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Environmental Education in the Context of Education for Sustainable Development for Pre-service Teachers

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Annotation. Through a questionnaire, we will explore prospective teachers' attitudes towards selected SDGs, along with their general knowledge of the main environmental issues of sustainable development, namely biodiversity loss and climate change. Our aim is to design methodological material for kindergartens and primary schools, and thus to promote positive attitudes towards environmental education among children, pupils and teachers.

Keywords: *environmental education, education, sustainable development, science literacy, attitudes of the teacher.*

Introduction

A sense of environmental responsibility and environmental awareness can be developed in a positive school environment. A more sustainable society can be achieved through environmental education. In order to advance environmental education, ensure a sustainable classroom environment, address current issues, promote sustainability, and contribute to a sustainable future, future teachers need to have knowledge and awareness of environmental issues.

According to Maier (2012), we can only achieve sustainability if we maintain harmony and balance between the different aspects of sustainability, with no one aspect

growing at the expense of the others. The need for sustainability was well expressed by Mahatma Gandhi, who said that there is enough food on Earth to satisfy everyone's needs, but not enough to satisfy everyone's greed. Our planet cannot become any larger or richer to meet our wants and needs, given limited environmental resources, technological advances, and ever-increasing human demands. The concept of sustainability is based on the awareness of ecological linkages and integrates society, economy, and the environment as its three pillars (Mahato, 2018). These three pillars are environmental, economic, and social sustainability (Purvis et al., 2019). OECD PISA describes scientific literacy as the ability to understand and assess the natural world, including the changes that have occurred in it as a result of human activity. It includes the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence. The OECD PISA definition of scientific literacy is based on core competences. It seeks to determine how well students can use scientific evidence, identify scientific questions, and explain phenomena using science (Lakatošová & Veleg, 2015). In primary schools, environmental education is covered in several subjects. Based on knowledge of the ecological processes governing life on Earth, as well as the geomorphological and climatic conditions that influence the activities of humans and other living organisms, the content of environmental education enables students to understand, analyze, and evaluate the relationships between humans and their environment (Moyzeová, 2016; Grupač & Kubala, 2025).

The 2030 Agenda, encompassing the social, economic, and environmental pillars, includes 17 broad Sustainable Development Goals. Its key objective is to achieve sustainable development across instead of in terms of people, planet, prosperity, peace, and cooperation. Furthermore, it is essential to protect the planet, introduce sustainable production and consumption practices, and combat climate change. Peacebuilding is also an important issue (Ministry of the Environment, 2018). The interconnected challenges faced by countries include poverty, growing economic and social inequality, climate change, and the unsustainability of current production and consumption practices (Kubišová, 2021). By engaging all continents and fostering global cooperation, it is possible to contribute to more sustainable development and promote the principles of the 2030 Agenda.

The aim is to explore the attitudes and knowledge of prospective pre-primary and primary teachers. This focus is also motivated by the importance of strengthening environmental education, especially in light of an upcoming school reform – either by adjusting the curriculum or by linking the 4th and 5th grades across different levels of primary education. Building on both theoretical insights and empirical findings, we aim to develop a set of activities for children, future teachers, current teachers, parents, and the general public. These activities will be tailored to the age and developmental stage of children. Our goal is for these hands-on activities to spark an interest

in nature, foster a positive relationship with biology, and help children gain a deeper understanding of the living world and their role within it.

Literature Review

Climate Change and Biodiversity as a Major Awareness Issue

The term *sustainable development* was first used in 1987 in the report of the World Commission on Environment and Development, *Our Common Future*, presented to the United Nations (UN) Assembly: "Sustainable development is a mode of development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1990, p. 47; Moldan, 2015, p. 330). In light of this idea, we should be aware that our unsustainable way of life will negatively affect the lives of future generations.

The European Union was the world's fourth-largest emitter in 2019, following China, the USA, and India (European Parliament, 2023). Human-induced climate change is already influencing numerous extreme weather and climate events across all continents. This has resulted in widespread negative impacts and associated loss and damage to both nature and people (The Core Writing Team, 2023). In addition to rising sea levels and the significant loss of Arctic sea ice, both the atmosphere and oceans are warming. The effects of climate change on people and the environment are becoming increasingly visible. Floods, extreme heat, and wildfires – some of which are unprecedented – have already caused billions of dollars in damage. Habitats are changing in response to shifts in temperature and precipitation (The Royal Society, 2020).

The most common drivers of climate change are global warming and severe weather events. Cyclones, heatwaves, wildfires, droughts, and floods are expected to occur more frequently and with greater intensity as a result of these changes (Thiery, 2023). Sea level rise is another major consequence, with projections suggesting an increase of 0.17 to 0.41 metres by 2050. Recent observations indicate a rise in regional flooding (Prajapati et al., 2023). Climate change also impacts microbial communities, which are flexible enough to adapt to new environmental conditions. These changes can lead to microbial variations that significantly affect ecosystem functioning in a new climate system (Suhaib et al., 2022).

Although environmental education is fundamentally important and plays a key role in improving living standards, it remains a minor part of the school curriculum. Nature and environmental conservation are popular topics today, yet they receive limited attention in schools (Spring Celebration Team, 2018; Filip & Somr, 2025). According to Rusko and Balog (2007), the main goal of environmental education is to promote greater acceptance and understanding of environmental knowledge, often referred to as "environmental learning."

Science Literacy and Pupils' Performance in PISA

The Organization for Economic Co-operation and Development (OECD) first introduced the PISA study in 2000. It focuses primarily on assessing the reading, science, and mathematics literacy of 15-year-olds – that is, students at the age when they typically complete compulsory schooling and are potentially entering the labor market. The Slovak Republic, already a member of the OECD at that time, expressed interest in this type of educational system feedback in 2003 (Miklovičová & Valovič, 2019).

In 2021, changes were made to the regular measurement of student performance, and the name was changed from PISA 2021 to PISA 2022. This adjustment was due to disruptions caused by the COVID-19 pandemic, which affected the timing of the planning and implementation of the international assessment. Pilot testing could not be completed as planned, and, like Slovakia, other participating countries were also unable to implement or finalize pilot data collection (Ministry of Education, Science, Research and Sport of the Slovak Republic, 2022).

Slovak students scored 488 points in scientific literacy in the 2006 PISA cycle, which was below the OECD average. In the PISA 2018 cycle, the OECD average in scientific literacy fell from 500 to 489 points, while Slovak students scored 464 points, which is again below the OECD average. Compared to the previous cycle (2015), the average score of Slovak students in 2018 increased slightly from 461 to 464 points. However, this three-point difference is not statistically significant, as it is comparable to the performance in 2015. With the exception of the 2003 PISA study, when Slovakia achieved the OECD average, the country's average score in scientific literacy has remained consistently below the OECD standard (Miklovičová & Valovič, 2019).

Methodology

Descriptive Statistics and Description of the Research Problem

The New Ecological Paradigm scale categorizes attitudes into three types – Ecocentric, which reflects the belief that human impact on the environment is so significant it threatens humanity's own survival, as the environment is in a precarious state. Technocentric, which assumes that environmental problems can be resolved through technological innovation. Dual-centric, which represents a middle ground that emphasizes a symbiotic relationship and equivalence between humans and the environment. Mudderisoglu and Altanlar (2011), in their research on the attitudes of university students, found that the technocentric attitude was the least prevalent among participants.

The aim of the questionnaire was to gather comprehensive information on perspectives, knowledge, and attitudes of prospective teachers toward environmental education, and to support improvements in the quality and effectiveness of teacher

preparation programs. The methodological approach involved a questionnaire-based assessment conducted in 2023 and 2024 across Slovakia, at universities with faculties of education and humanities. Data collection was carried out using an online questionnaire distributed via Google Forms, enabling broad participation from future teachers. The collected data were analyzed using Statistica software, ensuring a systematic evaluation of responses. To enhance the clarity and robustness of the methodology, future research should provide more detailed information on sampling techniques, validation procedures, and the statistical methods used to ensure reliability and validity. Refining these methodological aspects will strengthen the study's foundation and its contribution to further research in sustainability education.

The selection of participants was carried out using a combination of random and purposive sampling. First, university faculties offering teacher education programs across Slovakia were identified. Within these institutions, students were selected based on their enrollment in relevant study programs – Teaching for Pre-primary Education, Primary Education, or combinations including or excluding science subjects. The recruitment process was conducted through institutional mailing lists and internal communication platforms, ensuring broad access while reflecting both voluntary and accessible participation.

The final sample consisted of 345 respondents, predominantly female (93.9%). Participants represented all regions of Slovakia, which increases the ecological validity of the findings. However, due to the overrepresentation of female participants, the sample may not be fully gender-representative.

The selection of respondents was done through a combination of random and convenience sampling to ensure representativeness within the teaching disciplines. The questionnaire used was based on existing studies and theoretical frameworks, and its content validity was verified by experts in the field of environmental pedagogy. Prior to the actual data collection, pilot testing was carried out on a sample of 30 students, which allowed identifying ambiguities in the questions and subsequently adjusting the wording of some items. The reliability of the questionnaire was confirmed by calculating Cronbach's alpha for each scale (e.g., $\alpha = 0.78$ for the attitude scale), indicating satisfactory internal consistency.

The questionnaire items were based on the New Ecological Paradigm framework and existing studies on environmental attitudes and sustainability. The instrument included Likert-scale items categorized into three main attitude domains: environmental protection, economic development, and social inclusion. Each domain consisted of 5–7 items, and examples included statements such as "Protecting nature is more important than economic growth" or "Governments should prevent the waste of natural resources."

Participation in the study was fully voluntary and anonymous. Before starting the questionnaire, participants were informed about the purpose of the research, the

estimated time required, and the confidentiality of their responses. All participants provided informed consent by clicking an agreement checkbox before accessing the survey.

The research population consisted of a total of 345 respondents - students of Teaching for Pre-primary or Primary Education, of which 324 were female (93.9%) and 21 were male (6.1%). The mean age of the respondents was M = 21.51 years, standard deviation of age SD = 2.54 years. The youngest respondent was 19 years old, the oldest was 39 years old. Students from all regions of Slovakia participated in the study. The Žilina region had the largest representation (55.9%), and the Trnava region the smallest (1.2%).

In our research, we set hypotheses and research questions:

H1: We expect that there will be statistically significant differences in students' attitudes towards the main environmental issues of sustainable development between students with different backgrounds.

H2: We assume that a significant majority of students will demonstrate a satisfactory level of knowledge of the test of general knowledge on the main environmental issues of sustainable development, with a score of at least 36 points (i.e., a pass rate of at least 60%).

H3: We expect that there will be statistically significant differences in the results of the test on general knowledge related to the main environmental issues of sustainable development between students with different backgrounds.

RG1: Do students' attitudes towards different elements of sustainable development correlate with each other?

RG2: We assume that students' knowledge of environmental issues of sustainable development is related to their attitudes towards sustainable development issues.

Students' Attitudes Towards Sustainable Development

The analysis of the questionnaire responses concerning the environmental education of preservice teachers involved processing the data, identifying patterns, and drawing conclusions. Since sustainable development requires balancing environmental protection, economic growth, and social inclusion, the evaluation was structured around these three key areas.

The first five questions focused on students' attitudes toward environmental protection. A large majority agreed that environmental protection and human quality of life are interconnected (92.2% agreement, 1.4% disagreement). Similarly, many students believed that human interference often leads to disastrous consequences (73.4% agreement, 8.1% disagreement). Regarding the statement that environmental protection is more important than industrial growth, 71.6% agreed, 24.6% were neutral, and 4.8% disagreed. When asked about prioritizing biodiversity and environmental protection over industrial or construction interests, 65.5% and 65.3% of students agreed, respectively, while disagreement remained low (4.1% and 9.6%).

The second group of questions focused on sustainable economic management. More than half of the students agreed that economic policy should prioritize sustainable production (57.1% agreement, 3.5% disagreement, 39.4% neutral). On the issue of reducing economic disparities through personal sacrifice, 68.7% agreed, 24.3% were neutral, and 7% disagreed. Support for promoting fair trade was relatively strong, with 73.9% agreement, though 24.6% were undecided. A strong majority agreed that governments should act to prevent the waste of natural resources (83.8% agreement, 1.2% disagreement), and that reducing global poverty and hunger is more important than economic growth in developed countries (85.5% agreement, 12.8% neutral, 1.8% disagreement).

Regarding social inclusion, most students expressed strong agreement with promoting peace (92.4% agreement), providing free basic healthcare (89.8% agreement), and ensuring equal opportunities for men and women (83.5% agreement). Disagreement with these statements was minimal (1.2%, 2.3%, and 2%, respectively). For statements about intercultural contacts and social security responsibility, neutrality was more common (24.3% and 22% neutral, respectively), although a clear majority still agreed (75.1% and 70.8%).

Finally, attitudes toward university teaching styles were highly positive. Most students supported the idea that educators should promote future-oriented thinking (91% agreement), use student-centered methods (91% agreement), and encourage interdisciplinarity (82.1% agreement). About three-quarters agreed that teachers should link local and global issues (75.4%) and emphasize critical thinking over lecturing (74.4%), although a notable proportion remained neutral. Disagreement across these items was also consistently very low (around 1–4%).

Results

The first hypothesis compared the attitudes of students with different academic backgrounds – Teacher Education students with a science subject (n = 268), Teacher Education students without a science subject (n = 124), and Teacher Education students for pre-primary or primary education (n = 345) – towards key environmental issues related to sustainable development. Before applying the Kruskal-Wallis test, the assumptions of nonparametric analysis – namely the independence of observations and the ordinal nature of the data – were verified and met in this study. The Kruskal-Wallis ANOVA was then used for analysis. (Explanation: H = test statistic, N = sample size, p-value = significance level.)

The results of the Kruskal-Wallis ANOVA indicated no statistically significant differences in the views of students from different backgrounds on the three core components of sustainable development: environmental protection ($H = 0.96$; $p = 0.619 > 0.05$), economic growth ($H = 1.173$; $p = 0.556 > 0.05$), and social inclusion ($H = 1.648$; $p = 0.439$

> 0.05). Given the ordinal nature of the data (Likert scales) and its distribution, the use of this nonparametric test was appropriate.

In the case of Hypothesis H3, where statistically significant differences were found (H = 108.28; p < 0.001), it is advisable to include an effect size measure, such as epsilon squared (ε^2), to better quantify the practical significance of the observed differences between groups. Similarly, although Hypothesis H1 did not yield statistically significant differences, reporting the exact H values and briefly interpreting them – even when very small – would help readers assess whether the differences are negligible or just short of significance.

Table 1

Kruskal-Wallis ANOVA; Sustainable Development

Independent (grouping) variable: Approval Kruskal-Wallis test H (2, N = 737) = ,0841; p = ,9588				
	Code	**Valid N**	**Sum of Ranks**	**Mean Rank**
Teacher training combined with a science subject	101	268	98170.5	366.3078
Combined teaching without a science subject	102	124	45685.0	368.4274
Teaching for pre-primary or primary education	103	345	128097.5	371.2971

The Kruskal-Wallis ANOVA results also confirmed that there are no statistically significant differences in the views of students with different backgrounds on the three core elements of sustainable development - environmental protection (H = 0.96; p = 0.619 > 0.05), economic growth (H = 1.173 ; p = 0.556 > 0.05) and social inclusion (H = 1.648 ; p = 0.439 > 0.05), hypothesis H1 was not confirmed.

The next hypothesis tested our assumption on whether a significant majority of the students of Pre-primary and Primary Education Teacher Education achieved an average score of at least 36 points, i.e. an average pass rate of at least 60%, in a knowledge test focusing on the main environmental issues of sustainable development.

Table 2

Binominal Test Success Rate of Students' Knowledge Level

	Level	**Count**	**Total**	**Proportion**	**p**	**95% Confidence Interval**	
						Lower	**Upper**
Score	≥ 36	59	345	0.171	<.001	0.133	0.215
	< 36	286	345	0.829	<.001	0.785	0.867

As shown by the results of the binomial test (see table), a significant majority of students ($p < 0.001$) achieved an average score below 36 points – i.e., less than 60%– indicating that students' knowledge of this area is not satisfactory and is, in fact, at a low level. The 95% confidence interval further suggests that, within the broader population of students in this field, we can expect with 95% certainty that only 13.3% to 21.5% would demonstrate proficiency level of – unnecessary at least 60% (95% CI [13.3; 21.5]). Therefore, Hypothesis H2 was not confirmed.

The 60% threshold was selected as the instead of a pass benchmark in accordance with traditional academic grading systems, which are typically regarded instead of where it is as the minimum standard for satisfactory performance. This standard is commonly used in knowledge assessments in higher education, especially when evaluating foundational competencies required for future teaching practice.

Finally, to test instead of testing which are typically regarded instead of where it is the last hypothesis, we examined whether there are statistically significant differences in students' general knowledge related to key environmental issues of sustainable development. The Kruskal-Wallis ANOVA results revealed highly significant differences among students with different academic backgrounds ($H = 108.28$; $p < 0.001$).

Table 3

Kruskal-Wallis ANOVA; Total Test Score

Independent (grouping) variable: Approbation Kruskal-Wallis test H (2, N = 737) = 108,2814; p = 0.000				
	Code	**Valid N**	**Sum of Ranks**	**Mean Rank**
Teacher training combined with a science subject	101	268	126480.0	471.9430
Combined teaching without a science subject	102	124	44787.5	361.1895
Teaching for pre-primary or primary education	103	345	100685.5	291.8420

Subsequent multiple comparisons of p-values revealed that the largest knowledge differences exist between Teaching for Pre-Primary or Primary Education students and Teaching combined with Science students ($p < 0.001$). Specifically, Teaching for Pre-Primary and Primary Education students demonstrated significantly lower knowledge levels. Students in the Teaching combined with Science group achieved an average score of $M = 35.49$ on the knowledge test, corresponding to a success rate of 59.2%. In contrast, Teaching for Pre-Primary and Primary Education students scored an average of only 28.54 points, representing a 47.6% success rate.

Furthermore, Teaching for Pre-Primary and Primary Education students also scored significantly lower than students in the Teaching combined without Science

group ($p = 0.0056 < 0.01$), who had an average score of $M = 30.99$, or a 51.7% success rate. When comparing Teaching combined without Science students to those in the Teaching combined with Science group, the former performed significantly worse ($p < 0.001$). Therefore, Hypothesis H3 was confirmed.

The differences between groups were highly statistically significant ($p < 0.001$), and the effect size (e.g., eta² or Cohen's f) indicates a moderate effect size for these group differences.

Table 4

Approbation – Teaching for Pre-Primary or Primary Education

Spearman Rank Order Correlations
Marked correlations are significant at $p < 0.0500$

	Environmental protection	**Economic development**	**Social inclusion**
Environmental protection	1.000000	0.595231	0.513909
Economic development	0.595231	1.000000	0.592699
Social inclusion	0.513909	0.592699	1.000000

The first research question aimed to determine whether there is a relationship between students' attitudes toward different elements of sustainable development – namely environmental protection, economic growth, and social inclusion – using the non-parametric Spearman's rank correlation coefficient. The correlation analysis revealed positive, statistically significant ($p < 0.05$), and moderately strong correlations among all three variables. This indicates that students who support environmental protection also tend to support strategies promoting economic growth and addressing social needs.

Specifically, students' attitudes toward environmental protection were significantly correlated with their attitudes toward promoting economic development ($R = 0.595$) and with attitudes related to social issues such as poverty eradication and reducing inequality ($R = 0.514$). Additionally, attitudes toward economic growth were significantly related to support for social progress and improving living standards ($R = 0.593$).

The second research question aimed to determine whether the depth of students' knowledge about environmentalism and sustainable development is related to their attitudes and beliefs regarding the achievement of sustainable development. The correlation analysis revealed a weak but statistically significant relationship between knowledge and attitudes ($R = -0.1182$; $p = 0.0282 < 0.05$). This indicates that students who scored higher on the knowledge test demonstrating better understanding of environmentalism and sustainable development – end to have more positive attitudes toward the Sustainable Development Goals (SDGs).

Table 5

Comparison of Attitudes and Knowledge of Future Teachers

Spearman Rank Order Correlation MD pairwise deleted Marked correlations are significant at p<,0500				
Pair of Variables	**Valid N**	**Spearman R**	**T(N-2)**	**p-value**
Teacher training combined with a science subject	345	-0.118194	-2.20444	0.028157

Notably, higher knowledge scores were associated with lower scores on the attitude measure, where lower attitude scores represent stronger agreement with positive statements about sustainable development, reflecting a more favorable overall attitude.

Discussion

Based on the questionnaire results, this subsection evaluates and discusses the findings. We formulated two research problems and three hypotheses to explore the attitudes and knowledge of future teachers and to propose practical solutions for pedagogical practice.

The first research problem examined whether there is a correlation between the attitudes of pre-primary and primary education students regarding different aspects of sustainable development. The results showed that students who favor environmental protection also tend to support strategies that promote economic growth and address various social issues. The second research problem investigated whether students' attitudes and beliefs about achieving sustainable development are related to the extent of their knowledge about environmentalism and sustainable development. The findings suggest that students with higher knowledge scores have more positive attitudes toward the Sustainable Development Goals (SDGs).

The first hypothesis compared the attitudes of students from different educational backgrounds on key environmental challenges related to sustainable development. The results indicated no significant differences in opinions based on their study program. Most students showed overall support for the SDGs and their three core pillars: social inclusion, economic growth, and environmental protection.

Hypothesis 2 examined whether the majority of pre-service pre-primary and primary teachers achieved a passing score of at least 36 points (60%) on the knowledge component about key environmental challenges. The findings revealed that most students scored below this threshold, indicating a rather low level of understanding among prospective teachers.

The final hypothesis investigated differences in general knowledge about key environmental issues among students from different study programs. The largest knowledge gaps were found between pre-primary and primary education students and those studying teaching combined with a science subject.

To foster a more environmentally responsible society, it is crucial to support future teachers in developing positive attitudes toward sustainable development. Cultivating these attitudes will help create a generation of educators who can inspire and guide pupils toward a sustainable and environmentally conscious future. There is a strong connection between teacher trainees' familiarity with the natural world, their interest in the environment, and their positive views on sustainability. Future teachers are more likely to appreciate the importance of sustainability and integrate it into their teaching if they have a solid understanding of nature and ecological principles.

While basic knowledge of nature is essential, attitudes and behaviors are also shaped by personal beliefs, cultural backgrounds, and social norms. Therefore, the most effective way to develop positive attitudes toward sustainable development is through experiential learning, combining meaningful discussions with practical engagement. Closing the knowledge gaps is vital to fostering favorable attitudes toward sustainability. By focusing on appropriate strategies, we can equip future teachers with foundational environmental awareness, enabling them to effectively communicate the importance of sustainable development and inspire positive attitudes toward environmental protection, nature, and ecology in their students.

Research shows that persistent stereotypes affect how environmental education is prepared and delivered in schools. Specifically, environmental education is often viewed solely as part of science literacy; content-focused objectives are prioritized over skills development; science education is fragmented across isolated themes; and traditional teaching methods dominate, including heavy reliance on a single textbook and limited project-based learning. Furthermore, there are too few classroom activities aimed at developing students' science literacy and cognitive skills, and teachers often lack the capacity for reflective evaluation of their instructional methods (Výbohová, 2013).

There is a clear need to emphasize ecological and environmental education as a fundamental literacy for every individual. Greater focus should be placed not only on ecological information but also on education about the environment – shifting from education for the environment to education about the environment (Rakovská, Noskovič, 2013). The curriculum frames environmental education as an opportunity to influence pupils' knowledge and behavior, aiming to develop a well-rounded understanding of the interactions between humans and their environment grounded in the laws governing life on Earth (Kminiak, 2003).

The results of this study reinforce the importance of integrating environmental education within teacher training, especially in the context of sustainable development. While pre-service teachers generally hold positive attitudes towards environmental protection

and sustainability, their knowledge of these areas remains insufficient. This knowledge gap highlights the need to incorporate comprehensive environmental education strategies in teacher preparation programs to improve scientific literacy and pedagogical skills related to sustainability. These principles align with sustainable education objectives that emphasize interdisciplinary learning and hands-on engagement to build environmental awareness (Sterling, 2001).

In addition, the UNESCO (2017) Education for Sustainable Development framework offers a structured model for embedding sustainability into teacher training curricula. Quality environmental education and education for sustainable development not only increase awareness but also foster proactive engagement with sustainability. The educational process thereby supports young people's growth alongside their understanding of the world around them (Ivanegová, 2020).

Limitations of this study must be acknowledged. First, the reliance on self-reported questionnaire data introduces potential biases, including social desirability effects and subjective interpretation of questions by respondents. Second, the sample showed a significant gender imbalance, with women comprising 93.9% of participants, which may skew results if gender differences in attitudes or knowledge exist. Third, using an online questionnaire risks selection bias, as it primarily captures respondents with digital access and interest. Future research should aim for more representative samples and consider combining quantitative surveys with qualitative methods (e.g., interviews or focus groups) to deepen understanding of teacher trainees' motivations and attitudes toward environmental education.

Theoretical frameworks also provide useful insights. Bandura's (1986) social learning theory suggests that attitudes and behaviors develop through observation and modeling. Therefore, teacher trainees exposed to sustainable practices during their education are more likely to adopt and pass these practices on to their students. Similarly, Ajzen's (1991) theory of planned behavior posits that attitudes, subjective norms, and perceived control influence intentions and actions. If teacher trainees perceive environmental education as valuable and feasible within their curriculum, they are more likely to implement sustainable teaching practices.

Educational implications from this study are significant. Teacher training programs must prioritize sustainability by integrating interdisciplinary coursework, fostering experiential learning, and providing ongoing professional development in environmental education. Developing targeted curricular materials and interactive teaching strategies can help close the knowledge gaps identified. Moreover, collaboration between educational institutions, environmental organizations, and policymakers is essential to successfully implement sustainability initiatives in early childhood and primary education settings.

Suggestions

A 2019 survey by Friends of the Earth-CEPA examined how climate change and energy topics are integrated into school curricula and teaching practices across selected districts. The survey revealed that both the Innovated State Educational Programme (ISVP) standards and textbooks approved by the Ministry of Education, Science, Research and Sport of the Slovak Republic (MoESR) for first-grade primary schools largely omit detailed coverage of climate change and the relationship between social development and global warming. Although these topics receive somewhat more attention at the second primary school level, the coverage remains insufficient (Ivanegová et al., 2021).

Designing active, engaging activities for children and students is crucial to enhancing science literacy and cultivating science-literate citizens. Such activities equip pupils with the skills, knowledge, and enthusiasm needed to engage meaningfully with science, make informed decisions, and contribute to societal scientific advancement. Our activities target not only kindergarten children and primary teachers but also parents, the general public, and serve as developmental resources for future teachers. Although activities are presented with teacher accompaniment in mind, this is not mandatory. To introduce key concepts about plants, animals, nature, and ecology, we created an educational resource titled We Want to Know More.

These activities were developed using Bloom's Taxonomy of Objectives to structure learning goals and include discussion questions designed to promote reflection, improve retention, and raise awareness. The materials were created using Canva, an online graphic design platform, and are based on authoritative publications such as Krejča and Imro (2004), Krejča and Korbel (2009), Raid and Schwarzbach (2022), Slavíková et al. (2012), and official lists from the Ministry of the Environment of the Slovak Republic (2023), among others.

Promoting environmental awareness is essential for sustainable living and planetary well-being. Based on our research and collected insights, we recommend the following:

Tailor educational materials and approaches to children's individual characteristics, needs, and interests.

Use engaging discussions, clear and concise information, and original, easy-to-understand visuals that encourage critical thinking and research skills.

Organize seminars, workshops, or interactive activities for prospective and current teachers that foster creativity, effective learning, and experience sharing.

Integrate specialized training in university teacher education programs through compulsory or elective courses on nature and environmental education, covering basic ecology, biodiversity, ecosystems, environmental challenges, and field observations with practical applications.

Promote experiential learning through field trips and outdoor excursions that include hands-on, project-based activities and experiments focused on nature and sustainability.

Develop visually appealing and accessible educational materials such as brochures, activity guides, e-books, and books.

Applying these recommendations within theoretical frameworks highlights that enhancing environmental education in teacher training requires a multifaceted approach. This approach should combine experiential learning, interdisciplinary integration of sustainability, and professional development emphasizing hands-on engagement with environmental issues.

Conclusion

We compared the knowledge and attitudes of future teachers in pre-primary and primary education, focusing on biology or ecology and their connection to science education. This comparison is relevant given the integration of biology with environmental education in response to ongoing school reforms, curriculum restructuring, and efforts to better link primary and lower secondary education. Based on our questionnaire, prospective teachers across different approbations – pre-primary and primary education, teaching without a science subject, and teaching combined with a science subject – generally hold positive attitudes toward sustainable development. However, knowledge levels were unsatisfactory among pre-primary and primary education teachers, with an average success rate of only 47.6%.

The observed relationship between students' knowledge and their attitudes toward sustainability supports Ajzen's Theory of Planned Behavior (1991) and aligns with recent research by Biasutti and Frate (2017), who found that environmental knowledge significantly influences educators' pro-environmental behavioral intentions. This is further emphasized in contemporary experiential learning models (Friman et al., 2023), which are essential for developing environmental literacy and fostering sustainability-oriented pedagogical strategies.

Our findings resonate with Stevenson's (2007) critique, which points out contradictions between the goals of environmental education and its actual classroom implementation. Without experiential, critical, and participatory approaches, sustainability education risks remaining superficial and failing to cultivate genuine environmental values in students. Therefore, as indicated by our results, integrating active and interdisciplinary learning methods is crucial to bridging the gap between theoretical goals and practical outcomes in teacher training.

From a theoretical standpoint, our study supports the three-pillar model of sustainability (Purvis et al., 2019), which underscores the interconnectedness of environmental,

economic, and social dimensions. The positive correlations between students' support for environmental protection, social inclusion, and economic development suggest that they perceive sustainability as a multifaceted concept. However, the limited depth of knowledge among many participants highlights the need for more comprehensive engagement with the foundational principles of sustainable development.

Strengthening sustainability education aligns with global initiatives such as UNESCO's Roadmap for Education for Sustainable Development (ESD) 2030 (UNESCO, 2020) and contributes to achieving the United Nations Sustainable Development Goal 4.7, which mandates that all learners acquire the knowledge and skills necessary to promote sustainable development.

Future research should investigate the long-term effects of enhanced sustainability education within teacher training programs and examine how improved environmental literacy impacts teaching practices and student learning outcomes. Comparative studies of sustainability education approaches across different countries could also yield valuable insights into effective strategies for fostering ecological awareness and action among future generations.

In conclusion, our study highlights the urgent need to reinforce environmental education in teacher preparation programs. By providing a stronger theoretical foundation and equipping future educators with essential knowledge and pedagogical tools, we can nurture a generation of teachers who are not only aware of sustainability challenges but are also proactive in addressing them. This comprehensive approach is vital to making environmental education a core element of building a more sustainable and responsible society.

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Aplinkosauginio ugdymo vaidmuo rengiant mokytojus: tvaraus vystymosi kontekstas

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Santrauka

Šiame tyrime nagrinėjamos Slovakijos būsimųjų ikimokyklinio ir pradinio ugdymo mokytojų aplinkosauginės žinios ir nuostatos tvaraus vystymosi kontekste. Respondentai demonstravo labai palankų požiūrį į aplinką ir visapusiškai palaikė socialinį, ekonominį ir aplinkosauginį tvarumą, bet jų faktinės žinios apie pagrindines aplinkosaugos problemas pasirodė nepakankamos. Mokytojų rengimo programų studentai, kurių studijų programoje nebuvo daug dėmesio skiriama gamtos mokslams, gavo žymiai mažesnius balus nei tie, kurie specializavosi gamtos moksluose. Nustatyta teigiama koreliacija tarp nuostatų į skirtingas tvarumo dimensijas, taip pat silpnas, bet reikšmingas ryšys tarp aukštesnio žinių lygio ir palankesnių tvarumo nuostatų.

Šie rezultatai rodo, kad būtina stiprinti aplinkosaugos ir tvarumo ugdymą mokytojų rengimo programose, didesnį dėmesį skiriant patirtiniam mokymuisi, tarpdisciplininiams metodams ir praktinėms veikloms. Toks mokytojų rengimas itin veiksmingas siekiant ugdyti mokslinį raštingumą, skatinti būsimas mokymo programų reformas ir rengti pedagogus, gebančius ugdyti mokinius, sugebėsiančius atsakingai elgtis aplinkoje.

Esminiai žodžiai: *aplinkosaugos švietimas, švietimas, tvarus vystymasis, mokslinis raštingumas, mokytojo požiūris.*

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