and implementing recycling programmes, was suggested by 60 participants. The development of green transport infrastructure – such as the creation of bike lanes and the introduction of environmentally friendly public transport – was recommended by 50 students. Additionally, 55 participants proposed measures to reduce air pollution, including the transition to electric buses and the installation of filters in industrial plants.

During the discussion, participants noted that the assignments helped them realize the importance of environmental responsibility and the link between personal actions and global issues. Such experiments were found to develop critical thinking by 85 students and practical application of knowledge. The experiment demonstrated that students can not only analyse information about climate change and sustainable development, but also apply it to develop practical solutions, confirming the effectiveness of the Taxonomy of Educational Objectives (Bloom, 1956).

In the experiment "STEM technology and perception of environmental issues", during the model building phase, 87 students chose to increase pollution levels to 70%, which led to the extinction of 48% of the animal species in their models. Of these, 66 participants noted that only the most resilient species, such as wolves and raccoons, survived the increase in pollution, while the more sensitive species, such as hares and birds, disappeared. The 54 students who increased rainfall to 150 mm observed plant growth, but 36 of them noted that this led to flooding-related problems with root systems. In the data analysis phase, students recorded the results of the simulation. A total of 72 students concluded that contamination levels exceeding 60% led to a marked deterioration in plant health, evidenced by a 40% reduction in height and a noticeable loss of leaf brightness. The disappearance of key animal species such as foxes and owls at pollution levels reaching 80% was noted by 58 participants.

In the final discussion, 101 students agreed that the use of STEM technologies had greatly enhanced their understanding of environmental issues. Specific measures to reduce pollution, such as installing filters in industrial plants and developing recycling programmes, were suggested by 79 participants. The perception of environmental issues was reported to have changed by 97 students due to the use of simulations, which made these issues more relevant and fostered critical thinking.

In the Motivation in Environmental Education experiment, during the Basic Needs Satisfaction phase, all participants indicated that having a comfortable environment (comfortable chairs and access to water) had a positive effect on their ability to focus on the upcoming tasks. Of the 120 students, 88 felt that the comfortable physical climate contributed to a more productive start. In the second phase, participants wrote an essay on the health effects of pollution. The importance of the environment's direct impact on personal

safety was emphasized by 78 students. In the essays, 54 students gave specific examples of pollution-related illnesses such as respiratory diseases and allergies.

During the third phase of the experiment, the four groups of participants suggested different ways to improve the environment in the city. They recommended the introduction of waste sorting with separate waste collection, greening through planting trees and creating parks, organizing actions to clean up rivers and beaches, and conducting training seminars on sustainable consumption to raise environmental awareness among the population. In the self-actualization phase, participants developed 12 projects to raise environmental awareness. The most common initiatives were: environmental lectures for schoolchildren (35 students), beach cleaning projects (29 students) and greening actions (27 students). 84 students agreed that at this stage they had reached a high level of motivation and felt that they could make a real difference.

At the reflection stage, 90 participants noted that their motivation to act increased significantly at the self-actualization stage, when they realized the opportunity to contribute to environmental improvement. Environmental education was identified by 78 students as playing an important role in their self-actualization and in the development of values related to environmental protection. These results underline the effectiveness of using the Theory of Human Motivation (Maslow, 1943) in the context of environmental education, demonstrating how fulfilment of different needs can influence students' motivation for environmental activism.

Discussion

The results emphasize the importance of environmental education in developing a responsible attitude towards the environment. The experiments showed that using methods based on the Theory of Human Motivation (Maslow, 1943), the cognitive principles of the Taxonomy of Educational Objectives (Bloom, 1956), and the practical application of STEM technologies significantly increases participants' motivation to take action to protect nature. Understanding the factors that influence motivation is important for creating a sustainable society and managing natural resources to help preserve the ecosystem for future generations (Spytska, 2024a; Tryhuba et al., 2022).

Students consider discussions and debates on environmental topics as an effective way to develop responsibility. This result does not agree with Torres and Bosio (2020), it is argued that lectures and unidirectional learning remain the most effective in developing students' responsible attitudes towards environmentalism. Torres and Bosio highlight those formal educational approaches, including lectures and theory classes, create a more structured understanding of the topic, which can be beneficial for students at the beginning of their studies. The results of this study show that active methods such as discussions and debates promote deeper student engagement and ownership. This may indicate that students prefer interaction and sharing in the learning process, which is better in line with current educational trends emphasizing active learning and critical thinking. Differences in preferences may indicate the need to revise traditional methods of teaching ecology in favour of more interactive formats.

The emotional component in environmental education is very important, because it not only motivates to take care of nature, but also helps to form a deep connection with the environment, which coincides with the study of Asongu and Odhiambo (2024). The authors

point out that emotional involvement is a key factor in developing environmental responsibility. Asongu and Odhiambo argue that positive emotional responses to environmental issues promote not only a deep awareness of environmental challenges but also students' active participation in environmental protection. The results of both studies indicate that the emotional component plays an important role in the process of developing environmental identity and responsibility among youths, which underscores the need to integrate emotional aspects into environmental education programmes.

Globalization contributes to the understanding of the need for global cooperation in the field of environmental protection (Tekesbaeva et al., 2023; Faichuk et al., 2022). This result coincides with the study of Edsand and Broich (2020), which emphasizes that globalization promotes an understanding of the importance of international cooperation in solving environmental problems. Edsand and Broich argue that the interaction between countries brought about by globalization enables the sharing of knowledge, technology and resources, which is necessary to respond effectively to global environmental challenges. Both papers demonstrate that people who recognize the interdependence of environmental issues show higher levels of involvement in international environmental initiatives. The convergence in results indicates that an emphasis on global cooperation should be at the heart of environmental education programmes and practices, as it fosters responsible attitudes towards the environment and encourages active participation in environmental issues.

Respondents identify digital technologies and online discussion platforms as the most effective pedagogical technologies for integrating global environmental issues into the classroom. This fact coincides with the study of Quiroga (2024). The author emphasizes the importance of digital technologies in the educational process. S. Quiroga argues that the use of online platforms facilitates greater student participation in discussions on global environmental issues because they overcome geographical barriers and bring together students from different countries. Both studies emphasize that the introduction of digital technologies in the educational process is a key factor in increasing student engagement and environmental awareness.

218 respondents supported the introduction of compulsory environmental education as a means of improving environmental education and scientific research, which contradicts the results of the study by Estelles and Fishman (2021). The authors argue that voluntary environmental education is more effective because it attracts students who are already interested in the topic. Estelles and Fishman highlight that compulsory programme can lead to passive comprehension of the material and decrease motivation in students. In contrast to the work of Estelles and Fishman, this study indicates that the introduction of compulsory environmental education can create a systematic approach to the formation of environmental culture, covering a wide audience, including those who have no initial interest in ecology. The results of this study demonstrate that legislative initiatives for compulsory environmental education can be an important step towards improving the overall environmental awareness and responsibility of society, in contrast to the approach proposed in the study by M. Estelles and G.E. Fishman.

85 students agreed that tasks based on the Taxonomy of Educational Objectives (Bloom, 1956) helped them realize the importance of environmental responsibility and the link between personal actions and global issues. This finding coincides with the study of Pertiwi et al. (2024), which emphasizes that the application of the Taxonomy of Educational Objectives in educational practices promotes a deeper understanding of educational

material and the development of critical thinking in students. The study by N. Pertiwi et al. points out that the multi-level structure of the Taxonomy of Educational Objectives, covering such cognitive levels as analysis, synthesis and evaluation, allows students to process information more effectively and apply the acquired knowledge in practice. This is consistent with the results of this experiment, where students not only analysed environmental concepts, but also synthesized specific recommendations for solving environmental problems. Both studies confirm that the use of Taxonomy of Educational Objectives in educational approaches promotes deeper learning and practical application of this knowledge in real-life situations.

The introduction of STEM technologies has significantly increased the understanding of environmental issues. These findings are in line with the study of Husamah et al. (2023) who also studied the impact of STEM on environmental education among students. H. Husamah et al. demonstrated that the use of simulations and interactive technology in learning enables students to become more aware of the environmental consequences of various actions. It was observed that 95.2% of the study participants stated that the use of such teaching methods significantly increased their understanding of the relationships between pollution and ecosystem health. The similarity with this experiment is that in both cases the use of technology facilitated not only the analysis of information but also its practical application to solve real environmental problems. The results of this study and the study by Husamah et al. emphasize the importance of introducing STEM technologies in the educational process to improve students' environmental awareness and critical thinking.

90 participants reported a significant increase in their motivation for action at the self-realization stage, which confirms the effectiveness of applying the Theory of Human Motivation Hierarchy of Needs (Maslow, 1943) in environmental education. These results coincide with the study of Bakar (2023), who also analysed the impact of need satisfaction on students' motivation for environmental activism. A.A. Bakar revealed that creating a favourable learning environment where students' basic needs such as comfort and safety are met significantly increases their engagement and activity. He emphasizes that when students feel supported and have the opportunity to realize their ideas, it leads to a sense of responsibility for the environment. Both studies highlight that meeting the needs of the Theory of Human Motivation, such as the need for recognition and self-actualization, promotes students' active participation in solving environmental problems, strengthening their ties to the community and the world around them. Systematic attention to psychological aspects in environmental education not only stimulates the development of personal responsibility, but also contributes to the formation of active citizenship (Drachuk & Sopivnyk, 2019).

The legal framework of the Kyrgyz Republic partially favours the development of environmental education in educational institutions, which is confirmed by the opinion of 280 respondents, indicating insufficient legislative support in this area. This fact partially coincides with the study of McGlone et al. (2024) conducted in New Zealand, where 72.2% of respondents noted that the legislation does not fully support environmental education in educational institutions, which affects the level of awareness of people about environmental problems. However, in contrast to New Zealand, where there is a need for further refinement of legislative initiatives, in Kyrgyzstan there is a positive trend in the development of the legal framework, which indicates a desire to improve support for environmen-

tal education. The Kyrgyz Republic is gradually introducing new regulations aimed at integrating ecology into curricula and programmes, which is already beginning to have a positive impact on educational processes.

During the discussions, it was confirmed that active learning methods such as discussions and debates contribute to the formation of environmental responsibility in students, unlike traditional lectures. Emotional engagement and the use of digital technologies increase student participation in environmental issues. Supporting compulsory environmental education emphasizes the importance of a systematic approach to building an environmental culture. The introduction of methodologies such as Taxonomy of Educational Objectives (Bloom, 1956) and STEM-technologies has a positive impact on motivation and understanding of environmental issues.

Conclusion

For a deeper understanding of environmental education in the context of globalization, a comprehensive analysis was conducted, which included an assessment of psychological and pedagogical aspects, the impact of global changes on environmental education, as well as the application of modern educational technologies for the formation of environmental awareness. In the course of the study, it was determined that 148 students (77 men and 71 women) demonstrated a very high level of knowledge in the field of ecology and sustainable development. A high level of knowledge was noted in 197 students (102 males and 95 females) who had sufficient awareness to understand environmental issues, but rarely applied this knowledge in practice. Medium level of knowledge was found in 66 students (35 males and 31 females) and low level was found in 45 students (22 males and 23 females) who are willing to study ecology. A very low level of knowledge was shown by 24 students (12 males and 12 females) who showed almost no interest in ecology. It was confirmed that Taxonomy of Educational Objectives effectively structures the learning of environmental concepts, promoting high cognitive understanding. The use of STEM technologies was seen as a way to develop practical skills and critical thinking, which enhances students' readiness to solve actual environmental problems.

The study found that satisfaction of basic needs enhances motivation to participate in environmental education, forming personal responsibility and emotional involvement. The emotional component in environmental education was noted as important by 270 respondents (137 men and 133 women), but 96 respondents (46 men and 50 women) considered it unimportant. Globalization, according to 139 respondents (70 men and 69 women), pushes the awareness of the need for global cooperation. Personal responsibility for the environment is increasing for 121 students (63 males and 58 females) and interest in international environmental initiatives for 102 respondents (50 males and 52 females). However, 118 students (57 males and 61 females) believe that globalization weakens motivation due to the emphasis on consumption. Interactive workshops and group discussions were confirmed as effective for developing critical thinking for 142 respondents (70 males and 72 females), and project-based learning was confirmed as the most effective for developing analytical skills for 129 students (62 males and 67 females). The discussion emphasized the importance of taking all these factors into account in order to increase the effectiveness of environmental education and student involvement in solving actual environmental problems.

The study confirmed the main hypothesis that the integration of modern psychological and pedagogical approaches significantly enhances students' environmental awareness, motivation, and engagement in the context of globalization. Bloom's Taxonomy was shown to deepen cognitive understanding, as students effectively progressed from basic knowledge to evaluation and synthesis of environmental solutions. The use of STEM technologies increased practical engagement and critical thinking, while Maslow's theory was validated through a rise in motivation linked to the satisfaction of basic and higher-order needs. The hypothesis regarding low awareness of national environmental legislation was partially confirmed, revealing a curricular gap. Overall, the results demonstrate that interdisciplinary, interactive, and emotionally engaging methods are effective in fostering environmental responsibility among students.

Limitations of the study include the influence of cultural and social factors on perceptions of environmental issues, limited access to resources, and the difficulty in assessing the long-term effects of educational programmes in the context of globalization. Further research could focus on the influence of media and social networks on the formation of young people's environmental consciousness, assessing the effectiveness of environmental education programmes in different cultural contexts, and the impact of global environmental crises on educational strategies in different countries.

Conflicts of Interest: The authors declare no conflict of interest.

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Appendix A

Selection of participants

№	Question/Answer options
1.	Facility: ○ Issyk-Kul State University named after K. Tynystanov; ○ Kyrgyz National University named after J. Balasagyn; ○ International University in Central Asia; ○ American University of Central Asia.
2.	Your role: ○ student; ○ educator; ○ researcher; ○ expert.
3.	Paul: ○ masculine; ○ female.
4.	Age: ○ 18–30 years old; ○ 31–42 years old; ○ 43–55 years old.
5.	Have you participated in international projects related to ecology? ○ yes (specify which ones): ○ no.
6.	Main area of activity: ○ Environmental sciences; ○ Pedagogy; ○ Psychology; ○ Innovative technologies.
7.	Do you agree to take part in the study? ○ yes; ○ no.

Source: Compiled by the Authors

Appendix B

Survey for study participants

I block			
Students		**Teachers, researchers, and experts**	
№	**Question/Answers**	**№**	**Question/Answers**
1.	**How do you rate your knowledge of ecology and sustainable development?** ○ very high – I regularly study environmental issues, participate in environmental projects and actively apply this knowledge in practice; ○ high – I have enough knowledge to understand environmental issues, but I rarely apply it in my daily life; ○ medium – I am aware of the main environmental issues but do not go into detail; ○ low – I have little information about current environmental issues, but I am willing to learn more; ○ very low – I have almost no knowledge on the subject, and I am not interested in it.	1.	**What psychological and pedagogical principles do you consider the most important for the development of environmental culture in students?** ○ person-centred learning; ○ critical thinking and problem-solving; ○ development of emotional stability and the ability to empathize; ○ motivation through the personal example of teachers; ○ integration of knowledge through interdisciplinary approaches.
2.	**What personal qualities, in your opinion, are most important to develop for the formation of environmental responsibility?** ○ respect for the environment; ○ the ability to critically analyse environmental issues; ○ ability to work in a team to solve environmental problems; ○ an emotional connection to nature; ○ self-organization and discipline in the implementation of environmental initiatives.	2.	**How do you assess the level of students' emotional involvement in discussing environmental issues?** ○ high (students actively participate in discussions and show strong interest); ○ medium (students show interest, but are not always emotionally involved); ○ low (most students do not show emotional involvement).
3.	**Which teaching methods most effectively develop your personal responsibility for the environment? (You can choose several options)** ○ project activities with elements of real-world problem-solving; ○ discussions and debates on environmental topics; ○ individual assignments related to ecosystem analysis; ○ hands-on learning in nature; ○ group research papers.	3.	**What methods do you use to increase students' emotional engagement with environmental issues?** ○ direct interaction with nature (excursions, fieldwork); ○ visualization of the consequences of environmental disasters through films and videos; ○ discussions and reflection on personal environmental responsibility; ○ work in environmental projects where students can see the results of their activities.
4.	**How important to you is the emotional component in environmental education?** ○ very important — the emotional involvement motivates me to take a more active role in caring for nature; ○ important — it helps me to better understand the significance of environmental issues; ○ not particularly important — I prefer an analytical approach to ecology; ○ not important — emotions do not influence my decisions in this area.	4.	**What features of students' psychological development influence their perceptions of environmental issues?** ○ the ability to think critically and analyse independently; ○ emotional maturity and the ability to empathize; ○ social responsibility and readiness for teamwork; ○ personal values related to nature and sustainable development.

5.	**How does globalization affect your values related to the environment?** ○ pushes to realize the need for global cooperation; ○ reinforces my personal responsibility for the environment; ○ increases my interest in international environmental initiatives; ○ weakens my motivation because of the overemphasis on consumption and industrialization.	5.	**How do you assess the impact of globalization on the psychological and pedagogical aspects of environmental education?** ○ increases the need for an intercultural approach in teaching; ○ increases the emphasis on environmental education through international projects; ○ forms a duality: on the one hand, it stimulates environmental awareness, on the other hand, it reinforces consumer values; ○ doesn't have a significant impact.
6.	**What style of environmental teaching does it help you better develop critical thinking?** ○ interactive workshops and group discussions; ○ project-based learning and problem-solving; ○ lectures with an emphasis on analysing scientific data; ○ use of modern technologies, simulations and virtual laboratories.	6.	**What pedagogical technologies do you find most effective for integrating global environmental issues into the classroom?** ○ digital technologies and online platforms for global debate; ○ intercultural learning through international environmental projects; ○ project-based learning with a focus on solving local and global environmental problems; ○ involvement of students in real research and projects aimed at sustainable development.
№	**II block**		
1.	**How familiar are you with the Constitution of the Kyrgyz Republic as it relates to the rights to education and environmental protection?** ○ fully familiar: I know the main articles relating to the rights to education and the environment (Chapter IV: Articles 46, 47, 48,49); ○ familiar with the basic provisions: I know that the constitution guarantees the right to education and protection of nature, but not all the details; ○ had heard of the main points but had not studied them in detail.		
2.	**Which of the following legal acts regulating scientific research in the field of ecology do you know? (You can choose several options)** ○ Law "On Environmental Protection"; ○ The Paris Agreement; ○ The Convention on Biological Diversity ○ The United Nations Framework Convention on Climate Change; ○ The Montreal Protocol on Substances That Deplete the Ozone Layer; ○ Government Resolutions on the State Programme for Environmental Protection.		
3.	**Do you know about the existence of the "Programme for the Development of Education in the Kyrgyz Republic for 2021-2040" in the Kyrgyz Republic?** ○ I know the main goals, stages, and strategies for the development of the education system in Kyrgyzstan until 2040, including reforms to improve the quality of education and the introduction of innovative technologies; ○ I know about the existence of the programme and its main directions, such as modernization of educational standards and improvement of accessibility of education in the regions, but I have not studied the detailed aspects; ○ I am not aware of its existence and am not familiar with its goals or objectives related to the development of the educational system until 2040.		
4.	**To what extent, in your opinion, does the legal framework of the Kyrgyz Republic contribute to the development of environmental education in educational institutions?** ○ fully contributes: laws cover all necessary aspects (e.g. introduction of ecology into curricula); ○ partially contributes: there are necessary provisions, but they are not sufficiently specified; ○ does not contribute sufficiently: more specific acts and initiatives are needed; ○ does not contribute: I do not see a link between legislation and environmental education.		

5.	**To what extent do you agree with the statement that the existing legal framework stimulates the development of environmental science in Kyrgyzstan?** ○ I wholeheartedly agree. Laws and regulations create favourable conditions for research and environmental initiative; ○ I rather agree, but there are gaps that prevent active development; ○ I rather disagree. There are not enough resources and incentives for environmental research; ○ I completely disagree. The legal framework has no tangible impact on the development of science.
6.	**What legal documents would you recommend adding or change to improve environmental education and research in Kyrgyzstan? (You can choose several options)** ○ increasing funding for environmental research; ○ strengthening international cooperation in the field of ecology; ○ introduction of compulsory environmental education in schools and universities; ○ better defining environmental standards for curricula; ○ improvement of mechanisms of control over the implementation of environmental projects; ○ development of additional acts regulating the interaction between science and ecology; ○ don't need to be changed.

Source: Compiled by the Authors

Appendix C

Experiment scenarios

Title	Description of the experiment scenarios
Assessment of understanding of environmental concepts (Taxonomy of Educational Objectives)	1. Introduction and briefing (10 minutes): the researcher explains the purpose of the experiment, distributes the materials and briefly introduces the participants to the topic of climate change. 2. Step 1: Checking basic knowledge and understanding (20 minutes): participants analyse a scientific study describing the concepts of climate change and sustainable development. Task: answer questions to check their understanding of the material. Examples of questions: "What is the greenhouse effect and how does it affect the climate?", "Why is it important to preserve biodiversity?". Purpose: To assess the level of "Knowledge" and "Understanding" in the Taxonomy of Educational Objectives. 3. Stage 2: Knowledge application and analysis (30 minutes): participants receive a case study related to a practical environmental problem. Task: solve the situation by proposing measures to reduce the company's environmental impact, taking into account the knowledge acquired ('Suggest three specific steps the company could take to reduce its carbon footprint', 'How will emissions change if the company implements green technologies?'). Objective: to develop the 'Apply' and 'Analyse' levels. 4. Stage 3: Synthesis and evaluation (40 minutes): participants are asked to develop recommendations for improving the environmental situation in their city. Task: write a plan containing at least two innovations that could be introduced in the city, make an assessment of the possible consequences of these innovations for the population and nature. Examples: "How can the reduction of transport emissions affect air quality?", "What long-term benefits can plastic reduction measures bring?". Objective: to test the participants' ability to synthesize and critically evaluate. 5. Discussion of results (20 minutes): Participants share their suggestions, discuss what they learnt and how the assignments helped them to better understand environmental issues.
STEM technologies and perceptions of environmental issues	1. Introduction and preparation (15 minutes): The researcher explains that participants will create an ecosystem model to understand the effects of pollution. Technology: Software simulations that simulate a forest ecosystem (PhET Interactive Simulations, EcoBeaker). 2. Model building (30 minutes). Task: each participant chooses parameters (temperature, rainfall, pollution levels) and builds a model of the forest, observing how plants and animals react. Examples of changes they can make to the model: increase emissions from factories and see how biodiversity changes, increase rainfall and analyse how this will affect plant growth. Objective: to demonstrate the influence of external factors on the sustainability of an ecosystem and to develop critical thinking. 3. Data analysis (20 minutes). Task: write down the results of the simulation and answer the questions: "What level of pollution led to the deterioration of plants?", "Which animals disappeared from the ecosystem when pollution increased?". Objective: to apply in practice knowledge about ecosystems and analyse interrelationships. 4. Closing discussion (25 minutes). Participants discuss how using STEM helped them gain a deeper understanding of environmental issues. The researcher asks questions: "What measures can help reduce pollution in real life?", "How does the use of such technologies change your perception of environmental issues?".
Motivation in Environmental Education (Theory of Human Motivation)	1. Stage 1: Meeting basic needs (10 minutes). Task: before starting the task, participants are provided with all the necessary comfort (access to water, comfortable chairs). The researcher briefly explains that the participants will be working on an environmental project related to the effects of pollution on health. 2. Step 2: Safety Needs (20 minutes). Participants read materials and discuss how pollution affects human health. Assignment: Write a short essay on why environmental issues are important to the safety of society and their personal safety. Objective: connect environmental issues to safety needs. 3. Step 3: Needs for belonging and respect (20 minutes). Participants work in groups of 30 to develop ideas for improving the ecology of the city. Task: each group proposes one way of improvement (sorting rubbish, landscaping). Ideas are discussed, participants express opinions and support each other. Objective: to develop a sense of belonging and teamwork. 4. Step 4: Self-actualization (30 minutes). Participants are asked to develop a project to raise environmental awareness in the community. Task: write a project concept including target audience, objectives, methods (environmental lectures) and possible outcomes. Objective: to reach a level of self-realization by developing the ability to see the contribution to improving the environment. 5. Discussion and reflection (15 minutes). Participants discuss how their level of motivation changed at each stage. The researcher asks questions: "At which stage did the greatest motivation for action emerge?", "How, in your opinion, does environmental education help in self-actualization?".

Source: Compiled by the Authors