

FORMATION OF ENVIRONMENTAL COMPETENCES OF FUTURE PRIMARY SCHOOL TEACHERS IN INCLUSIVE EDUCATION

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Abstract. The study aimed to identify the peculiarities of developing environmental competence among students of pedagogical specialties in an inclusive educational environment in the Kyrgyz Republic. The research was conducted at Kyrgyz State University named after I. Arabyaev and involved 120 second- to fourth-year students majoring in Primary Education. A pedagogical experiment with pre- and post-intervention diagnostics was combined with quantitative and qualitative analysis. Before the formative stage, students showed mainly average or below-average levels of environmental competence: mean scores were 2.8 out of 5 for the cognitive component, 2.5 for the operational component, and 3.4 for the value-motivational component. The formative programme integrated environmental content with inclusive teaching methods, adapted materials, eco-projects, and digital tools for students with special educational needs. After the intervention, the experimental group improved to 3.6 for the cognitive component, 3.7 for the operational component, and 4.2 for the value-motivational component, whereas the control group showed only minor changes. Inclusive experience was associated with growth in environmental skills ($r=0.46$) and value attitudes ($r=0.39$), while the correlation with knowledge was weaker ($r=0.21$). The main difficulties were uncertainty in adapting environmental materials (45%), limited experience in creating inclusive didactic tools (31.7%), and insufficient awareness of digital resources (24.2%). The findings show that integrating environmental education with inclusive pedagogy strengthens primary school teachers' knowledge, practical skills, and value orientations. The results can improve teacher-training curricula by integrating environmental content with inclusive pedagogical preparation.

Keywords: education, sustainable development, children with special educational needs, educational process, teacher training.

1. INTRODUCTION

The research relevance is determined by the need for interdisciplinary coordination of the content of environmental and inclusive components of professional training, which is becoming a prerequisite for improving the quality of education at the primary level. The development of environmental competencies of future primary school teachers is a key task of modern teacher education in the context of achieving the Sustainable Development Goals declared by the United Nations (UN) (2025) by 2030. At the same time, in Central Asian countries, particularly the Kyrgyz Republic, there is an insufficient level of inclusion of environmental issues in teacher training programmes, which is significantly complicated by the challenges associated with the introduction of inclusive education. In such circumstances, it is necessary to create pedagogical approaches that can ensure the simultaneous formation of

environmental awareness and pedagogical readiness for employment in an inclusive educational environment.

A scientific analysis of modern literature confirms the growing interest in the relationship between the contextual features of education and the effectiveness of its content. Thus, Moldalieva et al. (2025) revealed the importance of considering the socio-cultural context when developing natural science curricula. The study proved that environmental education becomes effective only if it is adapted to the mental and cultural characteristics of a particular region, which is relevant for the multi-ethnic Kyrgyz society.

Another aspect of the interdisciplinary nature of the pedagogical process was revealed by Musaeva et al. (2025) in an investigation of the introduction of technologies for assessing reading literacy and communicative competence in language teaching. The experience of adapting such approaches to real-life learning environments can be used as a model for the development of environmental literacy, through the development of skills to work with environmental texts. It is also worth noting the development of critical thinking, a skill that is fundamental to a conscious attitude to environmental issues.

Isaeva et al. (2025) studied the impact of adaptive platforms and digital tools on the effectiveness of the educational process. The study substantiated that the use of adaptive technologies contributes to the personalisation of learning, which is especially important in inclusive education. The use of flexible digital solutions can increase students' motivation and develop sustainable skills in interacting with educational content, which is of high importance for training teachers to teach different categories of students.

The problem of linguistic and cultural adaptation was addressed by Omurzakova et al. (2025), who analysed the formation of language culture in the bilingual and multilingual educational space of modern Kyrgyz universities. The content of language training aimed at understanding cultural diversity can contribute to the analysis of the relationship between humans and the natural environment. In the context of environmental education, this creates the conditions for the formation of a tolerant, inclusive and environmentally responsible way of thinking.

The study by White and Fletcher (2025) employed a phenomenological approach to examine the perception of inclusive education by primary school teachers. The study determined that the level of teachers' readiness for inclusion is significantly correlated with the availability of practical experience and special training. This emphasises the importance of introducing an inclusive component into teacher training curricula, including environmental courses. A systematic review by Navas-Bonilla et. al (2025) highlights the potential of digital technologies in the implementation of inclusive education, through virtual reality (VR), augmented reality (AR) and gamified resources. A wide range of tools that can be used in environmental education to ensure the accessibility of the material to students with special needs is identified. Yeganeh et. al (2025) proposed a multi-level model of a meta-world classroom based on inclusivity, immersiveness and technological flexibility. Although the model is future-oriented, it already provides guidelines for modernising teacher education, in the direction of ecological integration into the digital environment.

The literature review by Djafri and Mujahidin (2025) concluded that inclusive education requires close intersectoral cooperation between education, healthcare, and social protection. This is directly related to the implementation of environmental issues, which also requires an integrated approach and cooperation between disciplines. Muxlisa (2025) emphasised the importance of pedagogical skills in reforming the primary education system, emphasising training teachers for innovative, adaptive and flexible professional activities. In this context, environmental education is an indicator of a teacher's ability to think critically, empathise and systematicity. Taddese et al. (2025) presented the results of a case study of inclusive practice in primary schools in Ethiopia. Despite limited resources, the effectiveness of the inclusive model is ensured through teacher training focused on flexibility and sensitivity to the needs of each student. This directly correlates with the idea of adapting environmental

education to individual learning pathways.

The generalisation of the analysed sources determined that modern scientific thought recognises the importance of integrating environmental and inclusive components into teacher education. At the same time, there is a lack of empirical research that would simultaneously consider both areas in the context of developing pedagogical competencies. This problem is especially relevant for the educational systems of the post-Soviet space, in Central Asia.

The study aimed to assess the level of environmental competence of student teachers and determine the effectiveness of inclusive pedagogical influence. Objectives of the study were to assess the level of cognitive, operational and value components of future teachers' environmental competence, incorporating the experience of inclusive education; to develop and conduct a comparative and correlation analysis of the dynamics of competence changes depending on the course, gender and experience of interaction with children with SEN (special educational needs).

2. RESEARCH METHODS

The empirical study was conducted in October-December 2024 at the Kyrgyz State University named after I. Arabaev (Bishkek, Kyrgyzstan), which is the leading higher educational institution in the country. The study was implemented within the framework of the educational programme of the speciality "Primary Education". The study included 120 students of 2-4 years of study (81.7% women; 18.3% men) aged 18 to 23 years. The gender ratio (81.7% women, 18.3% men) reflects the real gender structure of the contingent of students majoring in Primary Education at the university under study. Thus, this disproportion is not a distortion but represents the current situation in the field of primary school teacher education in Kyrgyzstan. The inclusion criteria were studying in the speciality "Primary Education", active participation in the educational process during the study period, and voluntary consent to participate. The exclusion criterion was academic absence during any stage of the study. The sample type is a quota, covering the distribution by gender, course of study, age and experience with inclusive education.

For comparative analysis, the sample was divided into two subgroups:

- students who have already had practical experience interacting with children with special educational needs during their pedagogical practice or volunteering (n=42);
- students without such experience (n=78).

This division was used to assess the impact of previous experience of inclusive education on the level of environmental competence (Table 1).

Tab. 1

Socio-demographic data of the study participants

Parameter	Amount (n=120)	Percentage (%)
Gender: Female	98	81.7
Gender: males	22	18.3
Age: 18 years	8	6.7
Age: 19-21 years	87	72.5
Age: 22-23 years	25	20.8
Experience in inclusion: present	42	35.0
Experience in inclusion: none	78	65.0

Source: compiled by the authors

The research process consisted of three stages: ascertaining (October 2024), formative (November 2024) and control (December 2024). At the starting stage, an input diagnosis of environmental competence was carried out in three components: cognitive (knowledge), operational (skills) and value (attitude). Data was collected using a standardised test (developed by the author of the study),

questionnaires with self-assessment elements (Likert (1932) scale 15) and analysis of answers in contextual tasks. The content of the tests was adapted to the specifics of the inclusive educational environment. The full texts of the tests, questionnaire and contextual tasks are provided in Appendix.

The formative stage involved the introduction of pedagogical influence in the form of the author's programme, which included practical classes with modelling environmental situations, development of inclusive didactic materials, organisation of group eco-projects and creation of lesson notes adapted to special educational needs. At the formative stage, the students were divided into 12 creative groups of 10 people. Each group worked on an author's eco-project, the content of which had to be adapted to the needs of an inclusive educational environment. The projects were defended in the form of group presentations with an individual presentation of each participant's contribution. The evaluation was carried out by experts according to individual criteria. Visual aids (icons, infographics), multimedia presentations (PowerPoint, Canva), and open-source videos were used to present the material.

The control stage included a repeated assessment using a similar scale. IBM SPSS Statistics 26.0 software was used for data processing. The student's t-test was used to compare the mean values in paired samples (input/output assessment). To identify differences between the two subgroups of students with and without experience of participating in the inclusive educational process, the non-parametric Mann-Whitney test was used. In addition, Pearson's correlation coefficients were calculated to establish the existence of a statistical relationship between inclusive experience and the level of environmental competence components. The level of statistical significance was set at $p < 0.05$, with 95% confidence intervals calculated. The error was estimated in terms of standard deviation (SD). The obtained results were visualised in the form of tables, histograms, pie charts and combined diagrams, which presented the dynamics of changes in an accessible form for analysis.

To ensure the reliability of the study, the procedure of informed consent, anonymity and voluntary participation of respondents was observed following the provisions of the WMA Declaration of Helsinki (2025), which regulates compliance with the norms of voluntariness, anonymity, academic integrity and respect for the dignity of participants in pedagogical research. The study did not require any medical interventions, and no risky or experimental methods were used.

3. RESULTS AND DISCUSSION

The analysis of the initial level of formation of future primary school teachers' environmental competence in an inclusive educational environment showed significant fluctuations in all three components: cognitive, operational and value motivational. To analyse the level of students' mastery of basic environmental knowledge, the results of the standardised test were processed element by element (Appendix). Table 2 shows the frequency distribution of correct answers to each of the ten test items, which identified the topics that were the most difficult for the respondents.

The analysis of Table 2 shows that the greatest difficulty for students was in comprehending such concepts as "sustainable development", "sources of air pollution" and "global warming". These results indicate that students have a fragmented understanding of systemic environmental challenges and an imperfect understanding of the relationship between human activity and the state of the environment. At the same time, the highest proportion of correct answers was recorded for tasks related to practical or familiar topics, such as identifying renewable energy sources and labelling garbage containers. Such results indicate that students can operate with some applied knowledge but have difficulty understanding the general principles of sustainable development, which is the basis for the formation of the cognitive component of environmental competence.

Frequency distribution of correct answers to the cognitive test (n=120)

No.	The subject of the task	% of correct answers
1	The concept of "sustainable development"	41.7%
2	Renewable energy sources	65.8%
3	Biodiversity	54.2%
4	Recycling of materials	62.5%
5	Greenhouse gases and global warming	48.3%
6	The concept of "ecosystem"	57.5%
7	The water cycle	50.8%
8	Sources of air pollution	45.8%
9	Colour coding of waste containers	68.3%
10	The concept of the "supply chain"	59.2%

Source: compiled by the authors

Based on the processed data, a histogram of the frequency distribution of the overall individual results of students by cognitive component was constructed. Each respondent's level was calculated as the sum of correct answers (out of 10), converted to a 5-point scale. The distribution of answers is shown in Figure 1.

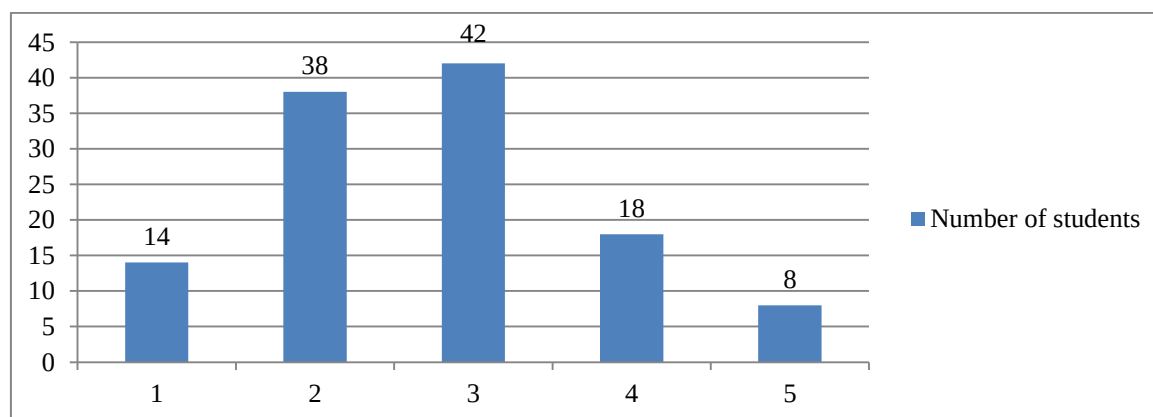


Fig. 1. Level of knowledge of ecology among students (on a scale from 1 to 5)

Source: compiled by the authors

The analysis of the data presented in Figure 1 shows an insufficient level of formation of the cognitive component of environmental competence in most students. The largest proportion of respondents (35.0%) received a score of "3" on a five-point scale, indicating partial mastery of basic environmental concepts. Another 31.7% of students demonstrated knowledge at the level of "2" points, and 11.7% only at the level of "1" point, which in total amounted to 78.4% of the sample with an average or below-average level of knowledge. The grade of "4" was given to 15.0% of students who mastered the basic environmental concepts but made mistakes in detail or demonstrated a limited understanding of inter-conceptual connections. Only 6.6% of respondents achieved a high level (grade 5), which indicated a confident mastery of the material and systematic environmental thinking. The overall distribution of results was asymmetrical with a shift towards lower scores. The data confirmed the prevalence of fragmentary knowledge among most students, which was manifested in the uncertain use of environmental terminology, inaccurate interpretation of key concepts and poor understanding of the concept of sustainable development. At the same time, the presence of a small group of students with a high level of knowledge showed the potential for further formative pedagogical influence. Such a distribution of results emphasises the need to strengthen the cognitive component in the educational training of future teachers, especially given the requirements of inclusive education.

The results of the operational component, which was assessed based on students' performance of contextual tasks, indicated an even lower level of practical skills in the application of environmental knowledge in the pedagogical process, in an inclusive classroom. Only 10.0% of students demonstrated a high level, demonstrating the ability to adapt environmental tasks to the needs of children with special educational needs, to offer variable approaches, and to use visualisation and examples from everyday life. A sufficient level was noted among 22.5% of participants: they were generally aware of pedagogical situations but did not always consider the individual needs of students or offered too general solutions. An average level was present among 33.3% of students: their answers to the tasks were vague, generalised or insufficiently structured. The lowest scores (34.2%) were recorded by participants who were unable to offer pedagogically sound solutions to the modelled situations or did not complete the task at all. This indicates a lack of practical readiness to implement the environmental component in real inclusive education.

The results of the value and motivational component, which was assessed based on the analysis of students' responses in the questionnaire using the Likert scale, were relatively higher than the other components. 21.7% of students had a high level: their answers showed a deep personal interest in environmental issues, awareness of the importance of responsible environmental management and a desire to integrate environmental issues into the educational process. Among respondents, 48.3% demonstrated an average level of positive attitude towards environmental education but showed uncertainty about personal readiness to implement it in pedagogical practice. A low level of motivation was present among 30.0% of students: their answers mostly reflected neutral or indifferent assessments, lack of pedagogical goal or personal environmental responsibility (Table 3).

Tab. 3

*Quantitative distribution of responses to the questionnaires on the Likert scale
(value and motivational component, n=120)*

No.	The wording of the question	1 – strongly disagree	2	3	4	5 – strongly agree	Average score
1	I believe that environmental education should be part of every lesson in primary school	6	12	29	41	32	3.6
2	I feel personally responsible for the state of the environment	8	15	30	35	32	3.5
3	I am ready to initiate environmental initiatives at school	13	17	39	31	20	3.1
4	I know how to develop environmental thinking in students	20	25	35	28	12	2.8
5	I am ready to change my behaviour following the principles of sustainable development	4	9	26	40	41	3.9

Source: compiled by the authors

The generalised results showed that the most problematic for the respondents were the cognitive and operational components, which reflects not only the lack of environmental content in educational training but also the limited practical orientation of students to implement inclusive environmental education. At the same time, the identified motivational potential of students can be the basis for the targeted formation of environmental competence in the context of further pedagogical influence.

As a result of the implementation of the formative pedagogical impact, qualitative changes in students' learning activities were recorded, which were manifested in a more conscious attitude to environmental issues, the ability to integrate environmental content into pedagogical products, as well as in the gradual acquisition of skills in adapting teaching materials to the needs of students with SEN. As such, 12 creative groups of 10 students were formed. As a result, 12 author's eco-projects were

created, the content of which covered environmental issues and accounted for the needs of children with various types of SEN, including hearing, visual, speech and intellectual disabilities. The students' works traced the dynamics from the reproductive reproduction of information to its meaningful processing and transformation into specific didactic scenarios. The projects on water conservation, waste sorting, and air pollution prevention included instructions for children with different types of disabilities (e.g., icons instead of text, audio, contrasting images, enlarged font, and symbolic designation of actions). The students demonstrated an increased understanding of the importance of sensitivity to the individual capabilities of students and the need for environmental education as part of their pedagogical responsibility. The projects were evaluated individually within each group. According to the results of the expert assessment (according to the criterion toolkit), in 79 cases out of 120 (65.8%) students, a high level of ability to plan and implement the educational process of environmental education with inclusive elements was recorded. 79 out of 120 students (65.8%) successfully implemented inclusive eco-projects, whereas 41 students (34.2%) demonstrated partial implementation or did not complete the projects.

The analysis of the products of students' learning activities confirmed the growth of their operational level. The analysis collected 24 adapted didactic developments, which included handouts, pair cards, board games, comic book templates, and instructions for interactive exercises. The students demonstrated not only the ability to transform environmental information following age-specific features but also the ability to choose effective forms of presenting knowledge for children with special educational needs. Enlarged graphic modules with contrasting colours were created for children with visual impairments, structured scenarios with repeating symbols for children with autism spectrum disorders (ASD), and game tasks with clear step-by-step instructions for students with developmental delays. Some of the assignments used QR codes with audio accompaniment, stickers-signals, and simple infographics. Most students (about 80%) independently included environmental literacy components that were not directly dictated by the task.

The effectiveness of the impact was also confirmed by the results of group interaction during eco-training. The students demonstrated the ability to work in teams and develop micro-campaigns for environmental change in the school environment, such as No Plastic in the Classroom, Green Walk to School, and One Water One Life. When discussing personal behavioural changes after the training, participants mentioned refusing to use unnecessary paper handouts, converting workbooks into digital format, and introducing a weekly "quiet hour without gadgets" as forms of environmental self-care. Overall, the results of the formative stage showed an increase in all three components of environmental competence. Quantitative changes were recorded in the results of the post-test assessment, but no less important was the identification of deeper changes in the content of the answers, in their inclusive sensitivity, emotional intensity and desire for the practical implementation of environmental knowledge in future teaching activities.

To study the impact of an inclusive educational environment on the formation of environmental competencies of future primary school teachers, the relationship between previous experience of interaction with inclusive education and the dynamics of changes in the components of environmental competence was analysed. Incorporating the data collected at the stages before and after the formative experiment, the correlations between the level of environmental knowledge, skills, attitudes and the availability of inclusive experience were determined. The analysis compared the results of two subgroups: students with experience of work (or practice) in an inclusive environment ($n=42$) and those who did not have such experience ($n=78$). The method of calculating Pearson's coefficients was used to establish the relationship between the above variables. As shown in Table 3, a moderate positive correlation was found between the experience of inclusive practice and the growth of environmental skills ($r=0.46$), as well as between the experience and the formation of a value attitude towards the environment ($r=0.39$). The lowest correlation was recorded in knowledge ($r=0.21$), indicating that direct experience of inclusive interaction mainly affects the practical and motivational components of environmental competence (Table 4).

Tab. 4

Correlation between the level of inclusive training and environmental competencies (n=120)

Parameter	The correlation coefficient, r
Inclusive experience ↔ Knowledge	0.21
Inclusive experience ↔ Skills	0.46
Inclusive experience ↔ Attitude	0.39

Source: compiled by the authors

To illustrate the interdependence between students' inclusive experience and the level of their environmental training, a diagram with a trend line was drawn, which demonstrates an overall positive trend (Figure 2). The graph shows that students with experience in inclusive education had higher scores in all three components of environmental competence compared to other sample participants.

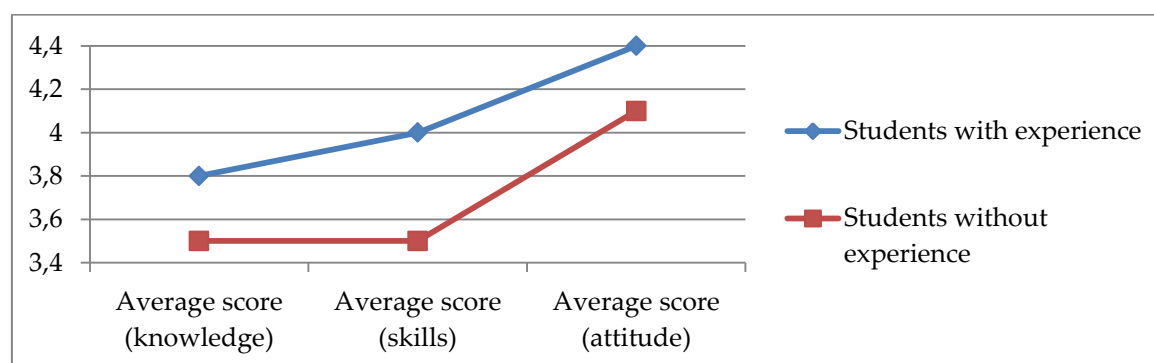


Fig. 2. Dependence of environmental competencies on inclusive experience

Source: compiled by the authors

The collected quantitative and qualitative results indicate a positive impact of inclusive experience on students' preparation for the integration of environmental topics into primary school teaching practice. To clarify the peculiarities of the formation of environmental competencies in different categories of students, a comparative analysis of the study results was carried out by gender and course of study. This approach identified potential differences in the assimilation of environmental content depending on the duration of pedagogical training and socio-psychological factors.

The comparison found that senior students (3-4th year) demonstrated higher average scores in all components of environmental competence (knowledge, skills, attitudes) compared to 2nd-year students. This correlated with the logic of accumulating pedagogical experience, including participation in internships, training, and project skills. Table 5 summarises the results by gender and year of study. Gender differences were less pronounced, but there were slightly higher scores among women in value-based attitudes towards environmental issues.

Tab. 5

Results of environmental competences by gender and course of study

Student category	Knowledge	Skills	Attitude
Females (n=98)	3.7	3.8	4.3
Males (n=22)	3.6	3.6	4.1
2nd year (n=46)	3.4	3.3	4.0
3rd year (n=42)	3.7	3.8	4.2
4th year (n=32)	3.9	4.0	4.5

Source: compiled by the authors

During the implementation of the formative stage of the study, several problems were identified that affect the effectiveness of the development of future primary school teachers' environmental competencies, especially in the context of inclusive education. The study of difficulties was carried out

by analysing students' open answers in the final questionnaire, reflective notes and the results of expert evaluation of individual and group tasks. The approach to the analysis was based on categorical interpretation and frequency counting of repeated answers.

One of the most common problems pointed out by the participants was the lack of confidence in the ability to adapt environmental educational material to the needs of children with special educational needs. Approximately 45% of students said they did not have a clear idea of pedagogical adaptation strategies in the environmental context. The second most common problem was the limited awareness of visual resources and digital tools that can be used to explain natural processes in an accessible way for children with hearing, visual or intellectual disabilities. Table 6 summarises the main difficulties recorded based on the content analysis of students' responses, indicating the proportion of respondents who indicated them.

Tab. 6

Student's difficulties in working with inclusive environmental content

Problematic aspect	Share of students (%)
Uncertainty in adapting materials	45.0
Lack of experience in creating inclusive teaching aids	31.7
Difficulty in explaining environmental concepts to children with SEN	28.3
Low digital literacy level	24.2
Difficulties in interpersonal interaction in an inclusive environment	21.7

Note: students could choose several answers. Percentages are calculated from the total number of respondents (n=120) separately for each item. Therefore, the total value exceeds 100%

Source: compiled by the authors

A general analysis of the identified difficulties has shown the need for targeted integration of an inclusive component into environmental education programmes for students of pedagogical specialities. The existing curricula are mainly focused on the general theoretical level of environmental training and do not provide sufficient tools for working in an inclusive classroom. To ensure a holistic view of the dynamics of students' environmental competence formation during the pedagogical experiment, the quantitative data were summarised in a summary table. Both the general dynamics in the sample and the comparative results of subgroups of students with and without experience of inclusive interaction were considered (Table 7).

Tab. 7

Summary table of input and output scores for environmental competence (n=120)

Metric	Total sample (before/after)	t-value / p-value	Subgroup with experience (before/after)	Subgroup with no experience (pre/post)	U-value/ p-value	Comment to changes
Know- ledge	2.8/3.6	t=3.91, p<0.01	2.9/3.9	2.7/3.5	U=1,201, p<0.05	Growth in both subgroups, is more pronounced in experienced
Practical skills	2.5/3.7	t=5.42, p<0.001	2.6/4.0	2.4/3.5	U=1,093, p<0.01	The greatest dynamics in the subgroup with practical experience
Attitude and motivation	3.4/4.2	t=4.25, p<0.01	3./4.4	3.3/4.1	U=1,176, p<0.05	Strengthening the motivational

						component in both subgroups
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Source: compiled by the authors

The results confirm the effectiveness of a systemic formative approach that combines environmental issues with elements of inclusive pedagogy. At the same time, the combination of the cognitive component with practice-oriented methods in the context of inclusive education contributes to better learning of the content and the development of a value-based attitude towards environmental issues.

During the control stage, significant changes in the level of students' environmental competence were recorded, which confirmed the effectiveness of the implemented pedagogical impact. The changes covered all three components of competence: cognitive, operational and value-motivational, showing different dynamics depending on the initial level of learning. The cognitive component showed a positive trend in the level of environmental knowledge: the average score increased from 2.8 to 3.6 on a five-point scale. Compared to the initial results, the proportion of students with low or very low levels (1-2 points) decreased from 43.4% to 15.9%, indicating a marked decrease in fragmented knowledge and an improvement in the systematic mastery of basic environmental concepts. Respondents' answers showed a deeper understanding of the concepts of sustainable development, biodiversity, ecosystem and global warming, and fewer common mistakes were made in interpreting complex inter-conceptual relationships. The ability to make generalisations, analyse cause and effect relationships, and provide reasoned arguments for the importance of environmental issues in primary education has increased. In the test tasks, the highest increase in the proportion of correct answers was recorded for the topics of "sustainable development" (+18.3%), "ecosystem" (+15.0%) and "sources of air pollution" (+14.2%).

The most dynamic growth was recorded in the operational component: the average score increased from 2.5 to 3.7. The proportion of students who demonstrated a high level of practical skills increased to 26.7% (previously 10.0%), and a sufficient level to 35.8% (previously 22.5%). At the same time, the number of students with an average level decreased to 24.2%, and with a low level to 13.3% (previously 34.2%). Significant improvements were recorded in the skills of adapting environmental content to the special educational needs of students: 80% of students introduced elements of inclusiveness into didactic materials, including the use of icons, audio, visual scenarios, cards with graphic coding and simple infographics. According to the results of the expert evaluation, 65.8% of students were able to design and implement inclusive eco-projects independently, which was 52.5% higher than the initial level.

The value and motivational component recorded an increase in the indicators of students' internal environmental orientation. The average score increased from 3.4 to 4.2 on a five-point scale. The proportion of students with a high level of attitude to environmental values increased from 21.7% to 42.5%, which indicates an increase in personal motivation and awareness of the importance of environmental issues. The share of students with an average level remained relatively stable, decreasing slightly from 48.3% to 44.2%. At the same time, the proportion of respondents with a low level of motivation decreased from 30.0% to 13.3%, which indicates the effectiveness of the formative impact on raising the environmental awareness of future teachers. To illustrate the positive dynamics of changes, a graph was drawn, which shows an increase in the average score for all components of environmental competence before and after the formative stage (Figure 3).

The graphical interpretation of the results confirmed the presence of a clear positive trend in the formation of all components of environmental competence. The greatest growth was noted in the operational component, which reflected an increase in the level of readiness for the practical implementation of environmental content in inclusive education. At the same time, the growth of cognitive and value-motivational indicators showed the systematic assimilation of theoretical knowledge and the deepening of personal attitudes towards environmental issues. The generalised dynamics of the results indicated the high effectiveness of the formative stage as a comprehensive pedagogical intervention that ensured the holistic strengthening of all elements of future primary school

teachers' environmental competence.

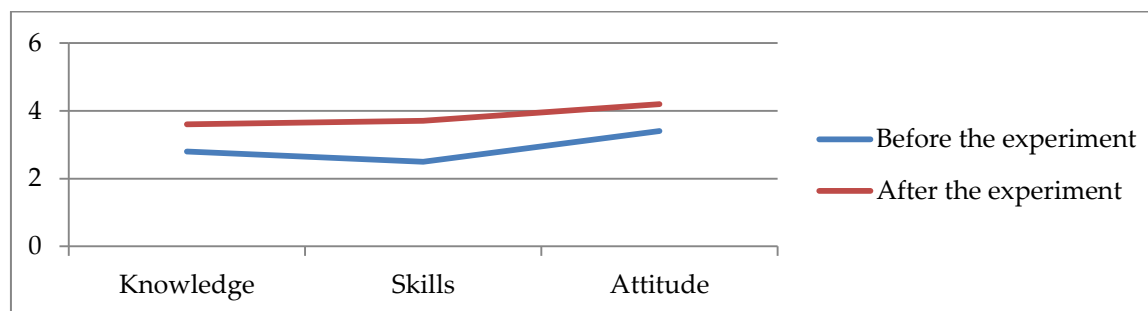


Fig. 3. Increased average score in environmental knowledge, skills and attitudes

Source: compiled by the authors

The study results confirmed the efficiency of combining environmental issues with an inclusive approach in the training of future primary school teachers. The increase of indicators for three components of environmental competence – cognitive, operational and value-motivational – indicated the effectiveness of the formative impact, which is consistent with previous international developments. The data on the improvement of environmental knowledge after the pedagogical intervention coincided with the findings of Muñoz-Losa et al. (2025), reported an increase in the level of environmental awareness of future teachers after completing sustainability-oriented programmes. As in the study conducted at the Kyrgyz State University named after I. Arabaev, the growth of the cognitive component was accompanied by an increase in student's involvement in environmental issues.

Operational competence, which covered the practical implementation of environmental knowledge in an inclusive context, showed the highest dynamics. This was in line with the position of Vesterinen and Ratinen (2024), who emphasised the key role of actionable competence in education for sustainable development. The increase in student's ability to adapt materials to meet inclusive needs found in the study confirmed the importance of practice-oriented approaches. The value and motivational component also underwent positive changes, which correlated with the results of Vesterinen (2024), who emphasised the importance of the value dimension in the environmental education of primary school students. The study determined that students began to identify themselves as subjects of environmental impact, which was consistent with the findings on the formation of pedagogical environmental responsibility.

The correlation between the presence of inclusive experiences and the growth of environmental skills ($r=0.46$) and attitudes ($r=0.39$) confirmed the importance of an inclusive environment as a condition for the development of competencies. A similar conclusion is presented in the analytical review by Liu and Potmesil (2024), which proved that the involvement of students in inclusive practice has a positive impact on the depth of professional competencies, in the field of values and interpersonal interaction. In the context of the vision of the future inclusive school, the results of the study were consistent with the findings of Nikula et al. (2024), where special education students shared the idea of the need for flexibility, ethics and environmental responsibility. The high level of empathy and pedagogical reflection recorded in students confirmed the effectiveness of the value-based approach to the formation of inclusive environmental competence. The applied approach combined quantitative and qualitative analysis, which corresponded to the methodology of Cohen et al. (2017) and provided a holistic understanding of changes in the educational environment. The use of diagnostic tools, assessment of dynamics and comparison with qualitative observations ensured the integrity of the findings.

The results of the study also correlated with the pan-European trend of integrating environmental education into teacher education. As noted by Vesterinen and Ratinen (2024), effective models of sustainable competence development require a combination of interdisciplinary content, action, and reflection, and these elements were included in the author's formative programme. Along with the

positive dynamics, several difficulties were identified: uncertainty in adapting teaching materials (45%), low level of digital literacy (24.2%), and lack of experience in creating inclusive didactic tools (31.7%). These difficulties indicated a systemic lack of preparation for inclusive environmental education, which has also been identified in other studies. For example, Navas-Bonilla et al. (2025) highlighted the lack of technological solutions to ensure the accessibility of environmental content for students with SEN.

The identified difficulties for students in adapting environmental content to an inclusive environment were consistent with the findings of Kruty et al. (2024). The study determined that the process of professional training of teachers requires increased attention to psychological competence, in the context of working with children with special educational needs. This was also confirmed in the current study: students pointed to psychological barriers and lack of confidence in interpersonal interaction as one of the main challenges of inclusive teaching of environmental topics. The importance of a global approach to the formation of pedagogical competencies, which involves the integration of content, culture and technology, was confirmed by van Werven et al. (2023). The comparative study emphasised the importance of adaptability, intercultural sensitivity and inclusive thinking as components of global competence. The data obtained in the Kyrgyz context on the growth of students' ability to adapt and consider the individual needs of students in eco-projects indicated the formation of such qualities within the framework of an educational intervention.

The results obtained after the implementation of the formative stage indicated the high effectiveness of an interdisciplinary approach that combined environmental content, digital tools and inclusive methods. A similar model of training was proposed by Riastini et al. (2025), arguing that successful primary teacher education in the twenty-first century should include the integration of content, culture, and technology. The involvement of digital tools (infographics, icons, audio recordings, QR codes) in project activities by students showed an increase in digital flexibility, which is a key element of modern inclusive pedagogy. Luo and Li (2024) proved that inclusive pedagogy based on evidence-based practices increases the overall professional competence of teachers. The study addressed the implementation of adaptive pedagogical strategies in student learning. These conclusions coincided with the results found in the present study: students successfully implemented 65.8% of inclusive eco-projects, which indicated the effectiveness of the formative component in terms of inclusive professional training.

Another aspect of institutional support for an inclusive approach is revealed in the study by Shoaib et al. (2024). The study emphasised the relationship between the educational environment, the level of teacher training and the readiness of students to implement inclusive education. Our study confirmed these trends: students with inclusive experience showed significantly higher results in adapting environmental material ($r=0.46$ for skills; $r=0.39$ for attitudes), indicating the importance of the organisational environment of the educational institution and practical experience. Confirmation of the importance of inclusive environmental education as a factor of equality and pedagogical empowerment of students was presented in the study by Pradhan and Naik (2024). The study emphasised that inclusive education creates conditions for equal access to knowledge and promotes the formation of pedagogical ethics.

The positive dynamics in the introduction of digital and multimedia tools in students' project activities correlated with the findings of Zhang and Zhang (2024), emphasising the transformative potential of artificial intelligence and digital technologies in supporting inclusive learning. The use of audio, icons, graphic scripts and QR codes in student development demonstrated the acquisition of digital flexibility, which is a prerequisite for modern inclusive pedagogy. In terms of attitudes towards inclusion, the results of the study, in which students with experience demonstrated a higher level of empathy and pedagogical responsibility, were consistent with the systematic review by Lindner et al. (2023). The review emphasised that teachers' positive attitudes towards inclusive education are shaped by practical experience, not just theoretical training. A similar relationship was confirmed by the correlation found between the experience of interaction with children with SEN and the level of

development of the motivational component. The study by Alvarez-García et al. (2018) highlighted the fragmentation of environmental training among students of pedagogical specialities. A similar problem was identified at the ascertaining stage of the current study, where the proportion of students with a high level of cognitive environmental competence was only 6.6%. This confirmed the relevance of targeted strengthening of the environmental component in the content of primary school teacher training.

The results of the study were also consistent with the approach proposed in a systematic review by Li and Ruppert (2020), identifying the concept of “teacher agency” as a key factor in inclusive pedagogy. The successful implementation of inclusive eco-projects by students showed signs of professional agency, including initiative, responsibility, and the ability to adapt educational content. The study highlighted the emotional and value components. This correlated with the findings of Rajendran et al. (2020), proving the importance of emotional intelligence in preparing for inclusive education. The increase in the level of pedagogical reflection, empathy and awareness of the role of the teacher as a carrier of values was an indicator of the formation of such qualities among the students of the study sample.

The analysis of students’ perceptions of sustainability and the future of environmental education, carried out during reflective self-assessment, correlated with the data of Yli-Panula et al. (2025), identifying critical distrust of students in rapid changes in the field of sustainable development without a significant revision of teaching methods. A similar sceptical attitude was manifested in some students’ responses to existing programmes that do not integrate inclusive and environmental content. The study by Abdulah and Mahmud (2025) noted that the development of inclusive competencies of mathematics teachers remains insufficient without the inclusion of real-life cases and examples. The same was observed in the study: only practical work with the adaptation of didactic materials, development of cases and inclusion in modelled situations changed qualitative dynamics.

Confirmation of the effectiveness of collaborative approaches to the formation of an inclusive culture was recorded by Lakkala et al. (2021), who analysed cases of interprofessional support for teachers in European schools. By a similar logic, the eco-trainings conducted as part of the formative stage created an environment that promoted teamwork, dialogue, and mutual professional enrichment among students. The generalised results of the study show that effective training of future primary school teachers should be based on the integration of environmental content, inclusive practice, digital technologies and emotional and value-based training. Comparison with international research has given grounds to consider the tested model effective and relevant to global approaches to inclusive sustainability in education.

4. CONCLUSIONS

The generalised data underlines the need to improve the content of teacher training through the targeted integration of inclusive and environmental education components. Although the study was conducted in the Kyrgyz Republic, its findings have broader international relevance because teacher education systems in different countries face a common challenge of simultaneously strengthening education for sustainable development and preparing teachers for inclusive classrooms. The proposed approach is not dependent on a specific national curriculum and can therefore be adapted to different educational contexts by modifying environmental topics, inclusive teaching strategies, and learning materials in accordance with national standards and the needs of local student populations.

The practical significance of the study is the creation of a basis for the introduction of innovative approaches to the formation of environmental competence in an inclusive context. It is recommended to introduce interdisciplinary modules, create electronic platforms with examples of adapted materials, and improve the criteria for assessing the environmental training of future teachers in real-life school inclusion. In other countries, the developed model can be used as a framework for designing or revising

teacher-training programmes that combine environmental education with inclusive pedagogy. Higher education institutions may adapt the formative activities, eco-projects, case studies, and SEN-oriented teaching materials to their own cultural, environmental, and institutional conditions. The three-component assessment framework covering cognitive, operational, and value-motivational dimensions can also be applied in cross-national or comparative studies to evaluate the effectiveness of similar interventions. Thus, the study provides a transferable methodological basis for strengthening teachers' readiness to address both sustainability and educational inclusion, while allowing national adaptation rather than requiring direct replication of the Kyrgyz model.

Among the limitations of the study are the geography of the sample (one higher education institution), the short duration of observation without assessing long-term changes in the professional activities of graduates, and the partial subjectivity of students' self-reports. Promising areas for further research include expanding the sample, involving external experts in the evaluation, using digital analytics, and assessing the impact of the inclusive approach on the development of other key competencies of teachers. Future international studies could additionally test the proposed model in countries with different teacher-education systems and compare its effectiveness across socio-cultural and educational contexts, which would make it possible to determine which elements are universally applicable and which require country-specific adaptation.

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Чалданбаева Айгуль, Азанбекова Гульназ, Сейтимбетова Салтанат, Мамекова Ассем, Шмідт Марія. Формування екологічних компетентностей майбутніх учителів початкової школи в умовах інклюзивної освіти. *Журнал Прикарпатського університету імені Василя Стефаника*, **13** (3) (2026), 186-203.

Метою дослідження було виявлення особливостей розвитку екологічної компетентності студентів педагогічних спеціальностей у контексті інклюзивного освітнього середовища в Киргизькій Республіці. Дослідження проведено в Киргизькому державному університеті імені І. Арабаєва за участю 120 студентів 2–4 курсів, які навчаються за спеціальністю «Початкова освіта». Застосовано метод педагогічного експерименту з попередньою та підсумковою діагностикою, а також кількісний і якісний аналіз результатів. Встановлено, що рівень сформованості екологічних компетентностей до початку експерименту переважно перебував на середньому або нижчому рівні (середній бал за когнітивним компонентом становив 2,8 за п'ятибальною шкалою, за операційним компонентом – 2,5, за ціннісним компонентом – 3,4). Після впровадження формувального впливу, що передбачав поєднання екологічного змісту та інклюзивних методів, студенти експериментальної групи продемонстрували суттєве зростання всіх показників: рівень знань підвищився до 3,6 бала, умінь – до 3,7, а ціннісного ставлення – до 4,2. У контрольній групі зафіксовано лише незначне підвищення показників без статистично значущих змін. Під час аналізу впливу інклюзивного досвіду виявлено кореляційний зв'язок між наявністю такого досвіду та зростанням екологічних умінь ($r = 0,46$) і ціннісних ставлень ($r = 0,39$). Серед основних труднощів, з якими стикалися студенти, були невпевненість в адаптації навчальних матеріалів (45%) та нестача цифрових інструментів (24,2%). Узагальнені дані підкреслюють необхідність удосконалення змісту підготовки шляхом інтеграції компонентів інклюзивної та екологічної освіти. Практична значущість дослідження полягає в можливості його використання для вдосконалення освітніх програм шляхом поєднання екологічної проблематики з інклюзивною підготовкою.

Ключові слова: освіта, сталий розвиток, діти з особливими освітніми потребами, освітній процес, підготовка вчителів.

Appendix

Tools for diagnosing the environmental competence of students of pedagogical specialties

Questions	Answer options
1. Standardised test to assess the cognitive component (knowledge)	
What does the term “sustainable development” mean?	a) Continuous economic growth b) Balance between meeting the needs of present and future generations c) Implementation of the latest technologies
Which of the following energy sources is renewable?	a) Coal b) Natural gas c) Sunlight
What is biodiversity?	a) The number of people in an area b) The variety of life forms on the planet c) The level of CO ₂ emissions
What is an example of reusing materials?	a) Incineration of plastic b) Handing in paper for recycling c) Burying waste

Which statement is true about global warming?	a) It reduces rainfall in the tropics b) It is caused exclusively by natural factors c) It is associated with an increase in the concentration of greenhouse gases
What is an ecosystem?	a) All living organisms on the planet b) An interconnected system of living organisms and their habitats c) Urbanised area
What is the name of the water cycle?	a) Deposition b) Hydrological cycle c) Filtration
Which of the following solutions reduces air pollution?	a) Use of petrol cars b) Switching to electric transport c) Burning leaves
What does the green colour on the bin mean?	a) Biological waste b) Paper c) Glass
What is the “supply chain”?	a) Consistency of resource use b) Sequential relationship between organisms in nutrition c) Nutrition in the field
2. Self-assessment questionnaire (Likert scale 1-5) (Scale: 1 – strongly disagree, 5 – strongly agree)	
I believe that environmental education should be part of every lesson in primary school.	
I feel personally responsible for the state of the environment.	
I am ready to initiate environmental initiatives at school.	
I know how to develop environmental thinking in students.	
I am ready to change my behaviour in accordance with the principles of sustainable development.	
3. Contextual pedagogical tasks (operational component)	
Situation: There is a child with a hearing impairment in the class. You are teaching the topic “The Water Cycle in Nature” (Goals include Describe how you will explain the material using visuals and alternative media)	
Situation: Children need to learn the rules of waste sorting. One student has intellectual disabilities (Goals include Offer adapted instructions or a game)	
Situation: You need to conduct an environmental game with elements of interaction in an inclusive classroom (Goals include Offer adapted instructions or a game)	
Situation: You need to conduct an environmental game with elements of interaction in an inclusive classroom (Goals include Provide an example of an assignment that will be available to all students)	
Situation: You are developing a mini-project on the topic “Clean Air, Healthy Planet” (Goals include How to integrate sensory or multimedia tools for students with autism spectrum disorders?).	
Situation: A lesson on the topic of the schoolyard ecosystem (Goals include Develop two questions for students who have difficulty expressing themselves in writing)	

Source: compiled by the authors