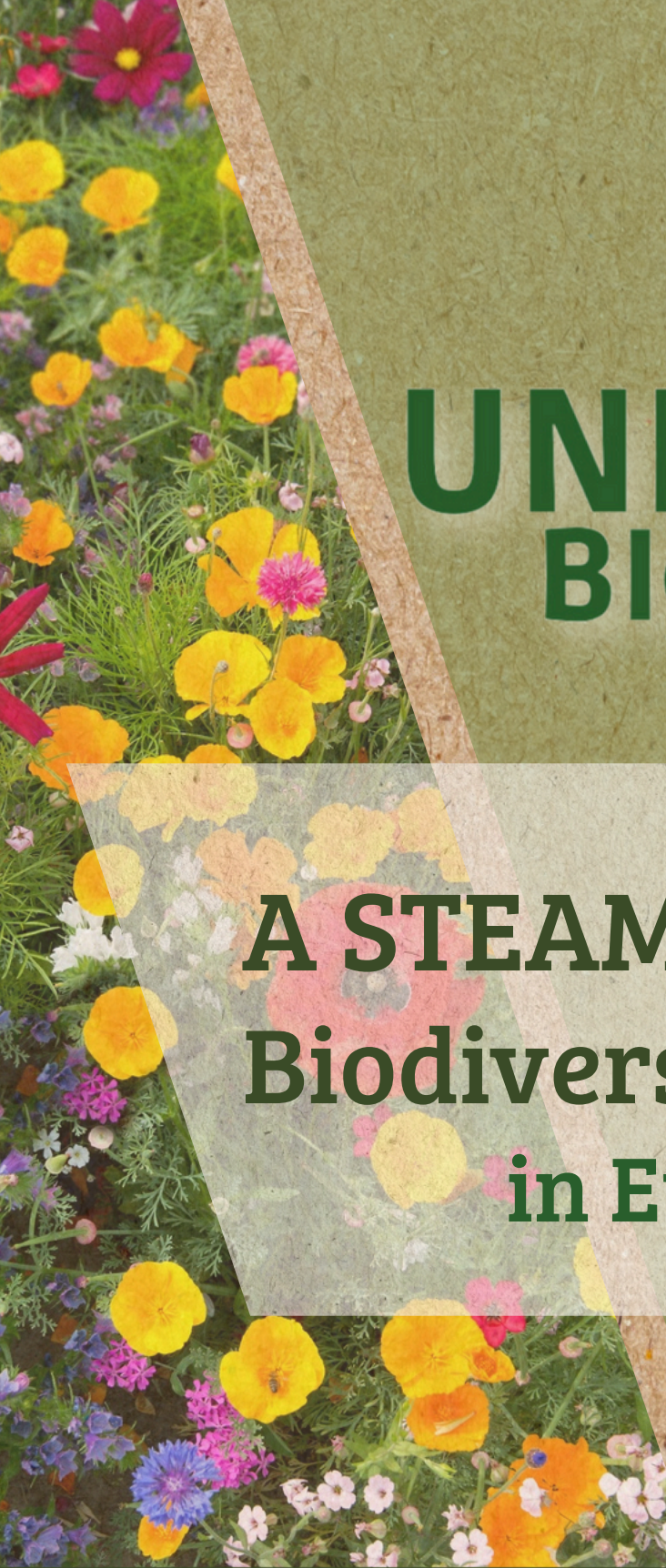

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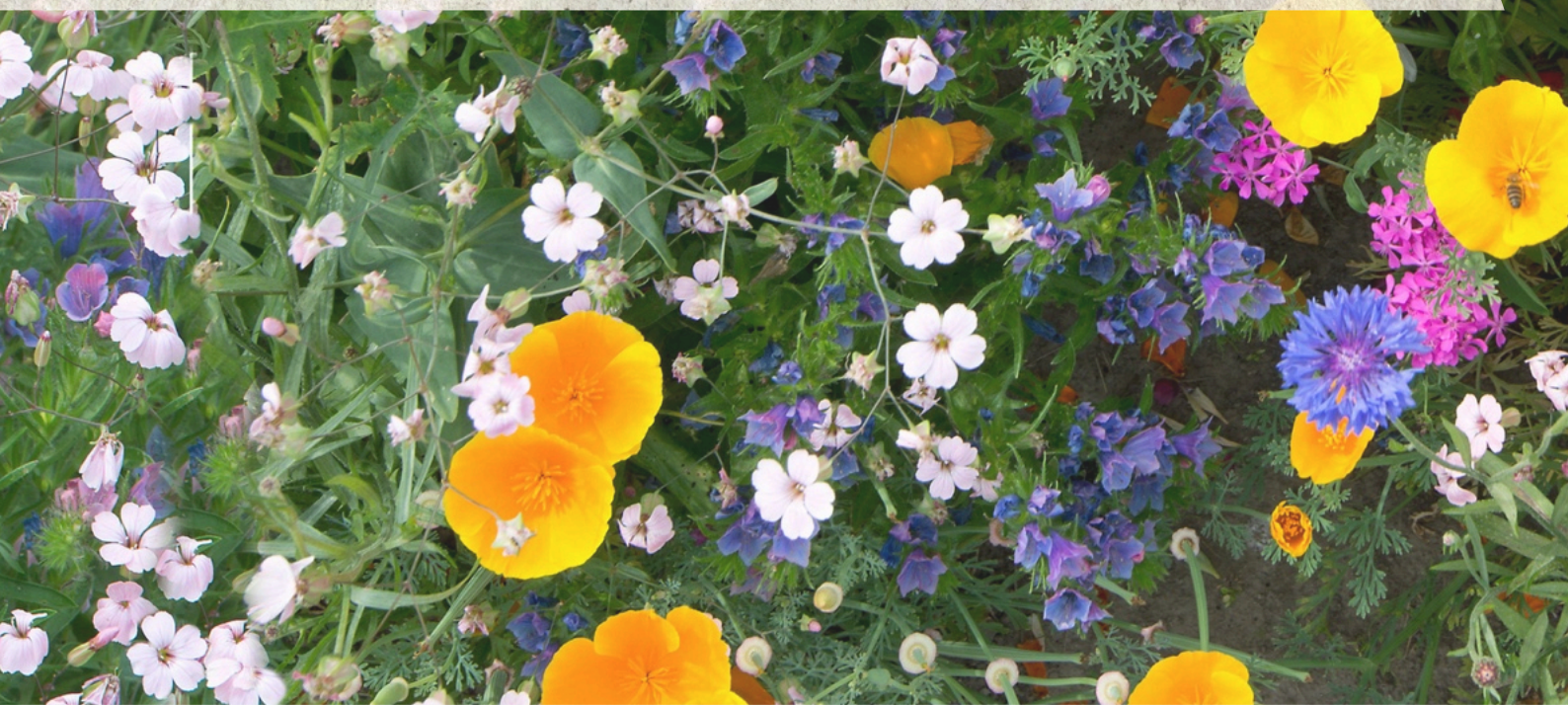
UNITED IN BIODIVERSITY

A STEAM Approach to Biodiversity Education in European Schools

Handbook for Decision Makers

Lambda Twelve Renctas ARTETEKA casadoprofessor IC ai Campi Elisi SZKOŁA PODSTAWOWA im. MARII KONOPNICKIEJ W MROKOWIE

This handbook serves as a comprehensive guide for educational leaders, policymakers, and practitioners committed to advancing biodiversity education through innovative, evidence-based approaches that prepare students for environmental citizenship and sustainable living in an interconnected global community.



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1

Introduction: general project overview, strategies and kick-off

General Overview

The United in Biodiversity project represents a pioneering initiative in educational innovation, addressing one of the most pressing challenges of our time through systematic curriculum integration. Funded under the Erasmus+ KA220-SCH framework, this 34-month transnational partnership brings together educators, non-governmental organizations, training institutions, and social enterprises across six countries to embed biodiversity education within European primary schools' curricula.

The project's foundation rests on the recognition that biodiversity challenges require systemic educational shifts rather than isolated interventions. Current educational approaches often treat environmental topics as peripheral subjects, failing to integrate them meaningfully across disciplines or to engage students in ways that foster deep understanding and lasting behavioral change. This handbook documents our comprehensive approach to transforming biodiversity education through STEAM (Science, Technology, Engineering, Arts, and Mathematics) integration.

Context and Policy Relevance

Biodiversity loss poses a critical global threat, accelerated by deforestation, climate change, pollution and illegal wildlife trafficking. Europe, despite being highly urbanized and industrialized, plays a central role both in addressing these challenges and contributing to them. According to the IUCN and the European Environment Agency, nearly 25% of assessed species in Europe face extinction threats. Biodiversity degradation compromises food security, water quality, climate regulation and the overall stability of ecosystems.

While the European Union has introduced key policies such as the European Green Deal, the EU Biodiversity Strategy 2030, the Farm to Fork Strategy and the EU Action Plan against Wildlife Trafficking, a significant gap remained in integrating these objectives into formal educational systems. Schools are in the ideal position to reach young people at an early stage, when environmental attitudes and habits are forming. "United in Biodiversity" served as a strategic educational bridge, transforming high-level policy commitments into classroom realities.

Strategic Objectives

The project was structured around two principal objectives. The first focused on curricular innovation, aiming to introduce biodiversity content in primary education through interdisciplinary STEAM frameworks and encourage real-world problem-solving and critical thinking about biodiversity.

The second objective centered on synergistic collaboration and institutional change, promoting alliances between schools, NGOs, policy makers and the community, while equipping educational institutions with learning tools for environmental sustainability.

These objectives aligned directly with Erasmus+ priorities such as environment and climate change (horizontal priority), improvement of excellence in STEM/STEAM education, and professional development of teachers and school leaders.

Stakeholders and Target Groups

The project addressed four main stakeholder groups. Direct beneficiaries included STEAM teachers, both in training and in service, and school leadership teams–decision-makers responsible for curriculum and professional development.

Indirect beneficiaries comprised pupils (8-14 years) who received enriched and contextualized environmental education, and environmental NGOs and community actors who engaged with schools through awareness-raising activities and resource sharing.

By working with decision-makers, professionals and students, the project ensured multi-level impact that supported transformation from policy to practice.

Partnership Composition and Complementarity

The project brought together six organizations that contributed unique competencies and geographical contexts, enabling shared learning and broader applicability of project results

Lambda Twelve from Greece coordinated the project and contributed expertise in digital course design and STEAM pedagogy.

RENCTAS from Brazil brought expertise in conservation, wildlife trafficking prevention and political advocacy.

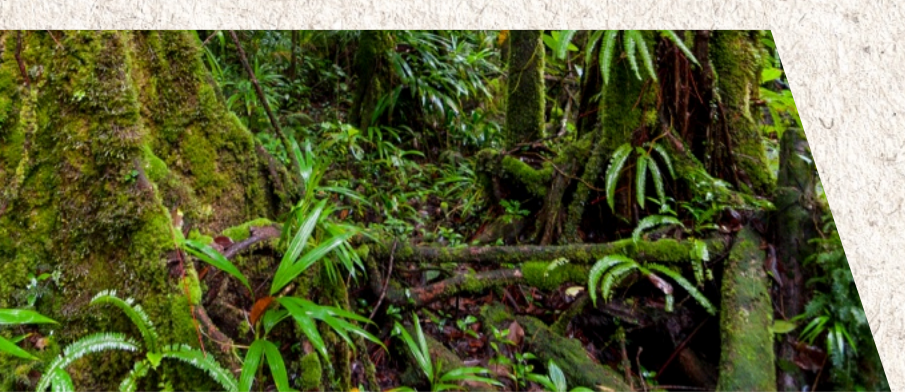
ArtéTeka from Ireland specialized in non-formal learning, creative education and youth artistic initiatives.

Casa do Professor from Portugal handled teacher training, mobility coordination and management of an extensive school network.

The Italian school **Istituto Comprensivo ai Campi Elisi** served as a pilot site for curricular innovation and outdoor learning spaces.

The Polish school **Szkola Podstawowa w Mrokowie** contributed ecological practices, student involvement and citizen science.

Each partner contributed unique competencies and geographical context, enabling shared learning and broader applicability of project results.



Project Structure and Work Packages

The project was divided into three main work packages (WP). WP1 focused on project management, including internal coordination, communication and reporting, monitoring and evaluation planning, risk management and quality assurance.

WP2, entitled "Pathway to Biodiversity in STEAM", included the development of an assessment rubric to evaluate biodiversity integration in STEAM subjects, the creation of 25 interdisciplinary lesson plans, an international teacher mobility programme (18 mobilities), the development of research theses for teachers in training, professional development workshops and peer collaboration.

WP3 was dedicated to institutional and policy innovation through the design and implementation of a Massive Open Online Course (MOOC), the publication of this handbook to guide leadership-level and policy actions, a final transnational conference in Italy and dissemination of results and engagement of new networks.

The Kick-off Meeting: Foundations for Success

The kick-off meeting of the "United in Biodiversity" project, held in Greece from 25-26 April 2023 and hosted by Lambda Twelve IKE, marked the official launch of this transnational initiative. As a foundational event of the 26-month project (subsequently extended by 8 months), the meeting consolidated a shared vision, refined project deliverables and fostered trust among consortium members.

During the three working days, the programme alternated between institutional presentations, review of project objectives and training on STEAM and biodiversity frameworks. Particular attention was given to detailed planning of work packages, with in-depth discussions on lesson plan development and rubric design (WP2), and brainstorming on the MOOC and Decision-Makers Handbook (WP3).

The meeting produced significant tangible and intangible results. The original work plan was updated to reflect realistic timelines for intellectual outputs, new intermediate deadlines for internal reviews and milestones for collecting feedback from teachers and students. Partnerships were strengthened through trust-building, open channels for future collaborations, understanding of partner strengths and preferred communication styles, and willingness to co-create rather than work in silos.

The kick-off meeting laid solid foundations for the success of "United in Biodiversity." By aligning vision, clarifying roles and building mutual trust, the partners ensured a coordinated and dynamic start to the project. The event exemplified effective international cooperation in educational innovation, with a shared commitment to biodiversity, pedagogy and systemic impact.

2

Expert panels and Rubrics: Development of Assessment tools

Overview of Expert Panels

Within the United in Biodiversity (UNIBIO) project, RENCTAS organized five expert panel sessions dedicated to the main drivers of biodiversity loss: Wildlife Trafficking, Climate Change, Pollution, Habitat Fragmentation and Invasive Species. Each online panel, held between August and September, brought together a multinational team of STEAM teachers and a guest specialist from an environmental NGO or institution, creating a high-value interdisciplinary educational forum.

The panels were designed not only to inform educators about urgent biodiversity challenges, but also to collaboratively develop STEAM-focused educational rubrics for each topic. This section documents the composition, format, educational contributions and significance of the panels in shaping curricular content and teacher training.

Composition and Panel Participation

Each expert panel involved approximately 8-10 STEAM teachers from partner institutions in Brazil, Greece, Italy, Poland and Portugal, accompanied by at least one invited expert on the respective topic. The teachers represented all STEAM disciplines (Science, Technology, Engineering, Arts, Mathematics), ensuring diverse and complementary perspectives.

RENCTAS engaged external specialist organizations to guide specific thematic content.

For **Wildlife Trafficking**, RENCTAS directly assumed the expert role, with coordinators Tiago Carvalho and Thiago Vargas presenting the phenomenon of wildlife trade and guiding discussion.

For **Climate Change**, Iroko Desarrollo Forestal Sostenible from Spain contributed through coordinator Marta Nuéro, who led the session with a detailed presentation on climate change causes and effects and shared Iroko's experience in climate and development projects.

Pollution was addressed with the contribution of The Clean River Project from Germany, represented by Franziska Braunschädel, who shared her organization's work on plastic pollution in rivers, answered teachers' questions and suggested activities derived from Clean River workshops with young people.

For **Habitat Fragmentation**, QG Enviro from Italy delegated secretary Giuseppe Scandone, an environmental educator who provided an overview of habitat fragmentation problems and actively participated in panel discussion, drawing from his NGO's experience in habitat conservation.

Invasive Species were examined by Invasoras.pt from Portugal, represented by Dr. Elizabete Marchante, a recognized expert in invasive species management. Elizabete provided a twenty-minute presentation on invasive species and shared a repertoire of educational activities that her project uses with school children.

The participation of each expert proved fundamental to the quality of results. They not only presented the most current knowledge on their topic, but also reviewed and contributed to educational outputs (the rubrics), ensuring accuracy and scientific quality. The presence of these specialists elevated the panels to an authentic professional development experience for teachers, exposing them to real-world conservation projects and expert guidance.

Panel Structure and Methodology

The five panel sessions followed a structured but evolving format, characterized by approximately one-hour duration, video meeting format and moderation by RENCTAS. The agenda generally included introductions and contextualization, expert presentation, rubric introduction, collaborative discussion with feedback, and process evaluation.

In the first session dedicated to Wildlife Trafficking, RENCTAS introduced all participants, outlined UNIBIO project objectives and clarified the panel process. This orientation ensured shared understanding of the focus on STEAM integration and expected results.

Each session featured a focused presentation from the invited expert (10-30 minutes). The Climate Change panel, for example, dedicated the first half-hour to Marta Nuéro's presentation on climate change science and impacts. These interventions equipped teachers with a solid content foundation on the issue being addressed, often including case studies, empirical data and examples of mitigation strategies.

Following the expert presentation, RENCTAS introduced a draft **STEAM rubric** developed specifically for that biodiversity topic. RENCTAS had prepared an initial rubric model, beginning with the Wildlife Trafficking panel. This rubric template was a criteria matrix designed to integrate the topic into learning objectives across STEAM subjects and at different competency levels.

The concluding part of each session was an interactive workshop where teachers actively participated in the process of reviewing and improving rubrics.

Teachers could express observations and suggestions both through direct input and through comments inserted in real-time in the shared Google Drive document. This participatory approach generated numerous proposals for modifications, additions and methodological refinements, while RENCTAS played a moderation role to ensure all STEAM disciplines were represented.

The methodological evolution of panels led to significant improvements in process effectiveness. After the Climate Change panel, the need emerged to share rubric drafts in advance with participants, allowing them to develop more thoughtful contributions. This innovation was implemented starting with the Habitat Fragmentation panel: distributing the rubric one week before the meeting allowed teachers to arrive at the workshop with structured proposals and in-depth reflections.

The collaborative philosophy that characterized the panels transformed teachers into true co-designers of final rubrics. RENCTAS's role was facilitation rather than direction, integrating concrete experiences and cultural specificities of educators from different European contexts. This participatory approach ensured that rubrics were not only theoretically valid but also practically applicable in diverse national educational systems.

STEAM Rubric Development and Educational Content

A main output of each panel was the development of a STEAM-based rubric for the respective biodiversity challenge. These rubrics took the form of detailed guides that outlined approaches to the environmental topic at different levels of student mastery, across multiple thematic areas. Through the panel process, rubrics evolved and acquired several distinctive characteristics.

Starting from the Habitat Fragmentation panel, rubrics were explicitly organized into three competency levels–Initial, Developing, Excellent–to support student learning progression. At the Initial level, students encounter basic concepts on the topic and related STEAM fundamentals.

The Developing level deepens understanding, introducing key concepts and connections between disciplines. At the Excellent level, students demonstrate advanced knowledge, global citizenship awareness and involvement in real-world initiatives.

Each rubric included criteria corresponding to **Science, Technology, Engineering, Arts and Mathematics**, detailing how each discipline could address aspects of the biodiversity challenge. During discussions, teachers actively developed exercises and project ideas for each STEAM field. Implementing this process for all five panels generated a rich collection of interdisciplinary teaching ideas.

Another significant addition, introduced during the Climate Change session, was a rubric criterion for "**Developed Competencies (Examples)**," listing concrete abilities and competencies that students would acquire–skills necessary for citizens to address biodiversity loss. This element connected the rubric to real-world outcomes, anchoring lessons to broader societal needs.

The rubric category initially labeled "Language and Content" was expanded to "**Language, Content and Exercises**" to explicitly incorporate sample learning activities. This modification emerged from teacher feedback, according to which the rubric should directly suggest classroom exercises, not just theoretical knowledge points.

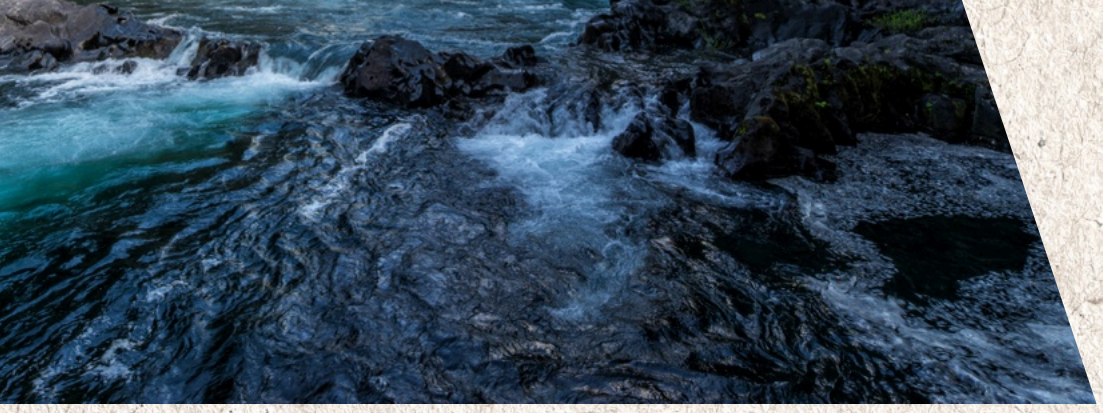
Invited specialists enriched rubrics by contributing field-tested activities and resources. Franziska from Clean River, for example, provided documents and suggestions for practical projects on plastic pollution that were integrated into the Pollution rubric. These inputs ensured that each rubric was grounded in effective and validated educational practices.

After each panel, RENCTAS consolidated all feedback and expert contributions to produce a definitive rubric document for the topic addressed. Evolving drafts and final versions were archived in the shared project drive along with meeting recordings and detailed minutes. By design, five rubrics were produced–one for each biodiversity challenge–collectively covering a matrix of 5 STEAM disciplines for 5 environmental challenges.

Educational Role and STEAM Integration

Expert panels served a dual educational role: professional development for teachers and curricular design for the project. For participating teachers, each session was an immersive learning experience. They acquired current knowledge on environmental issues from field experts, learning for example about local impacts of climate change, or how wildlife trafficking in one region influences global biodiversity.

Teachers positively evaluated the clear and informative presentations (the Pollution panel was judged "extremely clear and informative" thanks to the expert's contribution). This improved content knowledge proved critical since many educators had limited previous exposure to some topics (for example, a mathematics teacher might not be familiar with invasive alien species).



Simultaneously, teachers from different specialties exchanged ideas on how to connect their disciplines to biodiversity themes. During the Habitat Fragmentation discussion, teachers immediately began proposing STEAM project ideas on how engineering projects or artistic tasks could contribute to habitat fragmentation mitigation.

Another educational benefit was peer learning and networking. These panels connected teachers across different countries who shared best practices and cultural perspectives.

Impact on Curricular Design and Teacher Training

Expert panels were fundamental in shaping curricular outputs and the project's training strategy. Several impacts stand out.

The panels directly produced structured rubrics, which in turn guided lesson plan writing and MOOC course content. By involving teachers in rubric creation, the project ensured that eventual lesson plans (25 in total) and MOOC modules were teacher-informed and classroom-ready.

Through their involvement, the "guest" STEAM teachers improved their competency and confidence in teaching biodiversity. They practiced applying their subject expertise to global problems, which is precisely the skill set necessary for modern STEAM education. This capacity building effect was expected to spread outward: those teachers could become change agents in their schools.

Insights gained in panels fed into teacher training activities. For example, panel discussions identified misconceptions teachers or students might have and what content was most critical–this was useful in order to decide the MOOC development and learning objectives.

Panel work also ensured that the emerging curriculum aligned with broader educational priorities. By focusing on drivers of biodiversity loss, the content supported environmental literacy objectives established by international frameworks. Directly engaging STEAM teachers in environmental topics also advanced the goal of promoting excellence in STEM/STEAM education through real-world problem contexts.

Panels established a rich feedback development cycle that extended into future training. After rubrics were drafted, additional teachers from partner schools (in Poland and Italy) were invited to review them and provide feedback. The project built this feedback cycle to ensure that by the time of effective implementation, materials had been vetted by a broader educational audience.

In summary, expert panels were crucial in laying the foundations for UNIBIO project educational content. They produced concrete outputs (thematic rubrics) and intangible results (improved teacher knowledge, interdisciplinary collaboration skills) that together shaped a robust STEAM curriculum on biodiversity.

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3 Transnational Meeting and Lesson Plans: Training and experimentation

Overview of International Piloting Activity

The international piloting activity (training event), held in Braga (Portugal) **from 28 February to 1 March 2024**, formed part of WP2: Pathway to integrating biodiversity education in STEAM subjects. It provided a practical and replicable framework for embedding biodiversity education into of European primary schools STEAM curricula.

Hosted by **Casa do Professor**, the event brought together 18 STEAM teachers and representatives from 7 countries for practical training, peer learning and, collaborative refinement of project outputs, including assessment rubrics and lesson plans. The approach combined interactive seminars on the intersection between STEAM education and biodiversity, practical workshops to test 15 interdisciplinary lesson plans grouped into three themes (Pollution, Invasive Species, Climate Change), and peer feedback sessions to gather teacher insights and improve usability.

Pre-meeting Preparation and Diagnostic Assessment

Comprehensive preparation preceded the international gathering, with all participants completing diagnostic questionnaires designed to assess initial knowledge levels, expectations, and specific learning needs. This preparatory phase enabled organizers to tailor training content appropriately while establishing baseline measurements for evaluating learning outcomes and program effectiveness.

The diagnostic process revealed diverse starting points among participants, with teachers representing varying levels of experience in both biodiversity education and STEAM integration approaches. Some participants brought extensive environmental education backgrounds while others approached these topics for the first time, creating opportunities for peer learning and mutual support throughout the intensive program.

Training Objectives and Structure

The main objectives of the training activity were to build STEAM teachers' capacity to address biodiversity challenges in the classroom, pilot and evaluate interdisciplinary lesson plans aligned with national curricula, and foster international dialogue and exchange of practices in biodiversity education.

The three-day training combined theoretical presentations with practical activities. The first day included institutional presentations by partners, a review of the project and training objectives, and two seminars led by Ariana Macieira on integrating STEAM and biodiversity in education.

Ariana Macieira, a microbiologist from Braga and doctoral candidate at the Faculty of Biotechnology of the Portuguese Catholic University of Porto, conducted research on sustainability and food safety in local production. Her academic and professional background is closely linked to sustainability and reflects her scientific expertise. She participated in various local projects focused on sustainability themes and gained experience organizing scientific and sustainability workshops for children aged 10 to 17 at the university.

Practical Workshops and Experimentation

The second day featured a workshop on good practices in STEAM and biodiversity, facilitated by Hugo Dias. Hugo Dias holds a degree in Teaching Biology and Geology from the University of Minho and a post-graduate qualification in Special Education, focusing on visual and cognitive/motor domains. He served as Pedagogical Director of College D. Pedro V in Braga, having previously co-founded the Sementes de Liberdade (Seeds of Freedom) School.

The core part of the training consisted of group work aimed at piloting 15 lesson plans organised by theme. It is worth noting that, in addition to these, 10 further lesson plans were analysed, revised, and piloted by the partners after the training event, bringing the total number of lesson plans developed and tested to 25.

Group 1 addressed Pollution under the guidance of **Catarina Loureiro**, who holds a degree in Geology and a Master's in Geological Heritage and Geoconservation. Since 2010 she has worked in the fields of environmental education, sustainability, informal scientific education and outdoor education.

Group 2 addressed Invasive Species with **Vítor Martins**, a Mathematics and Science teacher. Since 2021 he has been seconded to the Centro de Ciência Viva de Braga, where he assumed responsibility for supporting applications for creating Practical Science Clubs in schools. He has been involved in coordinating Erasmus+ projects and served as coordinator for the Eco-School and Young Reporters for the Environment programs.

Group 3 focused on Climate Change with **Ana Nunes**, who completed her Master's in Preschool Education and is currently pursuing a PhD in Childhood Studies at the University of Minho. From 2018 to 2020 she worked as a teacher, and from 2019 to 2020 she also provided pedagogical coordination support.

Educational Visit and Final Feedback

The third day included an educational visit to the Quinta Pedagógica de Braga, an environmental training and experimentation center that serving preschool and primary students, children with special educational needs, elderly people, and other public public.

Education for environmental sustainability is one of the main objectives of this space. The goal is to raise awareness among children about environmental problems, particularly the importance of the environment for human wellbeing, as well as the significance of adopting environmentally respectful behaviors, understanding the effects of human activities on the environment and exploring sustainable alternatives.

The final feedback session with evaluation and certificate delivery concluded the training activity, allowing structured evaluations to be collected on the training experience and developed materials.

Key Results of the Braga Meeting

The Braga meeting produced several tangible and measurable results. Pre-mobility diagnostic questionnaires provided a baseline of participants' knowledge and expectations. Post-mobility questionnaires showed significant improvements in understanding STEAM methodologies applied to biodiversity.

The 25 lesson plans tested and refined based on teacher feedback represented the heart of the project's educational output. An interdisciplinary evaluation rubric co-designed with NGOs and educators provided concrete tools for learning assessment. Questionnaire results on training activities in Braga highlighted high participant satisfaction and effectiveness of the methodological approach adopted. The usability questionnaire for STEAM lesson plans confirmed that the interdisciplinary approach facilitates student understanding and increases their active involvement. The Braga piloting confirmed that providing teachers with ready-to-use tools and a shared vision for biodiversity education is a low-cost, high-impact strategy for making classrooms and curricula greener.

Development and Structure of Lesson Plans

The lesson plans developed in the United in Biodiversity project followed a common structure designed to ensure clarity, adaptability and replicability in diverse European school contexts. Each lesson plan included a clear title and indication of the target class with reference to the appropriate school level, learning objectives articulated in terms of knowledge, competencies and attitudes to be developed, and explicit connections to the Sustainable Development Goals of the 2030 Agenda.

The materials and resources section specified necessary digital tools, possible use of 3D printers, low-cost materials and external spaces. The activity sequence was structured in three phases: introductory to activate prior knowledge, operational development for active learning, and final reflection to consolidate learning.

Particular attention was given to strategies for inclusion and diversity, with simplified instructions, cooperative activities and multimodal resources to ensure participation of all students. Assessment criteria were accompanied by detailed rubrics that allow monitoring progress on three dimensions: knowledge, competencies and attitudes.

Ultimately, the lesson plans aim to make biodiversity education accessible and engaging, spark scientific curiosity, foster collaboration and creativity, and cultivate environmental responsibility through hands-on learning and active citizenship.

4

Practical Experiences: Research Theses and the Contribution of the Italian and Polish schools

Overview

In designing WP3, the main motivation was to anchor the project not only in theoretical frameworks but also in concrete, hands-on experiences. For this reason, the work package places strong emphasis on collecting direct feedback from students through mobility programmes and job-shadowing activities. These opportunities provide authentic insights into how biodiversity education is perceived, adapted, and implemented in real classroom contexts, while fostering a deeper understanding of both challenges and opportunities for teachers and learners.

In addition, the project strategically included direct analysis within schools. Alongside the contributions of expert panels and the development of evaluation rubrics, WP3 ensures that schools themselves become active laboratories for testing methodologies and fostering innovative practices. This strong practical orientation enhances the overall impact of the project, ensuring that the proposed models are not only theoretically sound but also feasible, adaptable, and meaningful within the daily reality of European primary education.

This chapter presents the research theses developed by two postgraduate researchers, as well as the experience of the Italian partner school, offering further concrete examples of application and contribution to the integration of biodiversity in educational contexts.

Research Thesis: Biodiversity Education in Greek Primary Schools

The research conducted by **Mitchell Rae** within the United in Biodiversity project, funded by ERASMUS+ and the EU, aimed to evaluate the implementation of environmental education in Greek primary schools, identifying the gap between government policies and effective practice. Through a three-month job-shadowing experience in a rural Greek school, the researcher observed the realities of environmental education provision and teacher support.

The study concluded that while Greece demonstrated solid environmental policy frameworks aligned with EU objectives, there was a significant disconnect in practice due to inadequate teacher training, insufficient resources and poor communication of initiatives.

The research used a qualitative and immersive methodology, with the student researcher participating in a 3-month placement funded by ERASMUS+ at a rural primary school in the Epirus region of Greece.

The key findings highlighted that teachers showed strong personal commitment to environmental education but lacked training, resources and awareness of national or EU initiatives. Government policies on environmental education were not effectively communicated or implemented at school level. Many schools relied exclusively on individual teacher or administrator initiatives for environmental education.

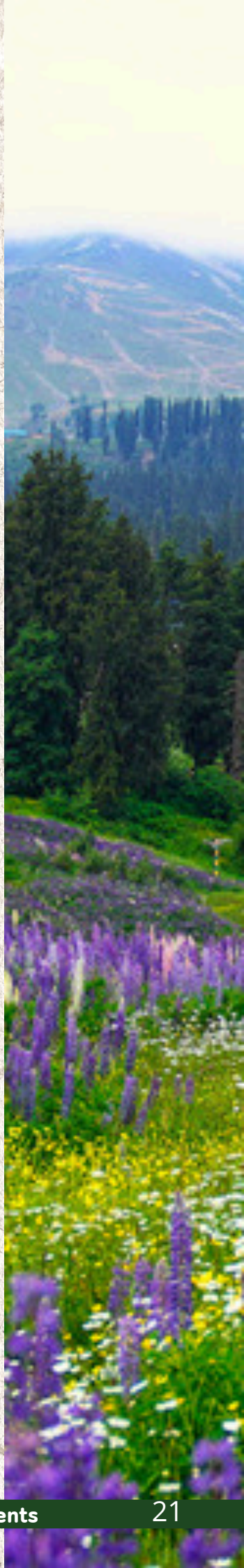
Disparities in educational quality and support were observed across different schools in Greece. Teachers expressed frustration with infrastructural deficits (e.g., poor internet, lack of teaching materials), which hindered their ability to teach environmental topics.

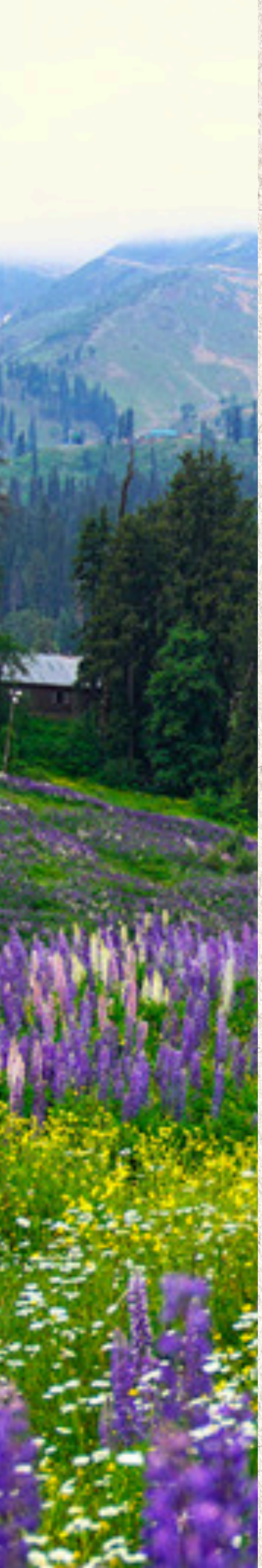
Research thesis: Arts-Based Approaches in Biodiversity Education

Research conducted by **Ella Barron Carton** investigated the use of arts-based practices in biodiversity education in ten European schools, with focus on poster creation workshops. The study highlighted how integration of creative activities in school contexts improves student understanding and retention of biodiversity-related topics and helps address emotional responses such as climate anxiety.

The research involved over 150 students from 10 schools in 5 European countries, using poster creation workshops as artistic intervention. Teachers received a scalable and sustainable lesson plan and subsequently provided structured feedback through qualitative interviews and quantitative questionnaire responses.

The results showed that the most common student reaction to biodiversity education before intervention was indifference. After the workshops, 7 out of 10 teachers reported positive changes in students' emotional engagement. Teachers noted that students felt empowered after creating and displaying their posters. 100% of teachers believed that the workshops improved content retention.





Students expressed pride in seeing their posters displayed, fostering a deeper connection and participation. Poster creation proved adaptable across different age groups and languages, improving inclusivity. The approach revealed universal appeal, allowing students to express creativity while learning complex scientific concepts.

STEAM Implementation in Mroków Primary School (Poland): an analysis

STEAM implementation faced challenges such as lack of time, rigid curricula, insufficiently interested teachers and lack of funding for interdisciplinary projects. Biodiversity-related activities were implemented in curricular lessons and extracurricular activities.

In biology/nature lessons and science clubs, ecosystems, field studies, species identification, protected/threatened species, invasive species and wildlife trafficking were addressed through group presentations (posters and multimedia). Mathematics lessons included data analysis, line and bar graphs, reading statistics and formulating conclusions.

Computer science lessons focused on creating presentations, graphs and tables for use in other subjects. School events such as Global Education Week, Earth Day and World Bee Day included conferences on biodiversity threats, film screenings, poster exhibitions and competitions.

Dissemination of school activities occurred through brief descriptions, photographic reports and videos on the school website, Facebook, eTwinning platform and YouTube. The school also organized Erasmus Days with participation from local schools, and project activities were presented during Erasmus+ mobilities (methodological courses, job shadowing).

The Contribution of the Italian school Istituto Comprensivo Ai Campi Elisi

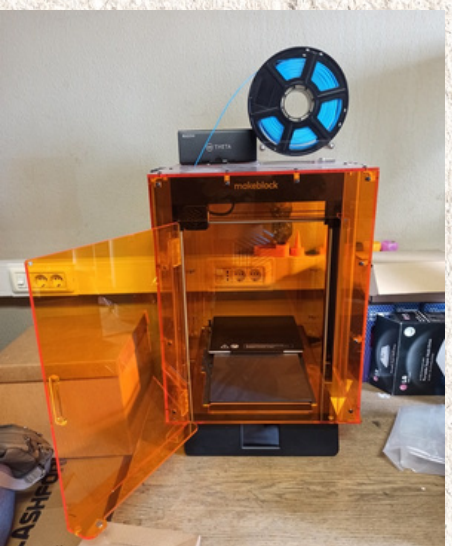
The Italian school represented an exemplary case of how biodiversity can be progressively integrated into the school curriculum through practical activities, citizen science, interdisciplinary projects and service learning. The school, located in Trieste and comprising one kindergarten, two primary schools and one lower secondary school, serves over a thousand students from 3 to 14 years old.

The institute has developed a long tradition of combining academic excellence with innovative didactic approaches, particularly in the fields of environmental education, sustainability and inclusion. In recent years, the school became an active part of the Italian national network of Green Schools, which promotes sustainable practices and integration of environmental awareness in daily teaching.

Early Phases Toward Biodiversity Integration in the Curriculum

The progressive integration of biodiversity in the curriculum was founded on creating a "Green Classroom" in the school garden, equipped with a small pond, dedicated green areas, raised garden beds and outdoor laboratory spaces. This environment served as a living laboratory where students could directly observe natural phenomena, study local flora and fauna and connect theory to concrete experience.

Biodiversity was not treated only in scientific disciplines. While biology, chemistry and physics remained central for studying natural systems, the integration process developed transversally.



In **secondary school**, in mathematics biodiversity was addressed through data collection and statistical analysis of species (following the lesson plans such as “Stranger Among US”, “Let them live”, “How does the number of natural habitats changes? - analysis of charts regarding habitat fragmentation” or again “Climate - hot potato”); in arts the aesthetic and cultural dimensions of ecosystems were explored (based on the following lesson plans “Protecting Coral Reefs through Upcycled Coral Sculptures”, “Upcycled Habitat Gardens”, “Seven R's Workshop - Upcycling Art and Environmental Education”, “Endangered Species Through The Prism Of Video Making”); in technology and engineering students used hydroponic cultivation systems or experimented with low-cost sensors to monitor the environment .

In **primary school**, biodiversity became an opportunity for discovery and practical experimentation. In science and history, children observed the cycle of nature by sowing different varieties of beans and caring for a small potted garden. This also allowed understanding the rhythm of seasons and seasonality of fruits and vegetables. In art, leaves and other natural materials collected in the garden were used for creative activities, exploring the richness of natural colors. Upcycling found space: waste and unused objects were transformed into artworks, opening reflection on the value of reuse (based on the lesson plans “3.Pollution# - Science” and “Seven R's Workshop - Upcycling Art and Environmental”). Simultaneously, the theme of pollution was addressed, with particular attention to plastics, to show how they pose a concrete threat to biodiversity (based on the lesson plan “Plastic pollution’s impact on biodiversity: what can we do to reduce our plastic use?”)

Citizen Science and Laboratory Teaching

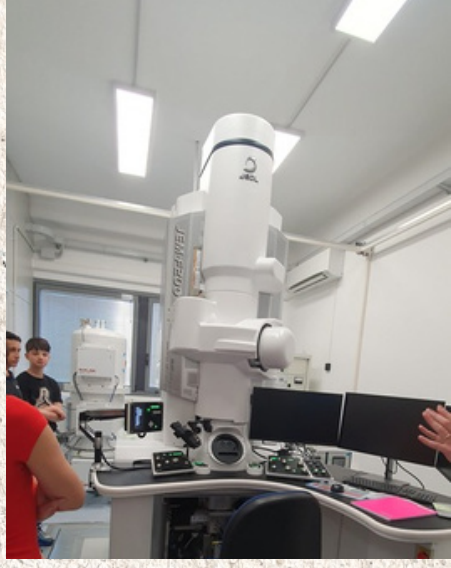
The school developed citizen science initiatives as part of its educational pathway. Students and teachers used Luftdaten stations and passive detection methods such as Radielli for air quality monitoring, particularly to measure pollutants such as PM10 and NO_2. These activities connected local observations to European and global networks, making students aware of the links between biodiversity, climate change and pollution.

With the aid of PCs and 3D printers, pupils designed and built birdhouses, water feeders and bird feeders, concretely contributing to reducing the phenomenon of habitat fragmentation and supporting local fauna. These experiences aligned directly with technology lesson plans developed in the United in Biodiversity project, such as "Guardians of the Atmosphere: Exploring Air Quality, Climate Change, and Biodiversity Loss" and "Parus Major's Inn - Design and Construction of a Birdhouse".

Experiences were strengthened through collaboration with higher education institutions such as the University of Trieste, with scientific and cultural entities of the territory, including the Natural History Museum, Promoscience, Elettra Sincrotrone, l'Immaginario Scientifico, Area Science Park and Grotta Gigante. Trieste, known as the "City of Science," offered a unique open-air laboratory in Europe, capable of offering students educational and cultural opportunities of the highest level.

Future Developments and Service Learning

Planned activities include the care and enhancement of school and urban green spaces, such as maintaining garden areas, collecting scattered waste, and ensuring proper management of recycling and waste separation. These themes are explored through CLIL (Content and Language Integrated Learning) activities, enabling students to discuss sustainability and the UN 2030 Agenda goals in English, German, or Spanish.



Building on the outcomes of the United in Biodiversity project, the school aims to standardize the use of the shared lesson plans developed within the partnership, embedding them systematically into the school curriculum. Teachers will also adopt the assessment strategies and rubrics designed in the project to ensure coherent and evidence-based evaluation of students' learning outcomes. To facilitate this process, teaching staff will be encouraged to take part in the project's MOOC training, strengthening their professional competences in biodiversity education, inclusive practices, and interdisciplinary methodologies.

Future service learning initiatives will further extend these activities to the broader community. In collaboration with families and local associations, students will share the results of air quality monitoring, take care of public and school green areas, create educational gardens, and promote circular economy practices such as composting. Through these actions, learning will move beyond the classroom, fostering civic engagement, environmental awareness, and a shared sense of responsibility for the local and global ecosystem.

Monitoring Inclusion and Diversity Standards

The student population of the Italian school was heterogeneous and included pupils from diverse socio-economic contexts, students with certified or non-certified special educational needs, and children with migrant backgrounds. This diversity enriched the learning environment but also required careful planning and systematic monitoring.

The school drew inspiration from inclusion and diversity guidelines developed within the United in Biodiversity project Lesson Plans.

Lessons were designed to offer multiple access modes, providing information in different formats (visual, auditory, textual) and using interactive resources to support comprehension.
Students often worked in mixed-ability groups, which encouraged peer-to-peer learning. The institute used checklists and rubrics developed by the United in Biodiversity project to monitor inclusion and diversity. These tools helped teachers evaluate student engagement, identify any participation gaps and determine when specific actions were necessary.
Beyond technical tools, the school aimed to create a culture where differences were celebrated. Biodiversity education thus became a metaphor for inclusion: just as ecosystems thrive thanks to diversity, classrooms were also enriched by diverse backgrounds, abilities and perspectives of students.

Dissemination and Sustainability

Dissemination proved fundamental for amplifying project impact and ensuring that biodiversity integration in school curricula had lasting effects. At local level, partner schools promoted events open to the territory–open days, science fairs, educational workshops–where lesson plans were presented to students, families, teachers and stakeholders.
Project results and lesson plans were shared through Erasmus+ networks, conferences and European digital platforms. The project website and social media channels of partner schools served as a living archive where lesson plans, guidelines and support materials were published.
Dissemination was not limited to sharing results, but aimed to create collaboration networks. By involving families, local associations and international partners, the project generated a multiplier effect: each lesson plan became an opportunity for learning and innovation even beyond the context where it originated, contributing to systemic change in biodiversity education.

5

MOOC: Digital Training for Educators

Educational Framework and Design Philosophy

The United in Biodiversity Massive Open Online Course represents the project's comprehensive approach to scaling biodiversity education beyond immediate partnership networks. Designed as a freely accessible professional development resource, the MOOC addresses the critical need for teacher capacity building in environmental education while providing structured pathways for integrating biodiversity concepts across STEAM disciplines.

The course architecture reflects contemporary understanding of effective online learning design, incorporating multimedia content delivery, interactive elements, personalized learning pathways, and practical application opportunities. Rather than functioning as a passive information repository, the MOOC operates as an active learning environment that engages participants in collaborative knowledge construction and peer support networks.

Modular Structure and Learning Progression

The MOOC organizes content across fifteen modules that follow a logical pedagogical progression from foundational knowledge through methodological understanding to practical application. This structure enables participants to develop comprehensive competencies while maintaining flexibility for individual learning preferences and time constraints.

The introductory module welcomes participants, establishes project context, and articulates learning objectives while encouraging engagement with broader project communities through platforms such as eTwinning. A preliminary proficiency assessment gauges existing knowledge about biodiversity concepts, enabling personalized learning pathway recommendations and progress tracking throughout the course experience. The core content module addresses five primary drivers of biodiversity loss through detailed examination of climate change, pollution, habitat fragmentation, wildlife trafficking, and invasive species. Each topic receives comprehensive treatment including conceptual foundations, impact assessment with European examples, solution strategies, and classroom integration approaches. The consistent sub-unit structure provides theoretical explanations through text or brief video lectures, illustrative case studies demonstrating impacts and solutions, and practical classroom activity examples for immediate implementation.

Pedagogical Innovation and STEAM Integration

The second major module focuses on integrating environmental education within schools through STEAM methodologies, transitioning from content knowledge to pedagogical practice. The introduction establishes rationales for STEAM approaches in environmental education while demonstrating how each discipline contributes unique perspectives and methodologies to biodiversity understanding.

A distinctive course feature involves track selection functionality that enables participants to focus on specific STEAM disciplines most relevant to their teaching responsibilities. Rather than requiring engagement with all five disciplinary areas, teachers can select one or two focus areas while maintaining access to comprehensive content for broader perspective development.

Each disciplinary track receives dedicated treatment by partner organizations with corresponding expertise.

Lambda Twelve leads science and technology content development, leveraging their experience in STEM education and digital learning environments. Science content emphasizes ecological field experiments and biodiversity surveys alongside citizen science project opportunities, while technology applications include geographic information system mapping for habitat change tracking and sensor programming for school garden monitoring.

Casa do Professor contributes engineering and mathematics content, drawing upon their extensive teacher training experience and professional development expertise. Engineering applications focus on environmental challenge solutions such as rainwater harvesting system design and wildlife corridor construction, while mathematics integration demonstrates biodiversity indices calculation, climate data statistical analysis, and population growth modeling approaches. They provide critical review and contextualization input during the development phases.

ArtéTeka provides arts integration content reflecting their experience in creativity-driven social change programming. Arts applications encompass visual arts, music, drama, and creative expression for environmental communication and awareness campaigns alongside community engagement through artistic collaboration and cultural heritage connections to biodiversity themes.

Assessment and Practical Application

The final module emphasizes assessment strategies and practical implementation, connecting theoretical understanding with classroom application through systematic evaluation approaches. Content directly references rubric frameworks developed through expert panels, teaching participants how to implement assessment tools for student learning evaluation while supporting their own professional development.

The module includes disciplinary-specific assessment guidance for evaluating interdisciplinary skills and biodiversity knowledge across STEAM subjects. Participants engage with rubric analysis exercises that demonstrate assessment implementation while building familiarity with evaluation frameworks and student progress monitoring approaches.

A capstone practical engagement sequence guides participants through identifying local biodiversity challenges, selecting and adapting lesson plans from project resources, implementing chosen activities within their classrooms, and sharing results with fellow participants through online platforms. This progression ensures that course completion translates into concrete classroom action rather than remaining at theoretical levels.

Collaborative Development and Quality Assurance

MOOC development reflects the collaborative partnership approach that characterizes the broader project, with different organizations contributing specialized content while maintaining overall coherence and quality standards. RENCTAS coordinates content development and ensures scientific accuracy across biodiversity topics while integrating expert knowledge from associated organizations including Iroko, Clean River Project, QG Enviro, and Invasoras.pt.

Lambda Twelve manages platform development and pedagogical design, creating interactive elements, track selection mechanisms, and multimedia content integration while establishing quality standards for e-learning effectiveness. Their coordination ensures technical functionality while supporting diverse participant needs and technological capabilities.

Partner schools provide critical review and contextualization input during development phases, with teachers and administrators from Campi Elisi and Mroków contributing examples from their institutional environments while ensuring alignment with national curriculum requirements and age-appropriate content development. This grassroots input ensures classroom relevance and practical applicability across diverse educational contexts.

Integration with Project Resources

The MOOC design creates seamless connections with other project outputs including expert panel rubrics, lesson plan collections, and policy recommendations. Rather than functioning as an isolated resource, the course operates as a comprehensive professional development environment that introduces participants to the full range of project innovations and support materials.

Lesson plan analysis videos demonstrate practical implementation of abstract integration concepts while providing concrete examples of successful classroom practice. These analytical approaches help participants understand how theoretical frameworks translate into effective teaching practice while building confidence for independent implementation attempts.

The course incorporates feedback and evaluation mechanisms that connect participant experiences to ongoing project development and improvement processes. User input contributes to continuous refinement of educational resources while building evidence bases for effective biodiversity education approaches across diverse institutional contexts.

Sustainability and Community Building

Planning for MOOC sustainability extends beyond technical platform maintenance to encompass community development and ongoing engagement strategies. The course remains freely accessible for at least three years following project completion, hosted on platforms maintained by the partnership while receiving periodic content updates to reflect evolving scientific understanding and policy developments.

Integration into ongoing training programs amplifies reach and impact as partners incorporate MOOC modules into regular professional development offerings. Lambda Twelve and Casa do Professor utilize course content within blended learning approaches and future Erasmus+ teacher training initiatives, while other partners adapt materials for national contexts and language requirements.

Community development occurs through eTwinning platform integration and social media engagement that enables continued participant interaction and resource sharing beyond individual course completion. Dedicated eTwinning groups facilitate ongoing collaboration on biodiversity education projects while social media campaigns maintain engagement around key environmental awareness dates and events.

The development of teacher ambassadors and alumni networks extends community impact through experienced practitioners who present their work at conferences, lead workshops, and mentor newer participants. These networks create sustainable capacity for continued biodiversity education advancement while reducing dependence on formal project structures and external funding sources.

Accessibility and Inclusive Design

Course design prioritizes accessibility and inclusion through multiple content formats, clear navigation structures, and language considerations that accommodate diverse participant backgrounds and technological capabilities. Content maintains B1 English proficiency levels for broad European accessibility while providing subtitles, transcripts, and visual support materials that enhance comprehension across linguistic and learning differences.

Technical requirements remain minimal to ensure participation across diverse technological contexts, while alternative access methods accommodate varying internet connectivity and device availability. The platform design enables offline content access and mobile device compatibility that supports flexible learning approaches and global participation.

Pedagogical accessibility includes multiple learning modalities, self-paced progression options, and differentiated content complexity that enables meaningful participation across diverse professional backgrounds and experience levels. Beginning teachers receive foundational support while experienced educators access advanced integration strategies and leadership development opportunities.

6 SWOT Analysis and Strategic Recommendations

Analytical Framework and Stakeholder Perspectives

The implementation of STEAM-integrated biodiversity education within formal schooling contexts presents complex challenges and opportunities that require systematic analysis across multiple stakeholder perspectives. This comprehensive SWOT analysis examines strengths, weaknesses, opportunities, and threats affecting students, teachers, school leadership, and parent communities while providing strategic recommendations for sustainable program development.

The analysis draws upon extensive project experience including teacher feedback, student assessment data, institutional partnership outcomes, and policy implementation challenges across six countries and diverse educational contexts. This evidence base enables realistic assessment of both potential and constraints while informing practical recommendations for continued program expansion and institutionalization.

Student-Centered Analysis

Students represent the ultimate beneficiaries of biodiversity education innovations, yet they also face significant adaptation challenges as educational approaches shift toward interdisciplinary, project-based methodologies. Increased motivation through engaging, hands-on learning activities represents a primary strength, as students respond positively to practical biodiversity projects that connect classroom learning to real-world environmental challenges and community engagement opportunities.

The development of twenty-first century competencies including critical thinking, teamwork, innovation, creativity, experimentation, and problem-solving provides students with essential skills for future academic and professional success. Digital and technological competency development occurs naturally through STEAM integration while social skill enhancement emerges from collaborative project work and peer interaction requirements.

However, students face considerable adjustment difficulties when transitioning from traditional learning models to interdisciplinary approaches that require independent thinking, collaborative responsibility, and process-oriented assessment.

These challenges prove particularly significant for students with learning difficulties or special educational needs who may struggle with group work dynamics, unequal task distribution, or conflict resolution requirements.

Assessment modifications that emphasize learning processes and mistake-based improvement rather than traditional grading systems can confuse students accustomed to conventional evaluation approaches. Additionally, inadequate access to necessary technological resources including computers and internet connectivity may limit full participation in technology-enhanced learning activities.

Enhanced interpersonal skills through teamwork experiences contribute to comprehensive personal development while feedback-focused assessment approaches support growth-oriented learning mindsets.

Potential threats include academic overload from project work demands that may lead to stress, information overwhelm, and motivational decline. Unclear assessment criteria and group work challenges can create feelings of unfairness or inadequate control over learning outcomes, particularly affecting students with diverse learning needs or social interaction difficulties.

Teacher Professional Development Considerations

Teachers serve as critical implementation agents whose professional capacity, attitudes, and institutional support determine program success or failure. Significant strengths include opportunities to apply innovative teaching methodologies that enhance professional satisfaction while developing interdisciplinary competencies that increase pedagogical flexibility and effectiveness.

Professional growth occurs through organizational and communication skill development via collaborative project work while increased motivation, job satisfaction, and professional recognition reduce burnout risks and career dissatisfaction. Participation in international projects enables professional development and experience exchange that expands career opportunities and global perspectives on educational practice.

Teacher weaknesses include insufficient preparation for interdisciplinary curriculum development alongside complicated funding acquisition and management processes that create administrative burdens. Limited time, equipment, and facility access for innovative project implementation constrains creative approaches while assessment difficulties and concerns about maintaining academic standards create resistance to pedagogical change.

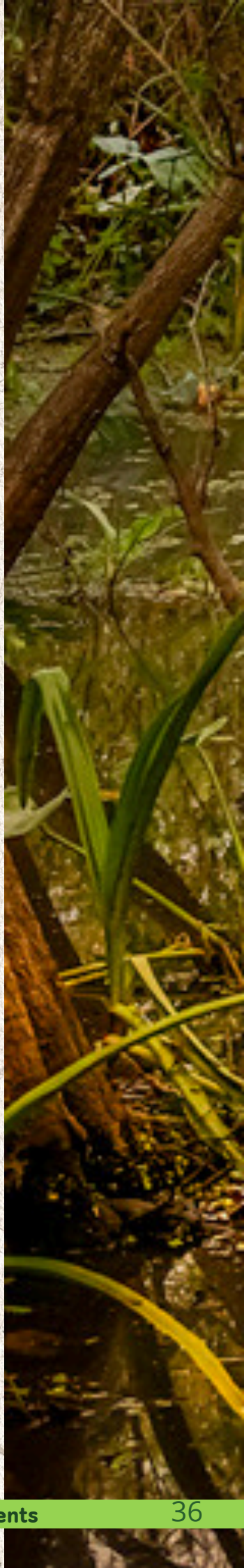
Professional development opportunities include competency-based teaching transitions that position teachers as mentors and facilitators rather than information transmitters. Access to European Union-supported training programs, workshops, and resource development initiatives provides continued learning opportunities while project-based and experiential learning approaches enhance teaching effectiveness and student engagement.

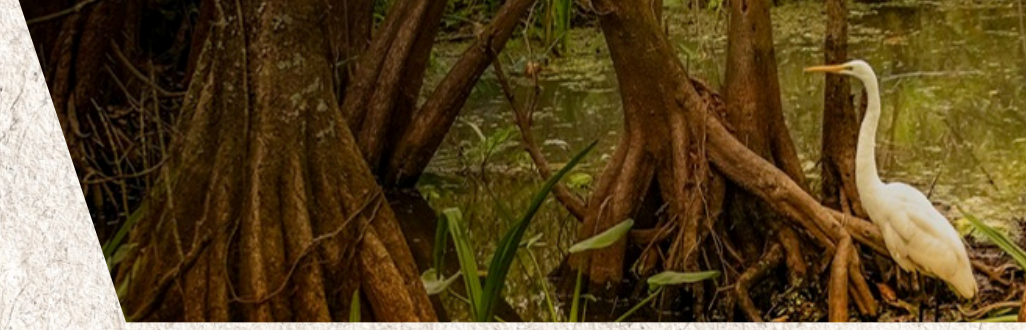
Teacher-specific threats encompass the absence of unified STEAM implementation standards that create uncertainty, particularly affecting less experienced educators. Preparation requirements exceed traditional lesson planning demands, potentially creating workload pressure and professional burnout. Uneven teacher experience with project-based approaches may widen competency gaps while limiting collaborative effectiveness and overall teaching quality.

Institutional Leadership and Governance

School leadership teams and governing bodies possess decision-making authority essential for sustainable program implementation yet face complex resource allocation and strategic planning challenges. Institutional strengths include opportunities to establish reputations as innovative educational organizations that implement cutting-edge practices aligned with global educational trends and European Union policy priorities.

High-quality teaching delivery by competent, committed staff who develop future-oriented competencies enhances institutional competitiveness within education markets while creating opportunities for additional funding acquisition through grants and special program recognition.





Strengthened community relations, local integration, and increased parental involvement contribute to institutional sustainability and public support.

Institutional weaknesses include limited financial resources and inadequate facilities for comprehensive STEAM program implementation alongside complex procedures for accessing necessary funding streams. Insufficient numbers of adequately trained teaching staff present ongoing challenges, as innovative methodologies require professional openness and behavioral change that may encounter resistance from established practitioners.

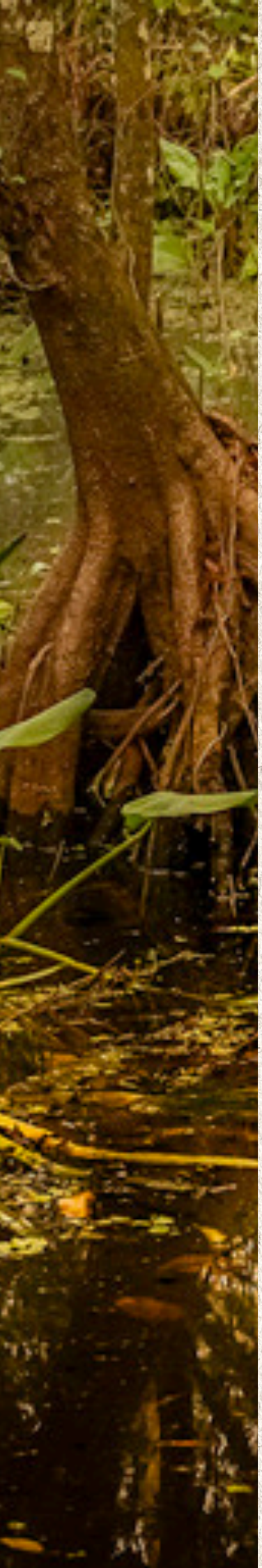
Organizational challenges include STEAM requirements for lesson restructuring, enhanced teacher collaboration, and flexible curriculum planning that may conflict with rigid national curriculum mandates and assessment requirements. These structural tensions limit institutional autonomy while creating compliance challenges across multiple accountability systems.

Leadership opportunities encompass improved educational quality through creativity, critical thinking, and collaboration enhancement that increases academic results and institutional attractiveness. Funding opportunities and innovative teaching approach development position schools as educational innovation centers while engaging parents, local institutions, and governmental partnerships that strengthen community integration.

Institutional threats include dependence on external funding sources for program sustainability alongside insufficient unified educational policies supporting STEAM integration across jurisdictions. Teacher shortages in interdisciplinary and project-based pedagogies limit implementation capacity while curriculum flexibility requirements may conflict with standardized testing and evaluation mandates.

Parent and Community Engagement

Parent communities represent essential stakeholder groups whose understanding, support, and active participation significantly influence program success and sustainability. Parental strengths include opportunities for enhanced understanding of children's educational needs, competency development awareness, and improved educational pathway planning through direct involvement in innovative learning approaches.



Increased engagement opportunities enable active participation in children's education through idea contribution, project support, and school development influence alongside initiative participation that strengthens parent-school relationships. Digital and technological competency development may positively impact parents' professional activities while building positive reputations as engaged educational partners.

Parental weaknesses include limited awareness of STEAM principles and potential benefits alongside concerns about departures from traditional subject areas and grading approaches. Insufficient digital skills, limited technology access, or inadequate time availability may constrain meaningful participation in children's educational activities while fears about examination preparation adequacy create resistance to innovative approaches.

Community opportunities include increased engagement in children's education through active project participation that strengthens parent-child relationships while developing digital and technological competencies throughout family systems. Confidence development regarding children's future employment market preparation through STEAM skill development including logical thinking, creativity, teamwork, and innovation capabilities enhances long-term educational support.

Threats to parent engagement include insufficient knowledge about STEAM approaches that may generate misunderstandings and difficulties supporting children's learning needs. Increased parental involvement requirements may challenge working parents while additional material, equipment, or extracurricular participation costs increase family financial burdens. Resistance to open, project-based, and experimental methodologies from parents accustomed to traditional educational approaches may undermine program support and sustainability.

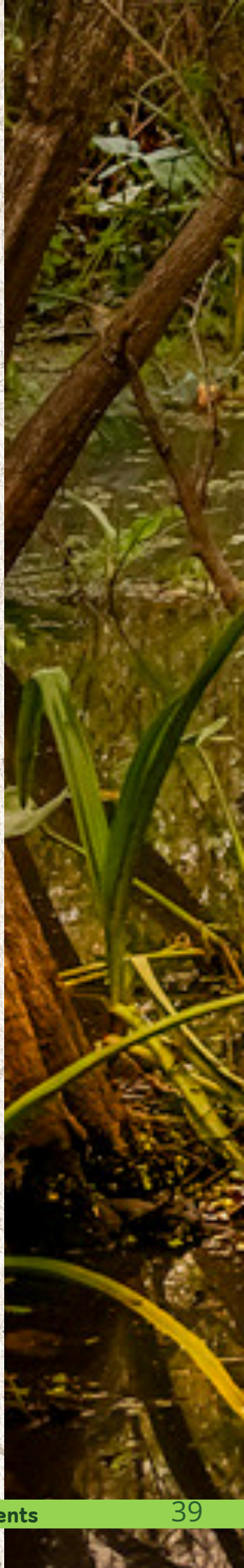
Strategic Recommendations for Sustainable Implementation

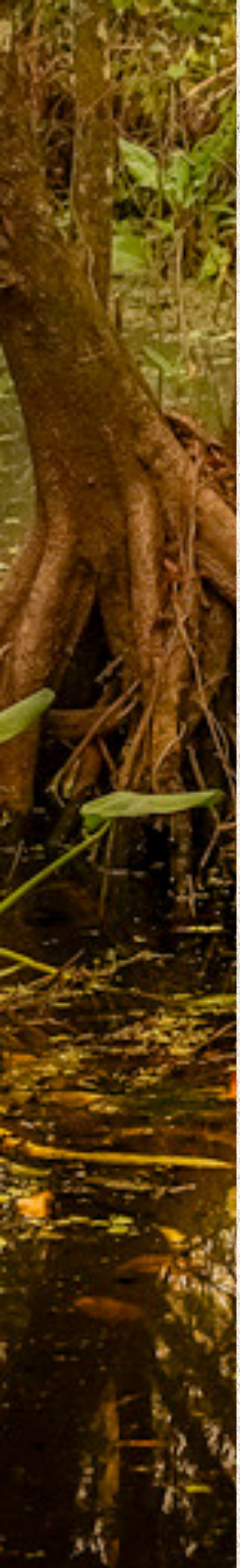
Effective biodiversity education integration through STEAM approaches requires comprehensive strategies that address identified weaknesses while leveraging strengths and opportunities across all stakeholder groups. Enhanced teacher preparation through structured professional development focused on environmental education represents a fundamental requirement alongside sustainability topic integration within teacher education curricula and ongoing certification programs.

Strengthened governmental support includes increased funding and institutional backing for environmental education initiatives combined with clearer communication channels for educational policy dissemination and implementation support. Improved teaching resource development through curriculum-aligned materials including digital and print media ensures equitable access to high-quality educational tools while addressing infrastructure deficits including internet connectivity and projection capabilities.

School-community collaboration enhancement encourages partnerships between educational institutions and environmental organizations, local government agencies, and cultural institutions while utilizing resources such as protected natural areas for experiential learning and environmental field study opportunities.

Student initiative empowerment supports student-led environmental clubs, campaigns, and community engagement projects while integrating environmental themes across all curriculum areas rather than confining them within specific subject boundaries.

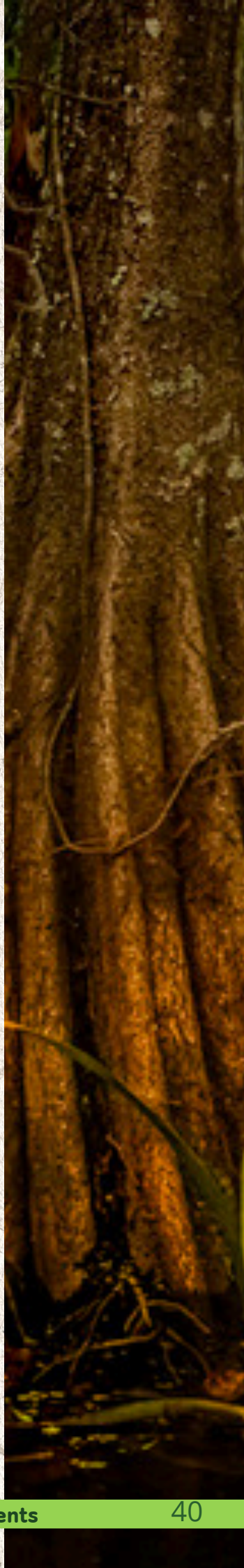




Monitoring and evaluation framework development enables biodiversity education indicator integration within school evaluation and inspection systems while supporting continuous improvement and evidence-based practice development. Policy coherence across educational levels ensures that biodiversity education receives consistent support from early childhood through secondary education while aligning with broader environmental policy objectives and international commitment fulfillment.

The implementation of comprehensive stakeholder engagement strategies addresses diverse needs and concerns while building broad-based support for sustained program development.

Regular communication, professional development opportunities, resource provision, and recognition programs create positive implementation environments while addressing identified challenges through systematic, evidence-based approaches that ensure long-term program viability and impact.



7 Conclusions and Future Directions

Synthesis of Project Achievements

The United in Biodiversity project demonstrates that systematic integration of biodiversity education within primary school curricula through STEAM approaches represents both an achievable goal and an essential component of contemporary educational practice. Through transnational collaboration, curriculum innovation, teacher professional development, and community engagement, the project has established concrete pathways for transforming environmental education from peripheral programming to foundational educational practice.

The comprehensive approach encompassing expert panel development of educational rubrics, intensive teacher training through international collaboration, systematic lesson plan creation and testing, institutional integration strategies, and massive open online course delivery has produced a replicable model for biodiversity education advancement. These interconnected components demonstrate that sustainable educational change requires multiple intervention strategies rather than isolated programmatic additions.

The project's most significant achievement lies in demonstrating that biodiversity education enhances rather than competes with academic learning across STEAM disciplines. Through interdisciplinary integration, students develop enhanced critical thinking capabilities, collaborative skills, and real-world problem-solving competencies while gaining essential environmental knowledge and developing conservation-oriented attitudes and behaviors.

Evidence of Educational Effectiveness

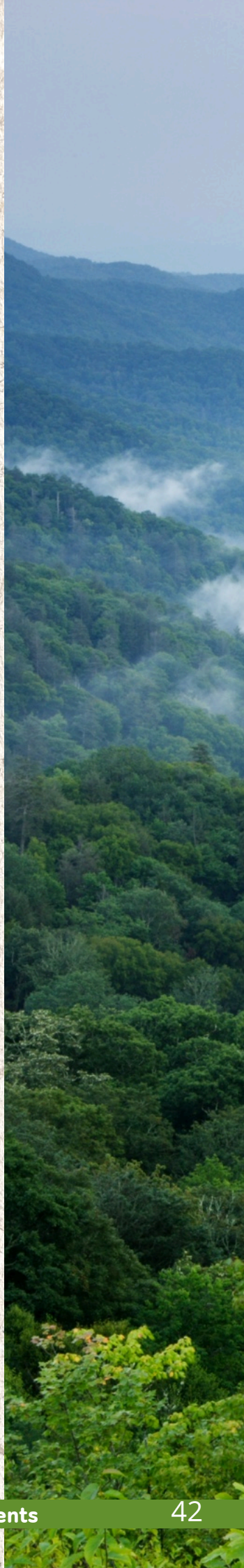
Systematic evaluation across partnership contexts provides compelling evidence for the educational effectiveness of STEAM-integrated biodiversity approaches. Teacher feedback consistently indicates improved student engagement, enhanced learning retention, and development of transferable skills that serve broader educational objectives beyond environmental content mastery.

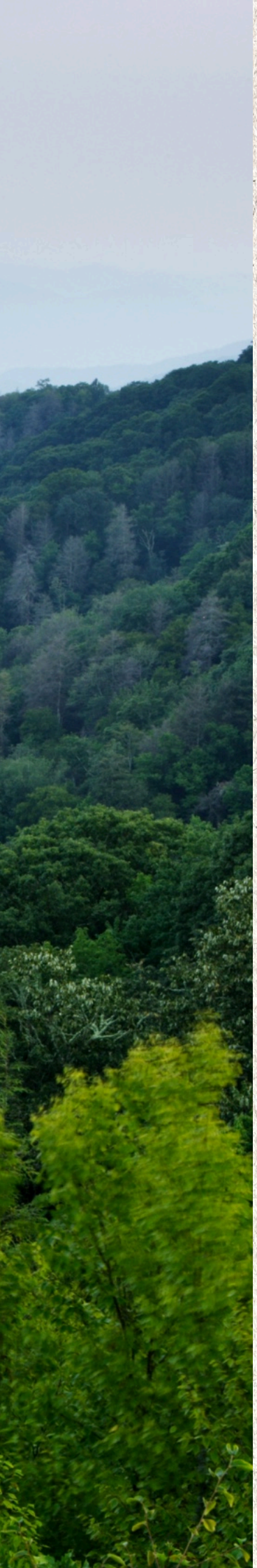
Student assessment data demonstrates significant gains in both scientific knowledge and interdisciplinary thinking capabilities, with particular improvements noted in collaborative problem-solving, data analysis, and creative application of learning to real-world challenges.

These outcomes align with broader educational priorities including twenty-first century skill development and preparation for future academic and professional demands.
Institutional impact extends beyond individual classrooms to influence whole-school approaches to environmental sustainability, community engagement, and innovative pedagogy. Participating schools report enhanced reputation within their communities, increased parent engagement, and strengthened partnerships with environmental organizations and cultural institutions.

Scalability and Transferability

The project design prioritizes scalability and transferability through development of open-access resources, flexible implementation frameworks, and systematic documentation of effective practices. The comprehensive resource collection including rubrics, lesson plans, professional development courses, and institutional guidance materials enables adaptation across diverse educational contexts while maintaining core principles and quality standards.
Cultural adaptability receives particular attention through multilingual resource development, consideration of diverse educational systems, and incorporation of local environmental challenges and opportunities within implementation frameworks. This flexible approach enables meaningful adoption across European contexts while maintaining coherence around shared environmental objectives and pedagogical principles.
The establishment of sustainable networks through eTwinning platforms, professional associations, and continuing education programs ensures that project impact extends beyond formal implementation periods. These networks provide ongoing support for participating educators while facilitating continued resource development and experience sharing among expanding communities of practice.





Policy Implications and Recommendations

The project outcomes provide substantial evidence for policy recommendations at institutional, national, and European levels that support systematic biodiversity education integration. At the institutional level, school leaders require support for comprehensive curriculum review processes, teacher professional development investments, and community partnership development that enables effective environmental education implementation.

National policy recommendations include curriculum framework modifications that explicitly integrate biodiversity content across subject areas, targeted funding allocation for environmental education infrastructure and professional development, and inter-ministerial coordination between education and environment departments that ensures policy coherence and implementation support.

European-level recommendations emphasize continued prioritization of environmental education within Erasmus+ strategic partnerships, development of harmonized guidance for biodiversity education implementation across member states, and integration of biodiversity literacy within existing competency frameworks such as GreenComp and DigCompEdu.

Long-term Impact and Sustainability

The project design incorporates comprehensive sustainability strategies that ensure continued impact beyond formal project completion. Open-access resource availability, integration with existing professional development systems, and establishment of practitioner networks create foundations for ongoing program expansion and refinement.

Institutional ownership of developed materials by participating schools, embedding of biodiversity education within continuing professional development programs, and establishment of cross-border teacher networks for peer learning provide sustainable infrastructure for continued program development and implementation.

Policy engagement through documented best practices and strategic recommendations positions project outcomes to influence broader educational policy development while strengthening collaboration between education and environmental sectors at multiple governance levels.

Future Research and Development Priorities

The project establishes foundations for continued research and development in environmental education effectiveness, STEAM integration methodologies, and teacher professional development approaches. Priority areas for future investigation include longitudinal impact assessment on student environmental attitudes and behaviors, comparative effectiveness studies across different implementation contexts, and development of advanced assessment tools for interdisciplinary learning evaluation.

Technology integration represents a significant area for continued innovation, particularly regarding digital citizenship, environmental monitoring applications, and virtual collaboration tools that enhance international partnership possibilities. The integration of emerging technologies including artificial intelligence, augmented reality, and advanced data visualization tools offers substantial potential for enhancing biodiversity education engagement and effectiveness.

Community engagement strategies require continued development to maximize educational impact while strengthening connections between formal schooling and broader social environmental awareness and action. Research priorities include family engagement approaches, intergenerational learning strategies, and community-based conservation project integration within educational programming.

Call to Action for Educational Leaders

The evidence presented throughout this handbook demonstrates both the necessity and feasibility of comprehensive biodiversity education integration within contemporary schooling. Educational leaders at all levels bear responsibility for ensuring that young people receive the knowledge, skills, and values necessary for environmental stewardship and sustainable living.

The resources and strategies documented within this handbook provide practical tools for immediate implementation while offering frameworks for systematic, long-term educational transformation. However, successful implementation requires committed leadership, sustained investment, and collaborative partnerships among educational institutions, environmental organizations, and policy development agencies.

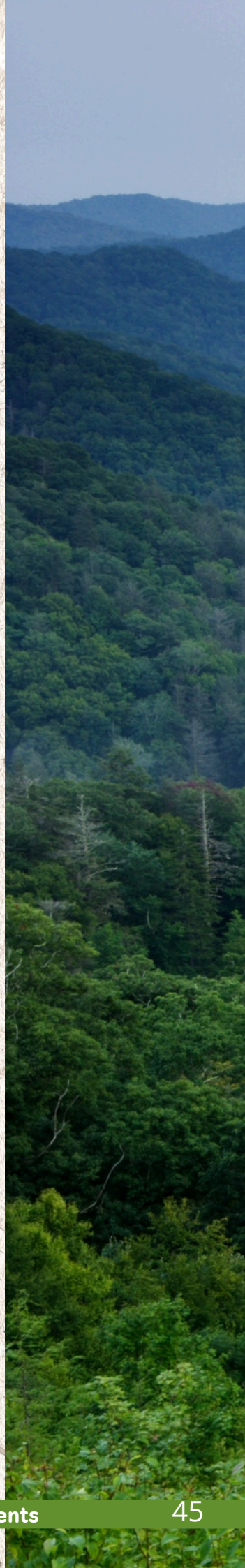
The urgency of global environmental challenges demands educational responses that match the scale and complexity of biodiversity conservation requirements. Traditional approaches to environmental education, while valuable, prove insufficient for developing the comprehensive understanding and action capabilities that contemporary and future environmental challenges require.

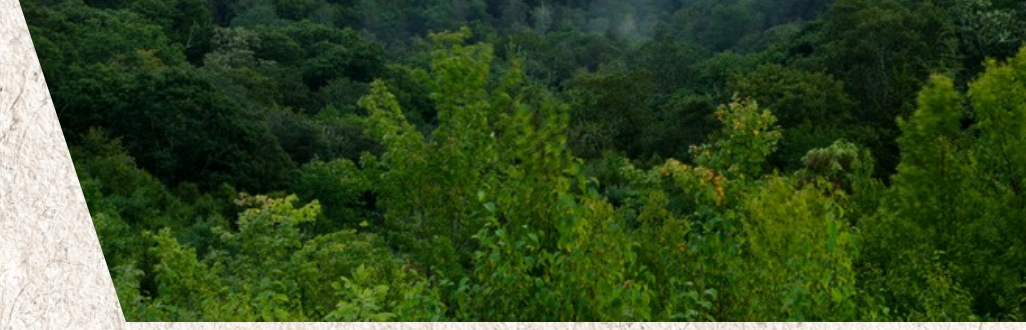
Educational leaders must embrace innovative approaches that integrate environmental content meaningfully across curricula while developing student capabilities for critical thinking, collaborative problem-solving, and effective action in complex, interconnected global systems. The United in Biodiversity project provides both inspiration and practical guidance for educational transformation that serves both academic excellence and environmental sustainability objectives.

Global Relevance and International Cooperation

While developed within European educational contexts, the principles, methodologies, and resources documented within this handbook possess global relevance and application potential. Environmental challenges transcend national boundaries and require international cooperation and shared understanding that education can foster through systematic, high-quality environmental learning experiences.

The project's international partnership model demonstrates effective approaches to educational collaboration that respect cultural diversity while advancing shared objectives. This collaborative methodology offers templates for broader international cooperation in environmental education while building professional networks that support ongoing innovation and resource sharing.





The integration of diverse perspectives from Brazilian and European partner organizations enriches educational approaches while demonstrating global dimensions of biodiversity challenges and conservation solutions. This international dimension enhances student understanding while preparing them for participation in global environmental citizenship and action.

Commitment to Continuous Improvement

The United in Biodiversity project represents a significant contribution to environmental education advancement, yet it also establishes foundations for continued innovation and improvement in teaching and learning approaches. The systematic documentation of experiences, challenges, and successes provides evidence bases for ongoing refinement while identifying priority areas for future development.

The commitment to open-access resource sharing and collaborative development ensures that project outcomes serve broader educational communities while encouraging adaptation, enhancement, and innovation that advances environmental education effectiveness. This collaborative approach to educational resource development offers models for continued cooperation among educators, researchers, and policy developers across diverse contexts.

Environmental education effectiveness requires ongoing assessment, refinement, and innovation that responds to evolving scientific understanding, educational research findings, and changing environmental conditions. The frameworks and networks established through this project provide infrastructure for continued development while maintaining focus on educational quality, environmental accuracy, and meaningful student engagement.

The future of environmental education depends upon continued collaboration among committed educators, supportive institutions, and innovative partnerships that prioritize both educational excellence and environmental sustainability. The United in Biodiversity project provides evidence that such collaboration produces meaningful results while establishing foundations for continued advancement in this essential area of contemporary education.

8

Appendices

Appendix A: Project Partnership Details

Lambda Twelve (Greece) - Project Coordinator Educational technology and teacher training enterprise specializing in STEAM pedagogy, digital course design, and innovative educational methodology development.

RENCTAS (Brazil) National network for combating wildlife trafficking, providing conservation expertise, policy advocacy, and environmental education programming focused on biodiversity protection.

ArtéTeka (Ireland) Creative education organization specializing in non-formal learning approaches, arts-based social change initiatives, and youth engagement through cultural programming.

Istituto Comprensivo ai Campi Elisi (Italy) Comprehensive educational institution serving over 1,000 students across early childhood, primary, and lower secondary levels, recognized for innovative environmental education and inclusion practices.

Casa do Professor (Portugal) Teacher training association coordinating professional development programs, mobility initiatives, and educational network management across Portugal's educational system.

Szkola Podstawowa w Mrokowie (Poland) Primary school emphasizing ecological practice, student engagement, and citizen science integration within traditional curriculum frameworks.

Appendix B: Key Project Outputs

Educational Rubrics: Five comprehensive assessment frameworks addressing wildlife trafficking, climate change, pollution, habitat fragmentation, and invasive species across STEAM disciplines.

Lesson Plans: Twenty-five cross-disciplinary lesson plans integrating biodiversity topics within Science, Technology, Engineering, Arts, and Mathematics subject areas.

MOOC Platform: Comprehensive online professional development course featuring fifteen modules and forty-five sub-units with personalized learning pathways and assessment tools.

Research Theses: Three graduate-level research projects investigating biodiversity education effectiveness, implementation strategies, and institutional integration approaches.

Project website: hosts all educational resources, materials, and tools developed by the partnership, freely accessible to educators worldwide

International Conference: Final dissemination event in Trieste, Italy, bringing together educators, policymakers, and environmental organizations for practice sharing and network development.

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