

Integration of environmental and inclusive education in the professional training of primary school teachers

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Abstract. The aim of the study was to identify the specific features, challenges and prospects for developing environmental competence in future primary school teachers at the Arabaev Kyrgyz State University. The research methodology was based on a mixed-methods approach and included a formative experiment conducted at the university with the participation of 50 students (experimental and control groups), as well as a comparative analysis of questionnaire results before and after the implementation of a 36-hour specialised programme. The study identified the level of students' environmental knowledge and skills, as well as the most effective pedagogical approaches and models contributing to the development of their readiness for environmental education of all categories of learners. Within the framework of the study, the dynamics of responses from the experimental and control groups were analysed to assess the impact of the developed programme on the formation of environmental literacy, attitudes towards inclusive education and readiness for inclusive practice. The findings demonstrated a significant positive shift in the experimental group: understanding of deep-seated environmental issues improved (increase of up to +12%), the frequency of demonstrating environmentally responsible behaviour rose (increase of up to +12%), a more positive attitude towards inclusion was formed (+32%), and self-assessed readiness to work in an inclusive context increased substantially (+56%). Analysis of the experimental group students' feedback revealed key positive aspects of the programme, such as the practical adaptation of visual materials, the development of tiered tasks, lesson modelling and the exploration of technical support tools. Among the suggestions for improvement, students highlighted the need for more practical work with children with disabilities, the necessity of internships in inclusive classrooms and a greater number of examples of adapted lessons. The data attest to the effectiveness of the developed programme in fostering key competencies of future teachers for inclusive environmental education. The findings contribute to the enhancement of educational programmes and methodological support for teacher training

Keywords: children's individual characteristics; adaptation; equal opportunities; children with disabilities; interactive sessions

INTRODUCTION

The current stage of societal development is characterised by an increase in global environmental problems, which necessitates the cultivation of a high level of environmental culture and a responsible attitude towards the environment in the younger generation. Primary school lays the foundation for environmental worldview and behaviour, which determines the importance of teachers' professional readiness to address these tasks. Concurrently with the environmental imperative, the educational landscape is actively evolving towards inclusion. The recognition of every child's right to quality education, irrespective of their individual characteristics and needs, makes it necessary to train

teachers capable of working effectively with diverse groups of learners, including children with disabilities (CwD).

The study of the formation of environmental competencies in future teachers, as well as the integration of an inclusive approach into teacher education, are areas that have attracted the attention of many researchers. V. Singh & A.K. Prajapati (2021) concluded that inclusive education entails creating an educational environment that ensures equal opportunities for the development and learning of all children, taking into account their uniqueness and needs, pointing out that co-education promotes the development of empathy, tolerance and collaborative skills.

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A.A. Adieva *et al.* (2025) believe that training teaching staff capable of integrating environmental education into the inclusive educational process is an important condition for ensuring the country's sustainable development and the social integration of all its citizens. The authors identified obstacles preventing teachers from integrating environmental education into the inclusive process, and also determined potential opportunities and resources to support this process. O. Mapako (2025), studying the formation of environmental competencies in primary school teachers in the context of inclusive education, argues that future teachers must possess methods for adapting environmental content and tasks for learners with various needs, as adaptation is important when teaching in an inclusive environment.

Researchers in the field of forming environmental competencies in future teachers, L. Oliveira *et al.* (2024), laid the foundations for the theory and methodology of environmental education in a pedagogical higher education institution, which include ecology as a science, the basics of natural history and nature conservation. In their conclusions, the authors defined the content of environmental knowledge, skills and values necessary for future teachers, and identified methods for cultivating students' environmental culture. The issues of environmental worldview and environmental responsibility in future teachers were investigated by N.N. Abdulah & M.S. Mahmud (2025), emphasising the importance of forming not only knowledge, but also deep convictions, value orientations and readiness for environmentally responsible behaviour. D. Nimante & M. Kokare (2022) proposed a model of teacher environmental competence and assessed the level of its development. As a result, the authors proved the necessity of forming holistic competencies enabling teachers to effectively solve professional tasks in the field of environmental education.

Research in the field of inclusive education and preparing teachers to work in an inclusive environment was conducted by F. İşcen-Karasu & D. Kayahan-Yüksel (2023), whose conclusions substantiated the need to create an accessible and supportive educational environment for all children, highlighting the importance of an individualised approach, collaboration between specialists and parents, as well as the specialised training of teachers to work in inclusive classrooms. A significant contribution to the development of the concept of inclusive education and the study of practical aspects of its implementation was made by A.T. Kebede, T.N. Phasha (2024). In the findings of their work, the authors focused on creating an inclusive culture in schools, developing inclusive pedagogy and using effective teaching strategies. However, the analysis of existing research has shown that insufficient attention has been paid to the issues of forming comprehensive environmental competencies in future primary school teachers specifically in the context of inclusion. Such aspects as the following remain underexplored: the development of specific methods and technologies for effectively integrating environmental education into the inclusive educational process; consideration of the individual characteristics of children with

disabilities when organising environmental activities; and the most effective forms and methods in an inclusive context.

Accordingly, the aim of this work was to analyse aspects of environmental competence development in future primary school teachers within the context of inclusion. To achieve this aim, the following objectives were set: to examine scientific approaches, models, and pedagogical technologies for fostering environmental competence in educators under inclusive education conditions; to identify the level of environmental competence development among students at I. Arabaev Kyrgyz State University and their understanding of inclusive education within an environmental context; and to determine the factors that facilitate the effective formation of environmental competence in future primary school teachers.

MATERIALS AND METHODS

The study employed a mixed-methods approach, combining qualitative and quantitative methodologies. This allowed for a comprehensive investigation of the students' level of environmental competence development and the specific features of its manifestation within the context of inclusive education. An analysis of works by C. Zalla & K. Yates (2021), M. Badawieh *et al.* (2024), and K.U. Alieva & A.S. Ismailova (2024) on the issues of environmental education, inclusive teaching, and teacher training was carried out to identify the content and structure of future teacher preparation.

The investigation into the level of environmental competence development under inclusive education conditions was conducted at I. Arabaev Kyrgyz State University from December 2024 to March 2025. It involved 50 third-year students (specialising in "Pedagogy and Methodology of Primary Education") aged up to 23 years (mean age – 21.5 years; 33 females and 17 males). Using random assignment, the participants were divided into an experimental group (EG) and a control group (CG), each comprising 25 individuals. The selection was based on voluntary written consent; individuals who violated the protocol, missed sessions, or withdrew their consent during the experiment were excluded from the sample. The procedure complied with ethical standards (National Health and Medical Research Council, 2007), ensuring anonymity and the right to withdraw from participation without any consequences. The dynamics of environmental literacy were assessed using an 8-item questionnaire (Table 1) administered before and after the experiment. The analysis of results was based on comparing the questionnaire responses (questions No. 1-2 – literacy, No. 5 – attitude towards inclusion, No. 6 – readiness, No. 7-8 – conditions for implementation) using descriptive statistics and qualitative synthesis. The formative face-to-face practical course (36 hours: 10 hours of theory, 16 hours of practice) for the EG focused on inclusion theory and laboratory practice in material adaptation. The CG underwent traditional training of an equivalent volume. Upon completion of the course, the EG students participated in a 4-item survey on the effectiveness of the training (Table 2).

Table 1. Questionnaire for assessing the level of environmental literacy

No.	Question	Answer option
1	What major environmental problems are you aware of? (Select no more than three)	a) environmental pollution (air, water, soil) b) climate change (global warming, greenhouse effect) c) biodiversity loss (extinction of plant and animal species) d) depletion of natural resources (shortage of water, minerals, forests) e) the waste problem (household, industrial) f) other (please specify)
2	Provide examples of environmentally responsible behaviour. (Select all applicable options)	a) resource conservation (water, electricity, heating) b) waste sorting and disposal c) responsible consumption (choosing eco-friendly goods, avoiding excess) d) care for nature (not littering, not harming plants and animals) e) participation in environmental campaigns and events f) environmental education of others g) other (please specify)
3	How can environmental activities involving children with diverse educational needs be organised? (Select all applicable answers)	a) individualisation of tasks, taking into account each child's pace and abilities b) use of hands-on work, games, observations, and various creative activities c) adaptation of materials (simplified texts, use of visual supports) d) work in small groups/pairs, taking into account different levels of preparedness e) creation of a supportive and safe environment f) organisation of excursions and hands-on activities in nature with due regard for accessibility g) use of information and computer technologies with adaptive capabilities h) involvement of specialists (special education teachers, psychologists) for consultations i) other (please specify)
4	What methods and techniques can be used to adapt environmental materials for children with SEN (Special Educational Needs)?	a) use of large font and clear illustrations b) provision of information in various formats (text, audio, video) c) use of visual materials (schemes, tables, pictures) d) simplification of instructions and texts, avoidance of metaphors and abstractions e) use of visual aids and hands-on tasks f) ensuring accessibility of the workplace and materials g) provision of additional time to complete tasks h) use of alternative assessment methods i) other (please specify)
5	Do you believe that environmental education can be effectively implemented in an inclusive classroom?	a) yes, absolutely b) probably yes c) probably no d) no, it is difficult e) I find it difficult to answer Open-ended response for obtaining qualitative data on motivation
6	How prepared do you feel to work with children with SEN within the context of environmental education?	a) prepared b) not fully prepared, lack knowledge c) unprepared d) lack practical experience
7	What difficulties might arise when implementing environmental education in an inclusive classroom? (Select all that you agree with)	a) insufficient foundational knowledge in natural sciences and ecology among children with SEN b) theoretical overload and lack of hands-on activities adapted for different needs c) teachers' insufficient mastery of inclusive environmental education methodologies d) difficulties in selecting and applying effective methods of teaching ecology to different categories of children e) lack of modern equipment, laboratories, and adapted materials f) lack of time for individual work with each child g) difficulties in interaction between children with different educational needs h) other (please specify)
8	What conditions are necessary for the successful implementation of environmental education in an inclusive classroom? (Select all applicable options)	a) adaptation of materials and teaching methods to accommodate different needs b) provision of an accessible educational environment (physical, informational) c) availability of necessary resources and equipment, including adapted materials d) flexibility and individualisation of the approach to teaching each child e) creation of a positive and supportive classroom climate (acceptance, support) f) support from and collaboration with specialists (special education teachers, psychologists) g) trained teachers (knowledge, skills in inclusion and environmental education) h) collaboration with parents (legal representatives) of children with SEN i) other (please specify)

Source: compiled by the author

Table 2. Questionnaire for determining the effectiveness of the programme in the experiment and students' readiness to work with children with SEN

No.	Question	Answer option	Question type
1	What new knowledge did you gain during the experimental programme?	Own answer	Open-ended
2	Which aspects of the programme were most useful to you?	Own answer	Open-ended

Table 2. Continued

No.	Question	Answer option	Question type
3	Which aspects of the programme could be improved?	Own answer	Open-ended
4	How would you rate your level of readiness to work with children with SEN within the context of environmental education after completing the programme?	a) ready b) rather ready c) not ready d) rather not ready	Closed-ended

Source: compiled by the author

The analysis of responses combined qualitative methods for examining students' detailed opinions and quantitative methods for summarising and presenting data from closed-ended questions, as well as the frequency of mentions in open-ended responses. To interpret the answers to questions No. 1-3, thematic analysis was applied with the aim of identifying key themes, ideas, and patterns within the students' extended responses. In order to determine the most prevalent opinions, the number of times specific themes or particular statements occurred in the students' answers was calculated. To summarise the responses to question No. 4, methods of descriptive statistics were employed, including the calculation of absolute and relative frequencies (percentages): determining the number and proportion of students who selected each response option.

RESULTS

Primary school constitutes the foundation for cultivating a caring attitude towards nature, the cornerstone for integrating environmental themes into the educational process. Within the framework of inclusive education, in a classroom where children with diverse educational needs learn together, environmental education assumes particular

importance. It not only imparts knowledge about nature but also fosters the development of social skills, the capacity for empathy, and a sense of responsibility. Inclusive education represents an educational philosophy aimed at establishing equitable learning conditions for all pupils, including those with special educational needs. The essence of this approach lies in the joint education of all children in mainstream educational settings, irrespective of their individual differences, be they physical, cognitive, social, emotional, linguistic, or other characteristics (Chhetri, 2025). The goal of inclusive education is not merely the mechanical placement of children within the same classroom, but the creation of an educational environment that accommodates the needs of each child, promotes their development and social integration, and cultivates in all learners a tolerant and respectful attitude towards differences. Ecology lessons in such a classroom help children to interact more effectively, teach them to work collaboratively, to consider the opinions of others, and to care for the surrounding world. Inclusive education, with its key principles – equity, accessibility, participation, and respect for the individuality of every child – creates a distinctive platform for developing environmental competencies in future teachers (Table 3).

Table 3. Principles of inclusive education and their connection to environmental competencies

Title	Description
Principle of equity	Requires consideration of the educational needs of all pupils, including those with special educational needs. Consequently, the process of developing environmental knowledge, skills, and convictions must be adjusted to account for the diversity of learners' perception levels and potential.
Principle of accessibility	Requires the creation of an educational environment in which every child can actively participate in the learning process, including environmental activities. This may involve the use of diverse methods and forms of work, the application of assistive technologies, and individual educational pathways.
Principle of participation	Underscores the importance of involving all learners in the educational process. In the context of environmental education, this means creating opportunities for collaborative research activities, project work, and discussion of environmental problems, which contributes to the development of communicative and social competencies alongside environmental ones.
Principle of value	Focuses primarily on the individuality of each learner and the necessity of considering their personal characteristics in the process of developing environmental awareness and a caring attitude towards the environment.

Source: compiled by the author based on M. Badawieh *et al.* (2024)

Environmental competencies constitute a complex of an individual's knowledge, skills, values, and attitudes that enable them to interact effectively with the environment, make environmentally responsible decisions, and carry out activities aimed at preserving nature and ensuring sustainable development. In other words, this is what a person knows, can do, and how they relate to issues of ecology and environmental protection, as well as their readiness and ability to act in accordance with environmental principles (Alieva & Ismailova, 2024). In the context of education, the environmental competencies of future teachers include

methodological competencies: the ability to organise and conduct lessons on environmental topics, taking into account the individual and age-related characteristics of pupils; the use of diverse methods and forms of work; and the assessment of the level of development of environmental knowledge and skills. It is worth noting that environmental competencies form an integrated system that allows an individual to be an environmentally literate, responsible, and active member of society.

Within the professional training of future teachers, three key components of environmental competencies

have been identified: the cognitive component – encompasses environmental knowledge (fundamental ecological concepts, laws of nature, the impact of human activity on the habitat, principles of sustainable development), an understanding of interconnections within ecosystems, and an awareness of environmental problems at regional, national, and global levels. The operational-activity component presupposes environmental skills and abilities, such as observing natural objects and phenomena, conducting simple environmental investigations, participating in nature conservation actions, and cultivating environmentally appropriate behaviour in everyday life and professional activity. It also includes methodological skills for organising environmental education for primary school children, particularly taking into account their special educational needs. The value-motivational component reflects the future teacher's environmental values, convictions, and attitudes, their responsibility for the state of the environment, their readiness for environmentally oriented professional activity, and their motivation to foster environmental culture in primary school children. This component also includes empathy towards living beings and an understanding of the importance of biodiversity conservation.

The formation of environmental competencies in future primary school teachers within the context of inclusive education is underpinned by a number of psychological theories. Albert Bandura's social learning theory (McLeod, 2025) has been advanced, which highlighted the importance of learning through observation and modelling, this being particularly effective in the development of environmental responsibility. Gardner's theory of multiple intelligences (Cherry, 2025) takes into account the diversity of learners' abilities and aptitudes. This theory enables the development of differentiated approaches to forming environmental competencies, taking into account the individual needs of children with disabilities. It is noteworthy that of particular importance for environmental education in inclusive settings is the concept of Universal Design for Learning, which proposes flexible approaches to teaching and accommodates the diversity of learners' needs, as well as ensuring equal access to education. Pedagogical science and practice have accumulated significant experience in the field of forming environmental competencies in future teachers. The analysis of existing models and approaches allows for the identification of several key directions and the determination of their potential and limitations in the context of inclusive education (Table 4).

Table 4. Models and approaches to developing environmental competences in education

Designation	Description	Advantages	Limitations in the context of inclusion
Subject-Centred Approach	Focuses on transmitting a system of environmental knowledge to students within discrete academic disciplines (e.g., biology, geography, chemistry). Environmental aspects are integrated into the content of these subjects.	Provides a robust theoretical foundation; fosters a systemic understanding of ecological processes and phenomena.	May prove insufficiently adapted to the diverse educational needs of students, particularly those with special educational needs. Additional methodological work on differentiation and individualisation of instruction is required. Does not always ensure the development of practical skills and a value-based attitude towards nature.
Interdisciplinary Approach	Involves integrating environmental issues into the content of various academic disciplines (not only natural sciences but also the humanities and socio-economic fields).	Promotes a holistic view of environmental problems, demonstrates their interconnectedness with various spheres of human activity, and develops systemic thinking.	Requires a high level of coordination among instructors from different disciplines. Developing integrated tasks and projects that accommodate diverse educational needs can present considerable difficulty.
Activity-Based Approach	Aims at the active participation of students in practical environmental activities: field research, environmental projects, volunteer initiatives, and the development of methodological materials for the environmental education of schoolchildren.	Facilitates the formation of practical abilities and skills, fosters initiative and responsibility, and enhances motivation to study ecology. Aligns well with the principles of inclusive education by allowing the forms and types of activities to be adapted to students' varying capabilities.	Requires meticulous organisation of practical activities, ensuring accessibility of the environment and materials for all students, and the design of differentiated tasks that account for varying levels of preparedness and ability.
Competence-Based Approach	Oriented towards developing not only students' knowledge but also their ability to apply it in professional practice to solve environmental problems. Identifies the key environmental competences essential for a future teacher.	Clearly defines learning objectives in the form of specific competences, ensures the link between theoretical preparation and practical activity, and enables the assessment of the level of environmental competence development.	Requires the development of diagnostic instruments and assessment tools that consider the diversity of students' educational needs. It is necessary to design an educational process that supports competence development at varying levels of complexity.

Table 4. Continued

Designation	Description	Advantages	Limitations in the context of inclusion
Socio-Ecological Approach	Emphasises the interconnection between social and environmental problems; cultivates in students an understanding of the social conditioning of ecological crises and the necessity of societal participation in resolving them.	Develops civic responsibility, forms readiness to participate in solving environmental problems at various levels, and promotes an understanding of the importance of inclusive approaches in environmental activity (engaging all members of society, including people with special educational needs).	May require additional training for instructors in the fields of social pedagogy and inclusive interaction. It is necessary to create conditions for the participation of all students in socio-ecological projects, taking into account their capabilities.
Pedagogy of Sustainable Development	Develops in future teachers an understanding of the principles of sustainable development and the ability to integrate them into the educational process. Particular attention is paid to issues of social justice, economic well-being, and environmental sustainability.	Forms a systemic, future-oriented worldview; promotes the development of critical thinking and the capacity for responsible decision-making. The inclusive dimension can be integrated through the examination of issues related to the accessibility of education and resources for all members of society.	Requires deep integration of sustainable development principles into curricula and programmes. Developing learning materials and tasks that accommodate diverse educational needs within the context of sustainable development can be a challenging undertaking.

Source: compiled by the author based on C. Zalla & K. Yates (2021)

The selection of the most appropriate methods and techniques for adapting environmental materials for children with disabilities depends on the specific nosology, developmental level, and individual characteristics of each child. The combination of factors that create favourable conditions for the successful formation of environmental competencies in all learners, including those with special educational needs, thereby contributing to the development of an environmentally responsible and inclusive society, exerts a positive influence on the process of forming environmental competencies within the field of inclusive education. These factors comprise the integration of environmental themes into the curriculum; relevance; adaptation and consideration of the special educational needs of all learners; the use of diverse teaching

methods; the creation of an inclusive educational environment; the active involvement of educators and their professional development; and engagement with parents and the local community.

Considering the significance of integrating environmental knowledge into the educational process, particularly for children with special educational needs, and drawing upon a set of key factors that create favourable conditions for the formation of environmental competencies, an experiment was conducted. A preliminary quantitative analysis of the responses from students in the experimental and control groups at Arbaev Kyrgyz State University prior to the experiment is presented in Table 5, which enabled an assessment of the initial level of development of the competencies under investigation.

Table 5. Questionnaire survey to determine the level of environmental literacy of students in the EG and CG before the experiment

Question No.	Responses	CG (No.)	EG (No.)
1	a) environmental pollution	18	15
	b) climate change	7	6
	c) biodiversity loss	5	4
	d) depletion of natural resources	3	2
	e) waste problem	10	8
2	a) resource conservation	15	13
	b) waste sorting and disposal	8	7
	c) responsible consumption	6	5
	d) careful treatment of nature	12	10
	e) participation in environmental campaigns	2	1
	f) environmental education and outreach	0	1
3	a) individualisation of tasks	2	1
	b) use of hands-on activities	5	6
	c) adaptation of materials	3	2
	d) work in small groups/pairs	4	3
	e) creation of a supportive environment	1	2
	f) excursions and practical activities	3	0
	g) use of ICT	6	6
	h) involvement of specialists	0	2

Table 5. Continued

Question No.	Responses	CG (No.)	EG (No.)
4	a) use of large print	7	5
	b) provision of information in various formats	4	3
	c) use of visual materials	6	6
	d) simplification of texts and instructions	5	5
	e) use of visual aids	8	8
	f) ensuring accessibility of the workstation and materials	2	3
5	a) yes, absolutely	3	2
	b) rather yes	10	8
	c) rather no	7	9
	d) no, it is difficult	3	4
	e) don't know / find it difficult to answer	2	2
6	a) I am ready	1	1
	b) not entirely ready, lack knowledge	9	11
	c) not ready	10	8
	d) lack practical experience	5	5
7	a) insufficient foundational knowledge base	2	1
	b) theoretical overload and lack of practical activities	5	6
	c) insufficient mastery of inclusive environmental education methodologies among teachers	4	3
	d) difficulties in selecting and applying effective teaching methods	6	7
	e) lack of modern equipment	9	10
	f) lack of time for individual work with each child	1	0
	g) difficulties in interaction between children with different educational needs	1	0
	h) other (please specify: __)	0	0
8	a) adaptation of materials and methods	2	3
	b) ensuring an accessible environment	6	6
	c) availability of necessary equipment	4	3
	d) individualisation of the approach to teaching each child	1	0
	e) creation of a positive and supportive climate in the classroom	6	7
	f) collaboration with specialists	2	6
	g) trained teachers	3	1
	h) cooperation with parents of children with disabilities	6	2
	i) other (please specify: __)		

Source: compiled by the author

The results of the initial questionnaire survey of students in the control and experimental groups prior to the experiment revealed an overall insufficient level of environmental literacy and readiness for inclusive environmental education. Both groups demonstrated some awareness of environmental pollution and waste issues; however, their understanding of systemic environmental problems, such as climate change and biodiversity loss, was poorly expressed. Among the examples of environmentally responsible behaviour, resource conservation and a caring attitude towards nature predominated, whereas active forms of participation, such as environmental campaigns and awareness-raising, were rarely mentioned. Awareness of inclusive teaching methods proved to be low, with such important aspects as individualisation and material adaptation scarcely noted. In the understanding of

adapting learning materials, references to visual aids and large print prevailed. The majority of students expressed doubts about their readiness to teach ecology to children with special educational needs and disabilities (SEND), citing a lack of knowledge and practical experience. Among the potential difficulties, a shortage of modern equipment and challenges in selecting effective teaching methods were identified, while the necessary conditions included ensuring an accessible environment and collaboration with parents. The data obtained confirm the need for implementing an experimental programme aimed at developing competencies in inclusive environmental education among future primary school teachers. The training programme in the experiment with students is based on methods and techniques for adapting environmental materials for children with SEND (Table 6).

Table 6. Programme content (thematic plan)

Session No.	Session Topic	Session Format	Session Procedure	Number of hours
1	Introduction to inclusive education and characteristics of children with SEND	Lecture-presentation	Studying the core concepts of inclusive education, the classification of SEND, and discussing the perceptual characteristics of children with various impairments	2

Table 6. Continued

Session No.	Session Topic	Session Format	Session Procedure	Number of hours
2	Principles and approaches to adapting learning materials for children with SEND	Seminar-discussion	Analysis of the principles of accessibility, individualisation, and sensory integration. Discussion of various approaches to adapting learning materials	2
3	Adaptation of visual environmental materials	Practical session	Analysis of examples of visual materials on ecology. Development and modification of illustrations, diagrams, and tables using colour coding and visual supports. Creation of accessible presentations; conducting a case study on adaptation	4
4	Adaptation of sensory environmental materials	Practical session	Exploring the use of tactile, auditory, and olfactory sensations in environmental education. Development of sensory bins and didactic materials with various textures; role-playing games	4
5	Simplifying and structuring text-based environmental information	Practical session	Analysis of complex environmental texts. Identification of key concepts. Exercises in simplifying sentences and structuring information using lists and diagrams. Creation of adapted texts; solving crosswords	2
6-7	Adaptation of interactive and hands-on environmental tasks	Practical session	Analysis of typical environmental experiments and observations. Development of adaptation options for children with visual and hearing impairments (using sound signals, tactile models, and verbal descriptions). Development of adaptation options for environmental games and project-based activities for children with musculoskeletal disorders and autism spectrum disorders (ASD) (using alternative means of participation, visual cues, structured tasks, and work with cards)	4
8	Use of assistive technologies in inclusive environmental education	Lecture-presentation	Overview of specialised software and applications, interactive whiteboards, and electronic resources that can be used to adapt environmental materials and support the learning of children with SEND	4
9	Development of differentiated tasks in ecology for children with SEND	Practical session	Development of a set of environmental tasks on the topic “The Water Cycle in Nature”, taking into account various levels of complexity and the educational needs of children with different types of SEND	4
10	Modelling an inclusive lesson in ecology	Practical session	Development of a script for a lesson segment in ecology using adapted materials and differentiated tasks to include children with various educational needs. Games. Presentation and discussion of the developed segments	4
11	Evaluating the effectiveness of adapted environmental materials	Seminar-discussion	Discussion of criteria for evaluating the effectiveness of adapted materials. Analysis of examples of assessing the academic achievements of children with SEND when using adapted materials. Reflection on the experience gained	2
12	Final assessment (defence of developed materials)	Presentation	Presentation and defence of the sets of adapted environmental materials and inclusive lesson segments developed by the students. Discussion and feedback	4

Source: compiled by the author

Within the framework of the experimental programme, students underwent training in adapting environmental materials for various nosological categories of children with disabilities (CwD), mastering specific techniques and methods tailored to each group: visual and tactile aids for children with visual impairments; visual materials and sign language for children with hearing impairments; structuring and sensory breaks for children with autism spectrum disorders (ASD); simplification and visualisation for children with intellectual disabilities; and ensuring accessibility alongside alternative means of task completion for children with musculoskeletal disorders (MSD). As a result of the training, students acquired practical skills in adapting and designing environmental materials, developing multi-level tasks, and planning inclusive ecology lessons supported by assistive technologies.

Upon completing the programme, students demonstrated increased readiness to work in an inclusive environment, deeper knowledge of the characteristics of CwD, the ability to apply adaptation principles, develop differentiated materials, and design inclusive ecology lessons, while exhibiting empathy and commitment to working with such children. Analysis of the theoretical frameworks indicated the effectiveness of combining activity-based and competence-based approaches, integrated with the principles of the socio-ecological approach and the pedagogy of sustainable development, for fostering environmental competencies in future primary school teachers within inclusive education settings. Analysis of the response dynamics of students in the control and experimental groups before and after the experiment revealed significant differences in the changes that occurred in both groups (Table 7).

Table 7. Indicators of awareness in the EG and CG after the experiment

Question No.	Answers	CG (No.)	EG (No.)
1	a) environmental pollution	18	22
	b) climate change	6	9
	c) biodiversity loss	5	6
	d) depletion of natural resources	1	3
	e) waste problem	11	9
2	a) resource conservation	15	16
	b) waste sorting and disposal	9	10
	c) responsible consumption	6	5
	d) caring attitude towards nature	10	12
	e) participation in environmental campaigns	3	4
	f) environmental education	0	2
3	a) individualisation of tasks	3	5
	b) use of hands-on activities	5	10
	c) adaptation of materials	4	12
	d) work in small groups/pairs	4	6
	e) creation of a supportive environment	2	9
	f) excursions and practical activities	3	6
	g) use of ICT	6	9
	h) involvement of specialists	2	5
4	a) use of large print	5	9
	b) presentation of information in various formats	6	6
	c) use of visual materials	4	8
	d) simplification of texts and instructions	5	5
	e) use of visual aids	8	10
	f) ensuring accessibility of the workspace and materials	2	5
5	a) yes, definitely	5	9
	b) rather yes	12	9
	c) rather no	2	2
	d) no, it is difficult	4	4
	e) I do not know / I find it difficult to answer	2	1
6	a) I am ready	1	15
	b) I am not fully ready, I lack knowledge	9	3
	c) I am not ready	10	2
	d) I lack practical experience	5	5
7	a) insufficient foundational knowledge	0	3
	b) theoretical overload and lack of practical activities	6	7
	c) insufficient command of inclusive environmental education methodologies among teachers	4	6
	d) difficulties in selecting and applying effective teaching methods	6	8
	e) lack of modern equipment	12	15
	f) lack of time for individual work with each child	0	0
	g) difficulties in interaction between children with different educational needs	0	0
	h) other (please specify: __)	0	0
8	a) adaptation of materials and methods	5	9
	b) ensuring an accessible environment	2	6
	c) availability of necessary equipment	5	9
	d) individualisation of the approach to teaching each child	1	6
	e) creating a positive and supportive classroom climate	5	9
	f) collaboration with specialists	1	6
	g) trained teachers	4	5
	h) collaboration with parents of CwD	6	6
	i) other (please specify: __)	0	0

Source: compiled by the author

Ecological literacy (questions 1 and 2). In the experimental group (EG), a more significant increase was recorded in the understanding of systemic environmental problems (climate change, biodiversity loss) and in the

frequency of responses reflecting an active environmental stance (participation in campaigns, awareness-raising). In the control group (CG), changes in these questions are negligible, and in some instances, a decline in indicators

is even observed. Attitudes towards Inclusive Education (question 5). The EG demonstrated pronounced dynamics towards a more positive perception of the feasibility of effective inclusive environmental education. The CG also exhibits a positive shift, albeit a less significant one.

Readiness for practical work (question 6). Self-assessment of readiness for practical work in an inclusive setting underwent fundamental changes in the EG, where the number of students confident in their readiness increased substantially. In the CG, the level of self-assessment remained virtually unchanged. Understanding of challenges and necessary conditions (questions 7 and 8). The EG exhibits a deeper awareness of the potential challenges of inclusion and a significant increase in the understanding of the necessary conditions for its successful implementation, including the adaptation of materials, ensuring accessibility, individualisation of instruction, and teacher preparation. In the CG, the dynamics in these questions are weakly expressed or absent. Comparative analysis demonstrates a pronounced positive effect of the experimental programme on ecological literacy, attitudes towards inclusion, and, most notably, on the self-assessed readiness for practical work within inclusive environmental education among EG students. In the CG, where instruction was conducted traditionally, no significant changes were recorded. This confirms the effectiveness of the developed experimental methodology.

Analysing student feedback on the experimental programme allows for the identification of a number of positive aspects that contributed to the development of their competencies in the field of inclusive environmental education. Students attached particular importance to practical sessions on adapting visual materials, noting their contribution to understanding the principles of creating accessible visualisations for children with various perceptual characteristics. Modules dedicated to the development of multi-level tasks proved useful for mastering a differentiated approach to teaching in an inclusive environment. The modelling of lesson segments provided a valuable opportunity for the practical application of acquired knowledge and for receiving constructive feedback. Information on assistive technologies for learning expanded students' knowledge of the resources available for working with children with special educational needs, and the study of the developmental characteristics of various categories of children with disabilities contributed to the formation of a more conscious approach to the teaching and learning process. The development of information transformation skills, particularly the ability to translate textual content into visual forms, as well as instruction in the principles of Universal Design, were noted as important acquisitions conducive to creating accessible learning materials. Furthermore, students expressed confidence in using tactile materials for studying nature with children who have sensory impairments and noted the development of skills in designing multi-level tasks that allow for the individual learning pace of each child to be taken into account.

Alongside the positive feedback, students put forward a number of suggestions for improving the programme. Five individuals pointed to a lack of practical training in interacting with children with disabilities and expressed a need for a greater number of practical sessions directly with this category of learners, as well as for the arrangement of visits and placements in operational inclusive educational settings. Another five students noted the necessity of providing a larger quantity of specific examples of adapted lessons on various environmental topics for different nosological groups. Three students expressed a wish for a list of supplementary resources and online platforms that facilitate inclusive education. Two individuals consider it important to place greater emphasis on developing empathy and emotional readiness for working with children with disabilities, while another two noted a certain overload of theoretical blocks, suggesting they be made more interactive and practice-oriented.

Analysis of the self-assessment of readiness levels for working with children with disabilities upon completion of the programme showed that a significant majority of students in the experimental group rated their readiness as fairly high: nearly half of the participants feel confident and competent, while another portion lean towards a positive assessment. However, a certain proportion of students still experience a lack of confidence in their readiness, and a small number feel unprepared (Fig. 1).

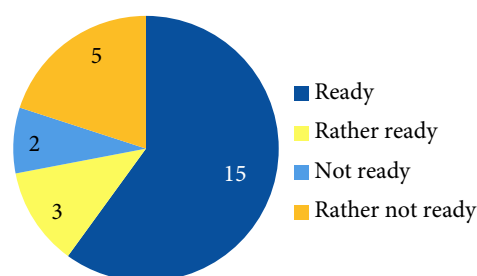


Figure 1. Self-assessment of the EG's level of readiness for working with children with disabilities upon completion of the programme

Source: created by the author

Thus, the training programme received an overall positive evaluation from students, who noted its contribution to the development of the requisite competencies. At the same time, the suggestions put forward indicate a need for further refinement of the programme, particularly by increasing the practical component, providing a greater number of specific examples and resources, and placing greater emphasis on the emotional aspects of working with children with disabilities. The data obtained represent valuable material for further analysis of the programme's effectiveness and for identifying avenues for its optimisation.

DISCUSSION

The conducted experimental study was aimed at identifying the effectiveness of the developed training programme

focused on fostering environmental competencies in future primary school teachers within the context of inclusive education. The experimental results demonstrated a statistically significant increase in the level of ecological literacy in the experimental group compared to the control group following completion of the developed training programme. This attests to the effectiveness of the proposed methodology, which included the adaptation of environmental materials and the use of inclusive pedagogical approaches. A questionnaire survey of experimental group students revealed their positive perception of the programme, its practical significance, and the utility of the proposed methods for adaptation and enhancing readiness to work in an inclusive classroom. The obtained results align with the findings of a number of researchers who underscore the effectiveness of targeted instruction in ecological literacy for future educators. I. Murni *et al.* (2023) in their study also noted a significant increase in the level of environmental knowledge and skills among teacher training students following the implementation of a specialised course emphasising practical activity and an interdisciplinary approach.

The findings of this study concerning the enhancement of future primary school teachers' readiness to work with children with disabilities through the implementation of a training programme emphasising the adaptation of environmental materials are corroborated by the work of A.G. Lugo (2024). The author's research indicates the necessity of embedding inclusive education issues directly within the process of developing future teachers' professional skills. The similarity of the conclusions lies in the assertion that targeted training, incorporating specific knowledge and skills related to inclusive practice, exerts a direct positive influence on the level of students' preparedness to work with children with disabilities. In particular, these results demonstrate that students who have undergone training with a focus on inclusion exhibit a high level of understanding of children's needs and greater confidence in their ability to adapt educational materials. However, it is important to note that the present study focused on a specific subject area – environmental education – and on a particular aspect of inclusive practice – the adaptation of educational materials – whereas the work of A.G. Lugo (2024) encompassed a broader spectrum of inclusive competences or a different subject context. Thus, the results of this study reinforce the author's argument in favour of the necessity of systematically embedding inclusive practices within the preparation of future teachers. They also demonstrate that, even within a specific subject area such as environmental education, the targeted development of relevant knowledge and skills significantly enhances students' readiness to work in an inclusive educational environment.

The data obtained in the study regarding the positive impact of the training programme on the formation of environmental competences in future primary school teachers find parallels in the work of B. Priyanga *et al.* (2022), which examined the influence of practice-oriented training on the development of these competences in future

primary school teachers. A key point uniting the results with the conclusions of the author and his colleagues is the confirmation of the significance of actively engaging students in the development of educational materials and the modelling of pedagogical situations. In the present study, the experimental group participants highly rated the practical sessions for children with disabilities, which directly implied their active involvement in the creation and transformation of educational content. Similarly, the research by B. Priyanga *et al.* underscored that when students are directly involved in the process of creating and applying pedagogical tools, their understanding of the subject and readiness for future professional practice increase significantly. The positive evaluation of the programme by students of Arabaev Kyrgyz State University, which emphasised the practical adaptation of materials, serves as further confirmation of the conclusions of B. Priyanga *et al.* (2022) that practical experience and the active role of the student in the learning process are key factors in the formation of sustainable professional competences, including in the field of environmental education.

The obtained data on the positive impact of the training programme are supported by the conclusions of the work of L. Lucassen *et al.* (2025). According to the authors' research, inclusion can have a positive effect on the academic outcomes of children with disabilities, provided that adequate support and resources are made available. The present study, although not directly focused on the academic results of children with disabilities themselves but rather on teachers' readiness to create conditions for their successful learning, indirectly confirms this interrelationship. The programme developed for the experiment was aimed at equipping future teachers with the competences necessary to provide adequate support and resources within the context of environmental education. The ability to adapt materials, employ differentiated approaches, and create an inclusive educational environment is a key factor in ensuring access to the learning process for children with disabilities and, consequently, in potentially improving their academic outcomes.

The results of the study resonate with the broader findings of the research by B.G. Stone & B. Saggars (2023), wherein the authors emphasised that the academic outcomes of peers without disabilities do not deteriorate in inclusive classrooms and may even improve owing to collaborative learning and diversity. Furthermore, the authors noted that inclusion fosters the social integration of children with disabilities, the development of their communicative skills, and a sense of belonging. When future teachers possess the requisite competences, they can more effectively stimulate interaction among all learners, promoting both academic growth and social integration. Thus, the present study contributes to establishing the pedagogical foundation for the positive effects of inclusion identified by B.G. Stone & B. Saggars (2023).

According to I.H. Yue Yim (2024), inclusion fosters the development of empathy and tolerance in all learners within

an inclusive setting and can lead to enhanced self-esteem and self-confidence in children with disabilities. The author considers that the key factors for successful inclusion are well-prepared teachers, methods of adaptation, and inclusive pedagogical technologies. Additionally, as indicated in the obtained results, teaching assistants (special education teachers, psychologists) and adapted educational materials and equipment are essential. It should be added that effective inclusion requires collaboration among teachers, parents, specialists, and school administration, where an atmosphere of acceptance, respect, and support plays a vital role.

The results of the present study, aimed at enhancing future primary school teachers' readiness for inclusive environmental education, should be considered within the context of the barriers to successful inclusion identified by J-W. Law *et al.* (2023), who highlighted such obstacles as insufficient funding and resources; inadequate training of teaching staff; insufficient accessibility of the educational environment; and stereotypes and prejudices regarding children with disabilities. Although the present study contributes to improving teacher preparation, it does not address systemic issues such as insufficient funding, limited resources, or existing stereotypes within society. Overcoming these barriers requires a comprehensive approach and concerted efforts at various levels – the school, the education system, and society as a whole. The conclusions of J-W. Law *et al.* underscored the need for further investigation of effective practices and the overcoming of existing barriers.

The tools for self-assessment and the development of inclusive practices, devised by V. Kumar *et al.* (2024), also underscore the importance of reflection and the continuous refinement of pedagogical approaches. By fostering future teachers' understanding of inclusion principles and practical adaptation skills, the programme in this experiment lays the groundwork for their ongoing self-assessment and professional growth in the field of inclusive education. Thus, the present study complements the work of V. Kumar *et al.* (2024), which proposes specific models and tools for implementing inclusive practices in schools.

Questions regarding the study of environmental competences within the context of inclusive education lie at the intersection of two important fields of pedagogical science and practice; consequently, there are fewer researchers engaged with this set of issues than in each of the fields individually. The work of Y. Herlanti *et al.* (2024) proposed practical methods of teaching and material adaptation and also provided examples of successful projects. This directly echoes the aim of the training programme in the present findings – to equip future teachers with specific skills and knowledge for adapting environmental content and organising inclusive environmental activities. The results of this study have empirically confirmed the necessity and effectiveness of preparing teachers for the integration of environmental education into inclusive education, thereby creating a basis for the development of key social and emotional skills in all learners through the exploration of the environment.

The study by M.J.N. Nalipay *et al.* (2023) focuses on the importance of fostering an understanding of the human-nature symbiosis for the development of preschool children with disabilities. The authors emphasised that practical interaction with nature contributes to the holistic personal development of such children. This finding directly aligns with one of the key aspects of the experimental curriculum: preparing future teachers to adapt environmental materials in consideration of sensory characteristics and to organise practical outdoor activities for children with disabilities. Having completed the programme proposed in this experiment, prospective teachers will be able to create learning situations in which children with various sensory needs actively interact with the environment, thereby forming an understanding of the interconnection between humans and nature, which, according to M.J.N. Nalipay *et al.*, is crucial for their comprehensive development.

T.C. Young & K. Malone (2023) investigated the development of social skills and empathy in children with disabilities in an inclusive setting and suggested that this has a direct bearing on the formation of the value-motivational component of environmental competencies, such as a responsible attitude towards nature and compassion for living beings. The authors stressed that direct experience with natural objects and phenomena is key to building environmental knowledge, skills, and values, particularly for children with disabilities. The findings of the present study – that, when educating future teachers, it is essential to design inclusive environmental lessons incorporating hands-on interaction with nature and material adaptation, thereby creating conditions conducive to the development of these very social and emotional aspects – are consistent with the authors' conclusions. As in the present research, the study by A.J. Tinedo Rodríguez (2020) indicates that the adaptation of teaching materials, methods, and forms of work is an indispensable condition for the successful inclusion of children with disabilities in environmental education. Environmental projects and collaborative outdoor activities can foster communication, cooperation, and a sense of belonging among all learners.

In their study, V. Lamanauskas & R. Makarskaitė-Petkevičienė (2023) asserted that environmental education, particularly within an inclusive context, holds significant potential for cultivating children's empathy for living beings and a sense of responsibility for the state of the environment. The results of the present research empirically confirmed and concretised this proposition, as well as the notion that purposeful environmental education indeed contributes to the formation of a deep emotional connection with nature in learners and serves as a foundation for developing empathy. In this experiment, this manifested in the positive dynamics of future teachers' attitudes towards environmental issues and their readiness for environmentally responsible behaviour following the completion of the developed training programme.

At the same time, certain aspects of the present study diverge from findings reported by other scholars. For instance, the study by A.S. Widodo *et al.* (2024) demonstrated

only a weak influence of standard ecology lectures on students' practical readiness to work in an inclusive context. The more notable positive outcomes in the present study may be attributed to the programme's focus on the practical adaptation of materials and students' active participation in the learning process. The results of this study may also somewhat diverge from the conclusions of N. Mousavi *et al.* (2024), who, while examining the impact of specific visualisation methods on the acquisition of environmental knowledge by children with disabilities, pointed to the necessity of a more differentiated approach to the selection of visual aids. In the present findings, the adaptation of visual materials was considered within a broader context, which could have led to generalised positive results that require further in-depth investigation into the efficacy of particular visual techniques for different categories of children with disabilities.

No significant studies were identified that explicitly oppose the integration of environmental education issues within the context of inclusive education in the preparation of future primary school teachers. The majority of contemporary pedagogical research underscores the importance of cultivating both environmental culture and readiness for inclusion in future educators as integral components of their professional competence. However, it can be posited that some authors may indirectly express reservations or point to potential challenges associated with such integration. For example, the study by J.J. Kayombo *et al.* (2025) focused exclusively on an in-depth examination of specific methods for working with particular categories of children with disabilities, without devoting sufficient attention to the environmental content of instruction. The work by M. Jaime *et al.* (2021), which was solely dedicated to environmental education, did not address the specifics of working within an inclusive classroom. Nevertheless, the overarching trend in pedagogical science is directed towards identifying effective pathways for integrating various facets of teacher professional preparation, including environmental education and inclusive practices, to ensure quality education for all children.

Overall, the data obtained corroborated the conclusions of many leading researchers who have noted the pivotal role of practical orientation and the inclusion of inclusive education issues in teacher training. The minor discrepancies with the findings of certain studies may serve as a point of departure for future research that delves deeper into the specifics of adapting environmental content for diverse groups of children with disabilities and into ways of optimising the integration of environmental and inclusive education within pedagogical preparation.

CONCLUSIONS

This study investigated the formation of environmental competencies in future primary school teachers within the

context of inclusive education. The experiment confirmed the effectiveness of the developed programme aimed at building skills in adapting environmental materials for inclusive classrooms. The implementation of a lecture and practical course on mastering methods for modifying visual, sensory, and textual content ensured a statistically significant increase in environmental literacy in the experimental group compared to the control group. In the experimental group, the following results were obtained: environmental literacy (up to a 12% increase in understanding of key issues and responsible behaviour), a more positive attitude towards inclusive environmental education (+32% in the selection of positive responses), and an increase in self-assessed readiness to work in an inclusive context (+56%), in contrast to the control group, where changes were minimal or insignificant. The majority of students in the experimental group positively evaluated the practical orientation of the programme, highlighting the benefits of adapting visual materials, designing multi-level tasks, and modelling lessons. A significant outcome was the acquisition of skills in handling visual and tactile information, as well as the principles of Universal Design. Despite this, some students (5 individuals) noted an insufficient number of practical sessions involving children with disabilities and a need for internships, as well as for additional lesson examples (5 individuals) and resources (3 individuals), which indicates directions for the further development of the programme. The obtained results attest to the effectiveness of the developed training programme in fostering the requisite competencies in future primary school teachers.

The small student sample constitutes one of the limitations of the present study, which may affect the comprehensiveness of the reflection of their actual readiness for practice. Furthermore, no long-term observation was conducted regarding the application of the acquired knowledge and skills by graduates in their professional activities. Future exploration of this topic could include a comparison of the effectiveness of different methods of integrating inclusive issues into the training of teachers of various subjects, as well as an analysis of the impact of training educators to adapt environmental content on the dynamics of academic achievement among children with disabilities in inclusive classrooms.

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