



Deliverable 3.6. Evaluation Report on BioBeo Education Programme

BioBeo

Innovative Education for the BioEconomy



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Abbreviations

E3STEM	Hellenic Education Society of STEM
MU	Maynooth University
OUAS	ODISEE University of Applied Sciences
RUAS	Rotterdam University of Applied Sciences
SDG	Sustainable Development Goal
STEM	Science, Technology, Engineering and Mathematics
TUB	Technical University Berlin
UCD	University College Dublin
FEE	Foundation for Environmental Education
IPA	Stichting International Parents Alliance
UH	University of Hohenheim

Executive Summary

Welcome to the BioBeo Education Programme:

The BioBeo Education Programme is a strategic initiative designed to enhance environmental literacy and deepen understanding of the bioeconomy. Since its inception in November 2022, it has been a fundamental component of the BioBeo project, championing educational methodologies that empower learners to engage meaningfully with concepts of sustainability, circularity and specifically, bioeconomy.

Collaborative Framework

This programme is a collective endeavour involving esteemed institutions, including University College Dublin (Ireland) Maynooth University (Ireland), Rotterdam University of Applied Sciences (Netherlands), E3STEM (Greece), Technical University Berlin (Germany), and Odisee University of Applied Sciences (Belgium), University of Hohenheim (Germany) Stichting International Parents Alliance (IPA) and the Foundation for Environmental Education (FEE). These partners have collaboratively developed educational resources that cater to diverse learner demographics, aligned with BioBeo's five thematic pillars: Life Below Water, Interconnectedness, Forestry, Outdoor Learning, and Food Loop.

Programme Highlights

- Primary Education Resources: Maynooth University has created six place-based lesson plans to convey bioeconomy fundamentals to primary learners through outdoor engagement and creative pedagogical approaches. FEE adapted these lesson plans to align with the methodology and themes of their Learning about Ecosystems and Forests (LEAF) programme, an outdoor education programme run in 25 countries.
- A standout highlight of the BioBeo Programme is the world's first bioeconomy puppet show, created and performed by students from MU and UCD. Using biobased and biodegradable materials, students built the puppets and stage frame, acting out the story based on Answering the Curlew's Call. Launched in April 2025, the show has reached over 300,000 children, with teacher guidance notes developed to support classroom use globally.
- Secondary Education Resources: Odisee University of Applied Sciences (OUAS) has created six place-based lesson plans to convey bioeconomy fundamentals to secondary learners through outdoor engagement and creative pedagogical approaches.
- Secondary Education Initiatives: The Bioeconomy Project Week, orchestrated by Rotterdam University of Applied Sciences, encompasses workshops and presentations for secondary education students, culminating in an interactive Bioeconomy Market Day. FEE also adapted each of the seven workshops to be stand-alone lessons that align with the methodology and themes of the LEAF programme.
- Innovative Learning Tools: The programme introduces the BioBeo Robot and educational comics like "Back to the Future with Beo and Raja," which leverage technology to facilitate the exploration of bioeconomy themes in engaging ways.
- Global Outreach: BioBeo has made significant strides in global engagement by participating in over 50 European events, such as the BioBeo Festival where education meets the bioeconomy organised by OUAS (Odisee), Athens Science Festival and Environ 2024, amplifying its impact and visibility. BioBeo was also a key partner in FEE's 2024 and 2025 annual Global Action Days (GADs) campaign. In the 2024 GADs, Activity 1 was

about getting climate-ready through bioeconomy, asking participants to look for examples of bioeconomy in their daily life. Over 70,000 participants from 60 countries and across 500 settings participated in this activity.

- Integration of an overarching parental engagement approach: IPA provided the background and practical suggestions to ensure parental engagement throughout the programme in order to build home-school partnerships, align education at home and at school, and avoid schools educating in ways controversial for families.

Key Achievements:

The BioBeo Education Programme has reached several significant milestones, including:

- The creation of animated storytelling videos alongside the launch of the BioBeo App, which promotes interactive learning experiences through gamified nature trails.
- The launch and inaugural meeting of BEST in March 2025 - the network for Bioeconomy Education and Sustainability Teachers.
- The publication of BioBeo Buzz. BioBeo Buzz is now titled BioBuzz and is the official newsletter for BioBeo, bringing you the latest updates, insights, and breakthroughs in biobased education and sustainability. BioBuzz also shares updates about our bioeconomy teachers network called BEST!
- Collaborative efforts such as the eTwinning project "Resource – Don't Go!" which fosters cross-cultural exchange and collective learning experiences.
- The co-founding of a new primary school LENA <https://www.lena-gp.de/> with main focus on bioeconomy and a new curriculum that includes entrepreneurship elements for the primary level. LENA will also develop train the trainer courses in the upcoming years to bring bioeconomy to schools in Germany. LENA is based on Montessori.
- BioBeo was added to the "[BNE-Kompass](#)", the online database for extracurricular resources in the field of Education for Sustainable Development in the state of Baden-Württemberg, Germany. The database is a contribution to the implementation of the [World Action Programme of UNESCO](#) and its follow-up programme (ESD for 2030) as well as part of the German [National Action Plan](#) for Education for Sustainable Development and the [Sustainability Strategy of Baden-Württemberg](#).
- A comic series on the bioeconomy with accompanying education notes for schools/educators.
- Bioeconomy module added to the [GAIA 20:30 Circular Economy](#) online course on FEE Academy, FEE's online learning platform. The course has 590 participants and a completion rate of 40%.
- IPA and FEE have created training material and guidance for teachers wishing to implement bioeconomy education after it was identified as a missing link.

Future Directions:

With a strong focus on experiential learning and alignment with the Sustainable Development Goals (SDGs), the BioBeo Education Programme is committed to ongoing evolution. It aims to nurture a generation of environmentally informed global citizens poised to drive the transition toward a sustainable and inclusive bioeconomy.

BioBeo Bioeconomy Definition:

“Bioeconomy is a systems-based approach that seeks to replace fossil resources in a sustainable manner with renewable biological resources from terrestrial and marine ecosystems – such as forests, crops, animals, fish, microorganisms, organic waste, and agricultural side streams, to produce food, feed, fibres, energy, bio-based products, and services within a circular economy framework designed to optimise resource use based on a cascading hierarchy of utilisation options. A sustainable and circular bioeconomy requires the application of education and training programmes, scientific research, technology, and innovation with the aim of not only creating economic value but also regenerating and expanding ecosystems and biodiversity as well as improving the health and the well-being of society. By addressing these systemic changes in the economy, environment, and society, the bioeconomy contributes to achieving a better and more sustainable future where no one is left behind.”

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Introduction

Welcome to the BioBeo Education Programme:

The BioBeo Education Programme embodies the BioBeo project's commitment to establishing an innovative and engaging educational framework that empowers learners to comprehend and embrace the bioeconomy. Launched in November 2022, this programme represents a key deliverable of Work Package 3 and has garnered contributions from partners such as Maynooth University, Rotterdam University of Applied Sciences, and E3STEM.

Objectives and Scope

The programme's primary objective is to integrate bioeconomy principles into educational environments, fostering sustainability and circularity through accessible and adaptable resources. These initiatives align with the Sustainable Development Goals (SDGs), ensuring global relevance and impact. The deliverable builds upon earlier project outputs and incorporates insights from stakeholder engagement and pilot programmes. Resources have been designed for primary, secondary, and mixed-age learners, featuring innovative tools like the BioBeo Robot, interactive apps, and animated videos.

Recent Developments:

“Since the project's inception, significant achievements include:

- Participation in over 50 European events, including the Athens Science Festival, has enhanced the programme's visibility and outreach.
- Introducing the BioBeo App allows learners to engage with nature through interactive trails.
- The establishment of the BioBeo Festival where education meets the bioeconomy organised by OUAS (Odisee), a distinctive platform for policy engagement and youth participation.
- The continuation of the Blended Intensive Programme between MU, OUAS, RUAS.
- The launch of the BEST (Bioeconomy Education and Sustainability Teachers Network)

Programme Delivery and Impacts:

Resources have been piloted in schools and communities throughout Europe, demonstrating their potential to inspire learners to connect with their local environments and appreciate the importance of sustainability. Collaborative initiatives, such as the eTwinning programme, have further broadened the programme's reach, fostering dialogue and shared learning among students internationally.

By synthesising these achievements, the BioBeo Education Programme lays a strong foundation for continued innovation and collaboration, advancing its mission to create a sustainable future for all through bioeconomy.

1. Overview of the BioBeo Education Programme

The BioBeo Education Programme was established as a fundamental component of the BioBeo project, reflecting its mission to enhance environmental literacy and deepen understanding of the bioeconomy. Developed in partnership with esteemed institutions—Maynooth University (MU), Rotterdam University of Applied Sciences (RUAS), Odisee University of Applied Sciences (OUAS), and E3STEM—the programme aims to empower learners to actively engage with themes of sustainability, circularity and bioeconomy through innovative educational resources and methodologies.

1.1. Purpose and Vision

The BioBeo Education Programme is founded on the vision of cultivating a generation of environmentally conscious global citizens. By integrating the principles of the bioeconomy into educational frameworks, the programme tackles pressing challenges such as climate change, resource scarcity, and biodiversity loss and focuses on bioeconomy as a solution. Its objectives are aligned with the Sustainable Development Goals (SDGs), emphasising themes such as Quality Education (SDG 4), Climate Action (SDG 13), and Life on Land (SDG 15).

1.2. Core Themes

At the core of the programme are five interconnected themes that were selected for their relevance to the bioeconomy and their potential to engage learners through practical, real-world applications:

Life Below Water: This theme emphasises the conservation and sustainable use of aquatic ecosystems, encouraging learners to explore the critical role that oceans, rivers, and lakes play in maintaining biodiversity and supporting the bioeconomy.

Interconnectedness: This theme reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things. It nurtures an understanding of the relationships between humans, the environment, and the broader biosphere.

Forestry: This theme addresses the essential role of forests within the circular bioeconomy, examining sustainable forestry practices and the governance challenges associated with effective forest management. Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.

Outdoor Learning: This is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover. Advocating for experiential education, this theme inspires active engagement with the natural world to enhance understanding and appreciation of the environment.

Food Loop: Focusing on circular approaches to food production and consumption, this theme introduces concepts aimed at efficiently reducing food waste and utilising by-products effectively. **Food Loop** encompasses farming, hospitality, retail, and energy production sectors.

Innovative Methodologies and Pedagogical Approaches

The programme utilises a variety of teaching methodologies and pedagogical approaches to engage learners and make bioeconomy concepts more accessible:

- **Active Learning:** Fostering hands-on exploration and problem-solving. Active learning fosters hands-on exploration and problem-solving, essential for understanding the bioeconomy. It encourages students to engage directly with real-world applications, think critically, and apply concepts to solve complex problems. This experiential approach enhances comprehension, making abstract ideas in bioeconomy more tangible and relevant for practical use in sustainable activities.
- **Place-Based Education:** Relating lessons to local environments and communities. Place-based education connects students with their local environments and communities, making lessons more relevant and impactful. In introducing bioeconomy, it fosters understanding of sustainable practices, local resources, and ecological systems. This approach encourages students to apply bioeconomic principles directly to their surroundings, creating practical solutions for environmental challenges.
- **Collaborative Learning:** Encouraging teamwork and shared discovery among participants. Collaborative learning promotes teamwork and shared problem-solving, crucial for bioeconomy education. It encourages diverse perspectives, fosters creativity, and builds critical skills like communication and cooperation. By working together, students gain a deeper understanding of complex bioeconomic concepts, while developing the teamwork needed for real-world sustainable solutions.
- **Inquiry-Based Learning:** Enhancing critical thinking and investigation through open-ended questions and scenarios. Inquiry-based learning encourages critical thinking by challenging students with open-ended questions and real-world scenarios. In bioeconomy education, this approach helps students explore complex issues, investigate sustainable solutions, and understand the interconnectedness of ecological, economic, and social systems, fostering problem-solving skills essential for addressing environmental challenges.
- **Relational Pedagogy:** This approach emphasises the importance of interpersonal relationships in the learning process, fostering collaboration, empathy, and shared knowledge, and noticing teaching and learning moments in our interactions in education. In the context of bioeconomy, this approach is appropriate as it encourages engagement between diverse participants — scientists, academics, engineers, learning communities, and industries—through dialogue and mutual understanding. It promotes the co-creation of knowledge, enhancing participants' ability to analyse complex, context-dependent bioeconomic challenges. By emphasising relational dynamics, this pedagogy aligns with the interconnected nature of environmental, economic, and social systems in bioeconomy, encouraging students to recognise and address real-world complexities in sustainable practices and solutions.

1.3. Foundations for Impact

Since its inception, the BioBeo Education Programme has been tailored to accommodate a variety of educational environments, ensuring its relevance for a wide range of learners. By exploring the bioeconomy through its five thematic areas, the programme offers a comprehensive framework for understanding how renewable biological resources can sustainably substitute fossil resources.

This thematic foundation supports all subsequent sections of the programme, influencing its resources, activities, and engagement initiatives.

2. Resource Development

The **BioBeo Education Programme** has delivered a diverse suite of resources to support the teaching of bioeconomy principles across primary, secondary, and mixed-age educational settings. These resources reflect the BioBeo themes of **Life Below Water, Interconnectedness, Forestry, Outdoor Learning, and Food Loop**, and are designed to foster a practical and engaging understanding of the bioeconomy.

2.1. BioBeo Primary Level Education Programme: Introducing BioBeo's 5 themes of the circular bioeconomy to primary school children, 6 Lesson Plans (English) (Also available in Irish)

Organisation: Maynooth University (MU)

Country: Ireland

Topic: Introducing BioBeo's 5 themes of the circular bioeconomy to primary school children.

Narrative: These 5 learning sessions will be conducted in the outdoor classroom, school environs, garden, or parklands. During these sessions, the teacher will introduce the 5 themes with a special focus on a pedagogy of place. Children and teachers will explore what a bioeconomy looks like in their locality and engage with the surrounding environment.

Methodology/ies: Active Learning, Guided Discovery, Talk and Discussion, Problem Solving, Collaborative Learning, Engaging and Interacting with the Natural Environment, Free Exploration of Materials, Learning through Play, Direct Teaching, Artistic and Musical Expressions and Responses.






SDG: 3,4,11,12,13,14,15,16.

3: Good Health and Well-being, 4: Quality Education, 11: Sustainable Cities and Communities, 12: Responsible Consumption and Production, 13: Climate Action, 14: Life Below Water, 15: Life on Land, 16: Peace, Justice and Strong Institutions.

Age group: 5th/ 6th classes, Primary.

Curriculum integration: From the National Council for Curriculum and Assessment Draft Primary Curriculum Framework: 1. Language 2. Science, Technology, Engineering, and Mathematics (STEM) Education 3. Wellbeing 4. Arts Education 5. Social and Environmental Education.

The following themes are addressed by this Material:

 Inter-connectedness	<u>Interconnectedness</u> ☒	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
 Outdoor Learning	<u>Outdoor learning</u> ☒	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
 Food Loop	<u>Food Loop</u> ☒	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
 Forestry	<u>Forestry</u> ☒	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
 Life Below Water	<u>Life Below Water</u> ☒	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

List of Lesson Plans:

- Learning session 1: Introduction/ Interconnectedness
- Learning session 2: An Coillín Beag/ Forestry
- Learning session 3: Create a pond/ Life Below water
- Learning session 4: Growing Food/ Food Loop
- Learning session 5: Art Adventure
- Learning session 6: Telling the Story

2.2. BioBeo Secondary Level Education Programme: Bioeconomy Project Week Activities (English)

Organisation: Rotterdam University of Applied Sciences (RUAS)

Country: Netherlands

Introduction: This project is implemented under the BioBeo project (EU Horizon). Students from the School of Education (RUAS) in the Netherlands are creating a 5-days project on bioeconomy. The student teachers, along with the lecturing staff who are partners in the BioBeo project, designed lesson materials during the Minor Sustainability and Big History.

During the 5-days project, students of secondary education will be introduced to the concept of bioeconomy. In the first four days, they will participate in workshops to learn about the 5 BioBeo-themes and how they are connected to bioeconomy. The knowledge and experiences gained, along with the biobased products they create, will be shared during a bioeconomy market on days 5, where friends and family can learn about the concept of the bioeconomy, the connection of the 5 themes and the overall goal: achieving a better and more sustainable future where no one is left behind (according to the bioeconomy definition in paragraph 1.1). The proceeds generated during the bioeconomy market will contribute to a bioeconomy project chosen by the school that further improves the innovations in the bioeconomy.

Summary: The project week is centered around the Bioeconomy Market Day.

- Day 1 to 3 the students will participate in workshops to gain knowledge and inspiration about the concept of the bioeconomy, addressing the 5 BioBeo themes.
- Day 4 they will choose a subject or topic to present on the Bioeconomy Market Day on day 5. They can design a workshop, sell produced items, or make a presentation about something they learned. These presentations always point out how this topic contributes to the bioeconomy and to achieving a better and more sustainable future where no one is left behind.

Day	Themes/subjects	Workshops/tasks
Day 1	Introduction to bioeconomy and the 5-days project programme *Interconnectedness *Outdoor learning *Forestry	<ul style="list-style-type: none"> ● Food hike ● The forest cleanup ● Back to Nature
Day 2	*Food loop	<ul style="list-style-type: none"> ● Dealing with food waste ● Healthy food and your impact
Day 3	*Life below water	<ul style="list-style-type: none"> ● Trash treasures
Day 4	Preparations for the bioeconomy market	<ul style="list-style-type: none"> ● Making pairs ● Choosing a subject ● Working on the subject
Day 5	Bioeconomy Market Day Closing of the project programme	<ul style="list-style-type: none"> ● Establish the bioeconomy market ● Host for friends and family






Topic, narrative, and methodologies: Secondary school students between 12 and 15 years old, will learn about the importance and the overall objective of bioeconomy in 5 days, or a project week. Bioeconomy has 5 subthemes chosen by the BioBeo Consortium (Reinmuth and Zwack, 2023). Interconnectedness, outdoor learning, food loop, forestry and life below water.

- Students and teachers will explore what bioeconomy looks like in their locality and engage with the surrounding environment, by discovering these 5 themes.
- Students will participate in workshops on 5 themes of their own choosing.
- We will use methodologies like active learning, guided discovery, talk and discussion, problem solving, collaborative learning, engaging, and interacting with the natural environment, free exploration of materials, direct teaching, and artistic expressions.

Sustainable development goals: We focus on the following goals: 3, 4, 11, 12, 13, 14, 15, and 16.



Themes: The following themes are addressed in the learning materials:

	<u>Inter-connectedness</u> ☒	Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	<u>Outdoor learning</u> ☒	Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	<u>Food Loop</u> ☒	Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	<u>Forestry</u> ☒	Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	<u>Life Below Water</u> ☒	Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

For schools that are not able to organise a Project Week, FEE adapted each of the seven workshops to be stand-alone lessons that align with the methodology and themes of the LEAF programme.

2.3. BioBeo Secondary Level Education Programme: Lesson Package on Bioeconomy, 6 Lesson Plans (English, French and Dutch)

Organisation: Odisee University of Applied Sciences Brussels (OUAS)

Country: Belgium

Topic: Bioeconomy, circular economy, interconnectedness, outdoor learning, food cycle, forestry, life underwater

Narrative:

- The basic idea of the bioeconomy is to move from an economy based mainly on fossil raw materials to an economy based on renewable biological raw materials.
- During the production (cultivation) of biological raw materials from plants, CO₂ is converted during photosynthesis into other carbon compounds that are stored in plants. Many organic raw materials can be produced and harvested within a year. Which is a huge advantage over fossil fuels, which take millions of years to form.
- In current production systems, stems, leaves and roots are often residual waste that is not of economic value. But this residual waste acquires economic value when it is composted or used as fuel in a biogas plant. The use of the material as a raw material for a biogas plant is called the "energetic use" of biological raw materials.
- Forestry is part of the bioeconomy at different levels. Forests provide the air we breathe and are not only recreationally interesting, but they are also the supplier of many biological materials in the bioeconomy. Moreover, they are ideal locations to connect natural and urban environments. Although forest products are becoming increasingly attractive from a sustainability perspective and are an important part of the circular economy, there are huge differences in the management of forestry activities worldwide.
- The use of fossil raw materials is harmful because the total amount of greenhouse gases released cannot be removed from the atmosphere within a reasonable period of time, but remains in the atmosphere, leading to negative effects, such as climate change.






The way the bioeconomy is talked about can contribute positively or negatively to the necessary changes to achieve a circular and sustainable bioeconomy.

The intention of this teaching package is to help students understand how the transition to a sustainable bioeconomy can best take place and which social actors play a role in this transition.

Sustainable Development Goals (SDGs): 2, 3, 12, 13, 14, 15

Age group: 12-15 years

Themes: The following themes are discussed:

	<u>Interconnectedness</u> ☒	Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	<u>Outdoor learning</u> ☒	Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	<u>Food Loop</u> ☒	Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	<u>Forestry</u> ☒	Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	<u>Life Below Water</u> ☒	Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

In addition to an introductory and a final lesson, this lesson package covers these 5 themes of the bioeconomy. These themes can be discussed in any order. The themes can also be taught as stand-alone lessons.

In this teacher's manual you will find 6 lesson preparations. In addition, a PowerPoint presentation and worksheets are available for students with each lesson.

Have fun with this lesson package about the bioeconomy!

2.4. Mixed Ages: Bioeconomy Special Topic Workshops (English)

2.4.1. Bees are the tireless workers of nature, 9 hours of material (Preschool and Elementary)

Organisation: E3STEM

Country: Greece

Topic: Sustainable economy and products, beekeeping, ecosystems, bioeconomy

Narrative: Beekeeping is an important aspect of the bioeconomy because it involves the sustainable management of honeybees, which are critical for pollination and the production of honey and other bee-related products. Beekeeping also plays a key role in supporting the production of crops that rely on pollination, such as fruits, vegetables, and nuts. As a result, beekeeping contributes to the sustainable production of food and other agricultural products.

In addition, beekeeping is an important part of the bioeconomy because it provides opportunities for small-scale farmers and rural communities to participate in the production of high-value products. Honey, beeswax, and other bee-related products can be sold locally or exported to other markets, providing income for beekeepers and contributing to the local economy.






Methodology/ies: inquiry-based learning, gamification.

SDG: the scenario focuses on Goal 15 LIFE ON LAND

Age group: 5-12

Curriculum integration: Environmental Sciences, Science, Biology, Chemistry, Physics

The following themes are addressed by this Material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> <input checked="" type="checkbox"/>	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> <input type="checkbox"/>	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
	<u>Forestry</u> <input checked="" type="checkbox"/>	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
	<u>Life Below Water</u> <input type="checkbox"/>	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

2.4.2. BioBeo Robot



Organisation: E3STEM

Country: Greece

Topic: BioBeo robot: a useful assistant that helps students learn what is Bioeconomy.

Narrative: BioBeo robot is a custom-made robot that can be used as a primary school teacher's assistant. BioBeo robot aims to help students learn in a fun and creative way what Bioeconomy is and why Bioeconomy is so important for our lives and for the environment!

This robot may have a body (hardware) with various mechanisms that enable movement (transport, rotation of the body and of the arms etc). In addition, it has a software so that it can perform various functions. It has a built-in screen to display the “Bioeconomy” application, where users can play interactive games and watch educational videos. A microbit board is integrated into the robot’s head to be used in temperature and brightness automation.

When brightness in BioBeo robot’s environment increases, the robot is activated and the microbit board displays the icon  on the led screen. Otherwise, the robot turns off and the microbit board displays the icon . When temperature in BioBeo robot’s environment increases, the microbit board displays the word “HOT” on the led screen. Otherwise, the robot turns off and the microbit board displays the word “COLD”.

BioBeo robot allows its users, i.e. mostly primary school students and their teachers, to intervene in its construction and mechanical parts (hardware) as well as in its software. Students and teachers can work together to create their own BioBeo robot! Specifically, they can design and build the robot body in a different way and with different materials. They can also modify and/or enrich the robot program with more functions, information, graphics and automations (e.g. measuring air/soil moisture, ph, watering plants etc).

Methodology/ies: Active Learning, Guided Discovery, Talk and Discussion, Problem Solving, Collaborative Learning, Engaging and Interacting with the Natural Environment, Free Exploration of Materials, Learning through Play, Direct Teaching, Inquiry-based, Engineering Design Process






SDG: <https://www.un.org/sustainabledevelopment/education/>

<https://www.un.org/sustainabledevelopment/gender-equality/>

Age group: 8-12 years old

Curriculum integration: Environmental Sciences, Biology, Chemistry, Physics, Mathematics, Computer Science, Arts, Bioeconomy Education.

The following themes are addressed by this Material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> <input checked="" type="checkbox"/>	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> <input checked="" type="checkbox"/>	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
	<u>Forestry</u> <input type="checkbox"/>	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
	<u>Life Below Water</u> <input type="checkbox"/>	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

2.5. Exploring the Ocean Currents in Circular Bioeconomy, 3 Lesson Plans (Secondary School, ESTEM)

Organisation: E3STEM

Country: Greece

Topic: Exploring the Ocean currents

Narrative: The oceans are increasingly affected by human activity, including acidification, plastic waste, over-fishing, and oil/gas extraction. Ocean currents absorb heat from the atmosphere, but this absorption depends on the motion of ocean currents and scientists consider that the continuously warming climate will affect this motion. The decrease in ocean circulation could have wide-reaching impacts on sea levels and fish populations and adversely affect the global climate (from <https://learn.microsoft.com/en-us/training/educator-center/instructor-materials/explore-ocean-currents>).






Methodology/ies: Active Learning, Guided Discovery, Inquiry Based Teaching and Learning

SDG: 12 (Responsible Consumption and Production), 13 (Climate Action)

Age group: Secondary Education (age 12 – 18)

Curriculum integration: Environmental Sciences, Geography, Biology, Chemistry, Physics

The following themes are addressed by this Material:

 Inter-connectedness	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
 Outdoor Learning	<u>Outdoor learning</u> <input type="checkbox"/>	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
 Food Loop	<u>Food Loop</u> <input type="checkbox"/>	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
 Forestry	<u>Forestry</u> <input type="checkbox"/>	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
 Life Below Water	<u>Life Below Water</u> <input checked="" type="checkbox"/>	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

List of Lesson Plans:

- Exploring the Ocean currents in circular bioeconomy - Effects of salinity and temperature on density and stratification
- Exploring the Ocean currents in circular bioeconomy - Effect of stratification on Mixing
- Exploring the Ocean currents in the context of circular bioeconomy - Convection under ice

2.6. From Satellite to Soil – Sustainable Agriculture

Organisation: E3STEM

Country: Greece

Topic: From satellite to soil - Sustainable Agriculture.

Narrative: Soils store carbon, water, and nutrients for plants. They play an important role in the challenges of climate change, the circular economy, human and environmental health, and water resources. Good soil health and nutrition is an essential part of the circular bioeconomy, in which bio-based solutions, derived from renewable raw materials and developed using industrial biotechnology, also play a role. For example, biodegradable and compostable plastics, both biobased and conventional, can also contribute to high-quality bio-waste. They are designed for specific applications and follow specific processes for end-of-life management, including separate collection and organic recycling. Bio-waste, in turn, can be used to produce

high-quality compost and organic fertilizers that help restore soil organic carbon, increase soil fertility and combat desertification¹.

The 'From Satellite to Soil - Sustainable Agriculture' educational scenario brings these concepts to life through a series of hands-on activities. Students first engage in an unplugged activity, crafting bioplastic from potato starch, exploring the practical applications of bio-based materials. They will then delve into the world of sensors and data with an Arduino-based activity, using soil moisture sensors to understand water retention and its impact on plant health. Furthering their exploration, students will combine unplugged and plugged learning to measure and analyze soil pH using Arduino, gaining insights into soil chemistry. Finally, they will utilize satellite imagery to observe and analyze forestry practices, connecting local soil health to broader environmental contexts.

Forestry is part of the bioeconomy on various levels. Not only do forests provide the air we breathe and serve a recreational purpose, but they are also the origin of many biobased materials of the circular bioeconomy. Apart from their various functions in the bioeconomy ecosystem, they can serve as locations to link natural and urban environments. Whilst forestry products are becoming increasingly attractive from a sustainability perspective and are a major component of the circular economy, there are massive global disparities in the governance of forestry activities worldwide.

Biological raw materials can be transformed into almost any product we know from our everyday lives. BioBeo will also provide an overview of possible products, based on the storylines and concrete contexts that will be developed along the curriculums.

Methodology/ies: brainstorming, inquiry-based learning, engineering design, Active Learning, Guided Discovery.

SDG: 8,12,13, 15,17






8: Decent Work and Economic Growth, 12: Sustainable Consumption and Production, 13: Climate Action, 15: Life on Land, 17: Partnerships for the goals.

Age group: Secondary Education (Ages 14 – 18).

Curriculum integration: Environmental Sciences, Science, Biology, Chemistry, Physics, Agriculture

¹ <https://www.agro-chemistry.com/news/soil-health-essential-part-of-circular-bioeconomy/>

The following themes are addressed by this Material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	<u>Outdoor learning</u> <input checked="" type="checkbox"/>	Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	<u>Food Loop</u> <input checked="" type="checkbox"/>	Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	<u>Forestry</u> <input checked="" type="checkbox"/>	Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	<u>Life Below Water</u> <input type="checkbox"/>	Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

List of Lesson Plans:

- Learning about the soil - Importance of soil PH. Manner to Correct it.
- Making plastic from potatoes
- Water Retention in Soil - Sustainable Agriculture
- Automated soil moisture control
- Sustainable forestry and products
- Let's have a BioBeo Party

2.7. Biorefinery

Organisation: UH

Country: Germany

Topic: Biorefinery

Narrative: A biorefinery is a refinery in which biomass is processed into various products. On the one hand, these are material products such as food and animal feed, as well as basic and fine chemicals for the chemical industry. The products are isolated from the raw material or produced from it using various chemical processes. These products can also be energy in the form of fuel, electricity or heat.

The principle of the biorefinery is comparable to that of an oil refinery, in which the raw material oil, which has a complex composition, is separated into individual fractions or components. Some of these are converted into other, easier-to-sell compounds by chemical processes.

Among other things, biorefineries should supplement and replace crude oil as an important raw material for the chemical industry. In addition, the large number of different chemical compounds in biomass could also result in new possible applications. Other important factors are efforts to protect the climate and the environment.

The concept of the biorefinery with a holistic and high-quality use of biomass is currently still in development. However, this concept has already been implemented to some extent, e.g. in the production of sugar, bioethanol and biodiesel, where attempts are made to use the by-products and co-products in a high-quality manner. Biogas plants are also occasionally referred to as biorefineries.






Methodology/ies: brainstorming, inquiry-based learning, engineering design, Active Learning, Guided Discovery.

SDG: 3 (Good-Health and Wellbeing), 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 9 (Industry, Innovation and Infrastructure), 12 (Responsible Consumption and Production), 13 (Climate action), 14 (Life Below Water), 15 (Life on Land)

Age group: Secondary Education (Ages 14 – 18).

Curriculum integration: Chemistry, Biology, STEM

The following themes are addressed by this Material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> <input type="checkbox"/>	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> <input checked="" type="checkbox"/>	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
	<u>Forestry</u> <input checked="" type="checkbox"/>	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
	<u>Life Below Water</u> <input type="checkbox"/>	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

List of Lesson Plans:

- Learning about the different types of biorefinery

2.8. Never Waste a Waste

Organisation: UH

Country: Germany

Topic: Never Waste a Waste!

Narrative: Waste is a global problem which has serious consequences. It can pollute our soil, oceans and groundwater, and air. The more waste we create, the more environmental damage we cause. Not only our environment but also our health and well-being are affected by pollution. Therefore, it is crucial to have proper waste management. A circular bioeconomy can be one of the solutions to this global waste problem with its principle of cascading use of resources.






Methodology/ies: Exploration, identification, classification, participation, active learning

SDG: 2 (Zero Hunger), 3 (Good-Health and Wellbeing), 4 (Quality Education), 6 (Clean Water and Sanitation), 12 (Responsible Consumption and Production), 13 (Climate action), 14 (Life Below Water), 15 (Life on Land)

Age group: Secondary Education (Ages 14 – 18).

Curriculum integration: STEM, Geography

The following themes are addressed by this Material:

	<u>Interconnectedness</u> ☒	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> ☒	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> ☒	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
	<u>Forestry</u> ☐	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
	<u>Life Below Water</u> ☒	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

List of Lesson Plans:

- Nature in Harmony
- Waste and Pollution
- Greening the School Garden

- Reduce, Reuse, Recycle
- Bioeconomy in my garbage can
- Art from waste
- Circularity and food waste

2.9. What did I see?

Organisation: UH

Country: Germany

Topic: What did I see?

Narrative: There are living and non-living organisms in nature and they are all connected to each other. Bioeconomy uses living or once-living organisms to produce bio-based products. Moreover, the existence of bioeconomy cannot be imagined without the existence of nature and its interconnected systems. Therefore, it is crucial to identify and classify the living and non-living organisms in order to understand the resources used in bioeconomy and their relationship in nature.

Methodology/ies: exploration, identification, classification






SDG: 2; 3; 4; 12; 14; 15

2 (Zero Hunger), 3 (Good-Health and Wellbeing), 4 (Quality Education), 12 (Responsible Consumption and Production), 14 (Life Below Water), 15 (Life on Land)

Age group: Secondary Education (Ages 5-7).

Curriculum integration: Biology

The following themes are addressed by this Material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	<u>Outdoor learning</u> <input checked="" type="checkbox"/>	Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	<u>Food Loop</u> <input checked="" type="checkbox"/>	Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	<u>Forestry</u> <input type="checkbox"/>	Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	<u>Life Below Water</u> <input checked="" type="checkbox"/>	Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

List of Lesson Plans:

- Nature in Harmony
- Living and Non-Living Things in the classroom
- Bioeconomy in My Life
- Discovery of Nature and Bioeconomy

2.10. Little Statistics

Organisation: UH

Country: Germany

Topic: Little Statistics

Narrative: We need to take care of nature as it is the basis for our food and biobased products. Therefore it is important to understand how long it takes for nature to grow certain plants that can be used as biomass resources for the bioeconomy.






Methodology/ies: exploration, identification, classification

SDG: 2 (Zero Hunger), 3 (Good-Health and Wellbeing), 4 (Quality Education), 15 (Life on Land), 12 (Responsible Consumption and Production),

Age group: Secondary Education (Ages 5-7).

Curriculum integration: Mathematics

The following themes are addressed by this Material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	<u>Outdoor learning</u> <input checked="" type="checkbox"/>	Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	<u>Food Loop</u> <input checked="" type="checkbox"/>	Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	<u>Forestry</u> <input type="checkbox"/>	Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	<u>Life Below Water</u> <input type="checkbox"/>	Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

List of Lesson Plans:

- Introduction to Little Statistics
- Preparation of Lesson Materials
- Exploration and Measurements of plants
- Visualization of results (art-based)

2.11. How to Grow Mushrooms - a BioBeo Teachers' Manual

Organisation: TUB, MU

Country: Germany, Ireland

Topic: Valorisation of organic waste, sustainable nutrition, mushroom cultivation, used coffee grounds

Narrative: "How to Grow Mushrooms" is a teachers' manual that contains scientific background information and practical tips on how to grow mushrooms on used coffee grounds for teachers. In addition, exemplary lesson plans, tasks and worksheets for different age groups as well as solutions are included. The following messages are addressed:

- For a transformation towards a sustainable society, education about sustainable practices and bioeconomic principles is key.
- It is elemental that students understand early on that the success of a sustainable and circular economy depends on our actions and behaviour and how and what we consume daily.
- Organic (lignocellulosic) waste such as used coffee grounds can be used as mushroom cultivation substrate and can be valorised into food.






Methodology/ies: Student-centered, action-oriented, project-based (experiential, experimental, participatory), collaborative learning, connected to the daily life of students

SDG: 12 (Responsible consumption and production)

Age group: 6-14 years old (primary to lower secondary)

Curriculum integration: Biology, nutrition education, environmental education, food loop, sustainable development, circular economy

The following themes are addressed by this Material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	<u>Outdoor learning</u> <input type="checkbox"/>	Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	<u>Food Loop</u> <input checked="" type="checkbox"/>	Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	<u>Forestry</u> <input checked="" type="checkbox"/>	Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	<u>Life Below Water</u> <input type="checkbox"/>	Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

2.12. BioBeo E-Twinning

Organisation: University of Hohenheim

Country: Germany, Sweden, Greece, Turkey, Romania

Topic: Resource Don't GO! project on E-Twinning

Platform: <https://school-education.ec.europa.eu/en/etwinning>

Narrative: The BioBeo EU project has developed an innovative approach to teaching children and young students about bioeconomy through play. The eTwinning project "Resource – Don't Go!" (RDG) was created to twin schools across European countries, fostering collaborative learning about the essence of bioeconomy. This eight-month project, running from October 2023 to June 2024, involved both primary and secondary schools in co-creating and playing the "Resource - Don't Go!" board game.

The main objective of the project was to provide playful insights into the solutions and challenges of a sustainable and circular bioeconomy. By engaging with the game, students enriched their knowledge of global challenges such as climate change and food crises, while exploring how bioeconomy can address these issues. Additionally, the project aimed to develop students' language, communication, and digital skills.






The work process was structured in two stages. The first stage introduced the concept of a sustainable circular bioeconomy to both teachers and students. Schools twinned on the platform through various activities, including student meetings and card sharing. In the second stage, students played the game under teacher guidance, sharing their experiences between schools via podcasts and school photos.

The project yielded diverse results, including school photos, game videos, game pawns crafted from recycled materials, posters on BioBeo's five themes, student-prepared game cards, and a podcast series featuring game card content². These outcomes were disseminated on the European School Education Platform (ESEP) and through BioBeo EU project's social media accounts on Instagram, Twitter, and LinkedIn.

Age group: Secondary Education (Ages 5-7).

Curriculum integration: all

The following themes are addressed by this Material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> <input type="checkbox"/>	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> <input checked="" type="checkbox"/>	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
	<u>Forestry</u> <input type="checkbox"/>	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
	<u>Life Below Water</u> <input type="checkbox"/>	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

Dissemination: The BioBeo eTwinning project was disseminated at the the BioBeo Festival where education meets the bioeconomy organised by OUAS (Odisee), Local Newspapers from the participating schools on the eTwinning platform.

Achievement: Teachers applied for the National Quality Label on the European Platform for Education eTwinning based on the BioBeo activity

Accompanying materials available: Introduction video to eTwinning

2.13. The BioBeo App and Dashboard

Organisation: YSBF, OUAS

Country: Estonia, Belgium, Austria, Denmark, Germany, Greece, Ireland, Netherlands, Romania, and Poland

Topic: Interactive bioeconomy trails for experiential learning.

Narrative: The BioBeo App is an innovative platform that seamlessly merges education with adventure. It is designed to guide children on interactive trails that delve into essential bioeconomy concepts in their natural surroundings. The app offers multiple route options, each specifically tailored to incorporate different themes of the BioBeo curriculum. As students navigate these trails, they encounter various challenges and activities that are engaging and educational. This experiential approach promotes active learning, allowing young learners to develop a richer and more personal connection to their environment while grasping key sustainability and circularity principles.

Accompanying the app is the BioBeo Dashboard, a versatile digital tool that serves to connect traditional classroom experiences with hands-on, real-world exploration. The dashboard allows educators to transform standard lessons into interactive and experiential learning opportunities by empowering them to create personalised routes and quizzes linked to local points of interest relevant to the curriculum. This functionality enriches the educational journey, as students can actively participate by exploring bioeconomy themes right in their communities.

Integrating the BioBeo App and Dashboard exemplifies BioBeo's commitment to harnessing technology in transformative ways for education. By fostering curiosity and encouraging active participation, teachers and students can engage with critical sustainability and circularity topics in innovative and meaningful contexts. The aim is to cultivate a generation that understands, values and actively contributes to a sustainable future.

Methodology/ies: Active learning, gamification, technology-enhanced learning.






SDG: 4, 11, 13,15

4: Quality Education, 11: Sustainable Cities and Communities, 13: Climate Action, 15: Life on Land

Age group: 8-18 years old.

Curriculum integration: Geography, STEM, Physical Education, Environmental Sciences.

The following themes are addressed by this Material:

	<u>Interconnectedness</u> ☒	Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	<u>Outdoor learning</u> ☒	Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	<u>Food Loop</u> ☒	Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	<u>Forestry</u> ☒	Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	<u>Life Below Water</u> ☒	Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

2.14. Comic Creation: *Beo and Raja: Back to the Future*, and, *Beo and Raja: Answering the Curlew's Call*

Organisation: MU and UCD

Country: Ireland

Topic: Using storytelling to explore bioeconomy themes.

Narrative: The BioBeo project has developed a series of educational comics to make bioeconomy concepts accessible and engaging for younger audiences.

1. *Back to the Future with Beo and Raja:*

This inaugural comic introduces readers to Beo, a curious dog, and Raja, a resourceful child, as they embark on an adventure through time to explore the foundations of the bioeconomy. The story emphasises important themes such as sustainability, interconnectedness, and the role of natural systems in supporting human life.

2. *Answering the Curlew's Call:*

"Answering the Curlew's Call" is an innovative comic created as part of the BiOrbic BioCultúr project, a collaborative endeavour between University College Dublin (UCD) and Maynooth University (MU). This comic explores the intricate connections that bind language, heritage, culture, and the bioeconomy together.

A captivating visual narrative with rich illustrations delves into the profound interdependence of cultural and ecological systems, emphasising the importance of sustainable practices deeply rooted in Ireland's rich traditions. Each page entertains and educates, weaving storytelling with clear educational objectives to enhance understanding of bioeconomy principles.

This engaging creative tool fosters a greater appreciation for Ireland's rich linguistic and environmental heritage tapestry. The comic will be launched at the BiOrbic/BioBeo Bioeconomy Education Workshop on Thursday, 20th February, promising to inspire attendees with its message and insights.

The two comics described here are part of an ongoing series to incorporate visually engaging illustrations and relatable narratives to spark curiosity and deepen understanding of the bioeconomy and its foundational themes.

Mary Colwell, of Curlew Action UK, wrote the following impact statement, “Saving the iconic Irish Curlew can’t be done just by nature organisations and the government, it takes everyone, everywhere to understand and care. The Curlews plight in Ireland is so extreme there is a real danger of losing it as a breeding bird across the land, so much so that many people won’t have heard or seen one. Keeping the cultural and collective memory of Curlews alive is essential; bringing them back to life in the hearts and minds of people is an essential part of conservation. Without public concern, no environmental measures will work in the long term, and wildlife like the Curlews will always be lost in the clamour of economics and politics. These charming productions will help engage new audiences to the crisis the birds face and I wish them every success.”

Methodology/ies: Storytelling, arts-based learning, inquiry-based learning.




SDG: 4, 13, 15

4: Quality Education, 13: Climate Action, 15: Life on Land.

Age group: 6-12 years old.

Curriculum integration: Environmental Sciences, Arts, Literacy, STEM.

The following themes are addressed by this Material:

	<u>Interconnectedness</u> ☒	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> ☒	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> ☒	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>



Forestry



Whilst **forestry** products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.



Life Below Water



Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

2.15. The BioBeo Song and An Talamh Bhláfar

Organisation: MU and UCD

Country: Ireland

Topic: Using songs to explore bioeconomy themes.

Narrative 1: The BioBeo Song teaches essential principles of bioeconomy by emphasizing sustainability, interconnectedness, and circularity within natural systems. The lyrics illustrate how nature’s processes—such as oxygen production by trees, the food cycle, and aquatic ecosystems—are interconnected and vital for sustaining life. By showcasing examples like edible gardens, pollination, and the importance of biodiversity, the song highlights how human activities can align with ecological systems to create a sustainable, circular economy. The focus on learning from nature’s patterns encourages students to understand and implement bioeconomic practices, where resource use is optimized while ensuring environmental balance and renewal.

Narrative 2: "An Talamh Bhláfar" (The Fertile Land) is a poignant song that weaves together themes of heritage, culture, and sustainability. Created collaboratively by Maynooth University (MU) and University College Dublin (UCD) as part of the Horizon Europe BioBeo project, alongside the efforts of the BiOrbic BioCultúr initiative, this composition aims to highlight the significance of the bioeconomy within communities through music. The song acts as a bridge, linking Ireland's rich cultural and ecological legacy with the core principles of the bioeconomy. Through its melodies and lyrics, it nurtures a collective vision of resilience and advocates for sustainable practices, encouraging listeners to contemplate their connection to the land and the environment. "An Talamh Bhláfar" embodies a vision of harmony where cultural identity and ecological sustainability coexist, inspiring generations to engage with and care for their surroundings.

Methodology/ies: Storytelling, arts-based learning, inquiry-based learning.






SDG: 12, 13, 15

12: Responsible Consumption and Production, 13: Climate Action, 15: Life on Land

Age group: 6-18

Curriculum integration: Environmental Sciences, Arts, Literacy.

The following themes are addressed by this material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> <input checked="" type="checkbox"/>	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> <input type="checkbox"/>	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
	<u>Forestry</u> <input type="checkbox"/>	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
	<u>Life Below Water</u> <input type="checkbox"/>	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

2.16. The BioBeo Buzz Newsletter

Organisation: MU, UCD, An Taisce

Country: Ireland

Topic: Engaging communities with bioeconomy education through interactive and accessible newsletters.

Narrative: The BioBeo Newsletter serves as a vital communication and dissemination link for the BioBeo project, reaching a diverse audience with the latest advancements in bioeconomy education. Published monthly, this dynamic newsletter is filled with engaging project updates, interactive activities, practical eco-friendly tips, and insightful features on biodiversity. Sustainability and bioeconomy. Its rich content aims to enhance readers' understanding of sustainability, the principles of circularity and bioeconomy. By sparking curiosity and promoting environmentally conscious practices, the newsletter seeks to foster a community of informed, eco-aware individuals dedicated to positively impacting our planet. From March 2025 the newsletter will be titled 'BioBuzz' to continue beyond the project like our BEST network.

Methodology/ies: Digital communication, Interactive Engagement, Awareness Building.






SDG: 4, 13, 15

4: Quality Education, 13: Climate Action, 15: Life on Land.

Age group: All

Curriculum integration: Environmental Sciences, STEM, Literacy.

The following themes are addressed by this material:

 Inter-connectedness	<u>Interconnectedness</u> ☒	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
 Outdoor Learning	<u>Outdoor learning</u> ☒	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
 Food Loop	<u>Food Loop</u> ☒	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
 Forestry	<u>Forestry</u> ☒	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
 Life Below Water	<u>Life Below Water</u> ☒	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

2.17. 2024 Global Action Days

Organisation: FEE

Country: Global

Topic: **Activity 1: Climate Ready through Bioeconomy**

Narrative: Bioeconomy means using renewable biological resources from the land and sea. Including crops, forests, fish, animals, and micro-organisms to produce food, materials, and energy. In your schools, homes or clubs find and photograph examples of products linked to bioeconomy, such as cloth bags, woollen clothing, organic food and FSC certified wood.

Methodologies: Interactive engagement, awareness-building, hands-on learning

SDG: 4,12,13

Age group: all

BioBeo Theme: Interconnectedness?

2.18. The Missing Link - A Practical Guide For Teachers On How To Teach Bioeconomy

This guide serves as a missing link between the theory of bioeconomy education and the lesson plans created within the framework of the project. It focuses on the methodology of how interested teachers can set out and engage all school stakeholders (students, parents, colleagues, non-teaching staff, etc.) in teaching about the bioeconomy. It gives practical advice and provides hands-on tools that support the teachers in their everyday work (not just when teaching bioeconomy). It also includes several tools for self-reflection, self-evaluation and dissemination to enable sustainability.

2.19. Introductory video for teachers on how to integrate Bioeconomy to their existing curriculum

Organisation: UH

Country: Germany

Topic: Engaging and enabling teachers to teach about the bioeconomy

Narrative: As a contribution to the 2025 BIP, support materials for the integration of bioeconomy-related topics were produced. A 7-minute introductory video was created using Synthesia, an AI-based software. The video has been uploaded to the BioBeo Youtube channel to ensure that it remains available beyond the project. The video is linked to course material that includes the PPT slides explained in the video and additional and very detailed recommendations on bioeconomy-related topics suitable for different subjects from existing curricula. From biodiversity, microbiology and life processes to applied chemistry and products and materials. This comprehensive collection of recommendations on how to integrate bioeconomy-related topics into existing curricula supports teachers in a very practical and accessible way to integrate bioeconomy into their existing lesson plans.






Methodology/ies: Train the trainer, Awareness-building

SDG: -

Age group: All age groups

Curriculum integration: Interdisciplinary

The following themes are addressed by this material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> <input type="checkbox"/>	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> <input checked="" type="checkbox"/>	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
	<u>Forestry</u> <input type="checkbox"/>	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
	<u>Life Below Water</u> <input type="checkbox"/>	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

It has to be noted that the introductory video was presented, together with the informational poster upcycling of residual streams, to interested teachers at BIP Rotterdam 2025.

2.20. Informational poster “Upcycling of residual streams”

Organisation: UH

Country: Germany

Topic: Engaging and enabling teachers to teach about the bioeconomy

Narrative: As a contribution to the 2025 BIP, support materials for the integration of bioeconomy-related topics were produced. An informational poster which may be used for lessons to visualize upcycling options for various residual streams from food production and processing for food and non-food chemicals and materials of the bioeconomy was created, based on research results achieved at UH’s bioeconomy research unit.






Methodology/ies: Train the trainer, Awareness-building

SDG: 12 (Responsible consumption and production)

Age group: Secondary education (12-18 years)

Curriculum integration: Interdisciplinary

The following themes are addressed by this material:

	<u>Interconnectedness</u> <input type="checkbox"/>	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> <input type="checkbox"/>	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> <input checked="" type="checkbox"/>	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
	<u>Forestry</u> <input type="checkbox"/>	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
	<u>Life Below Water</u> <input type="checkbox"/>	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

2.21. Teacher Guide on Background of Bioeconomy

Organisation: UH

Country: Germany

Topic: Engaging and enabling teachers to teach about the bioeconomy

BioBeo background information for teachers provides an overview of the concept of the bioeconomy and looks at the resource base, products, services, and technologies, while showing how the bioeconomy and circularity go together. It concludes with a look at the food system and new foods and their role in the bioeconomy. The teacher guide also comprises a BioBeo Glossary on the most relevant terms of the bioeconomy.






Methodology/ies: Train the trainer, Awareness-building

SDG: -

Age group: All age groups

Curriculum integration: Interdisciplinary qualification

The following themes are addressed by this material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> <input type="checkbox"/>	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> <input checked="" type="checkbox"/>	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
	<u>Forestry</u> <input checked="" type="checkbox"/>	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
	<u>Life Below Water</u> <input type="checkbox"/>	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

It has to be noted that the introductory video was presented, together with the introductory video for teachers on how to integrate Bioeconomy to their existing curriculum, to interested teachers at BIP Rotterdam 2025.

2.22. Definition infographic

Organisation: UH

Country: Germany

Topic: Engaging and enabling teachers to teach about the bioeconomy

Narrative: The bioeconomy definition infographic illustrates the story of the bioeconomy, starting with the ambition to move away from fossil-based resources and moving to a bioeconomy based on bio-based resources where no one is left behind. Particular emphasis is placed on demonstrating the relevance of education and skills development to the successful development of a sustainable and circular bioeconomy.






Methodology/ies: Train the trainer, Awareness-building

SDG: -

Age group: All age groups

Curriculum integration: Interdisciplinary

The following themes are addressed by this material:

	<u>Interconnectedness</u> ☒	Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	<u>Outdoor learning</u> ☒	Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	<u>Food Loop</u> ☒	Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	<u>Forestry</u> ☒	Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	<u>Life Below Water</u> ☒	Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

2.23. BioBeo AI and Bioeconomy Christmas Glossary Challenge

Organisation: UH

Country: Germany

Topic: AI in bioeconomy education

Narrative: The BioBeo project has innovatively leveraged its Glossary, originally included in the teacher's guide, to create an engaging Christmas challenge on social media. This initiative aims to captivate individuals interested in Bioeconomy while simultaneously demonstrating the potential of AI in bioeconomy education. The challenge involved transforming glossary terms into visual representations using AI-generated prompts. This creative approach addressed three key thematic challenges identified when integrating AI into bioeconomy education:

1. Combining AI Literacy with Bioeconomy Education:

The first challenge encouraged participants to recreate bioeconomy terms using AI through out-of-the-box thinking and artistic expression. This approach aligns with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) educational model. BioBeo believes this method is incremental in playfully introducing the concept of a sustainable and circular bioeconomy to learners across Europe, forming an essential piece of the STEAM education puzzle.

2. Tackling Gender Bias in AI-Generated Images:






A significant challenge emerged related to gender representation in AI-generated images. The team observed that technology was well-represented when male characters were used in the prompts. However, female characters were often depicted in stereotypical roles. For example, instead of showing a woman operating a 3D food printing machine, the AI would generate images of women

with kitchen scales, reinforcing outdated gender roles. This bias required detailed additional instructions to ensure fair and accurate representation of women alongside technological devices.

By addressing these challenges, the BioBeo Christmas challenge not only engaged the public in bioeconomy concepts but also shed light on important considerations in the use of AI for educational purposes. This initiative demonstrates the potential of integrating AI into bioeconomy education while also highlighting areas that require careful attention to ensure inclusive and accurate representation.

Integration: BioBeo BUZZ Newsletter + LinkedIN

The following themes are addressed by this material:

	<u>Interconnectedness</u> <input checked="" type="checkbox"/>	Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	<u>Outdoor learning</u> <input type="checkbox"/>	Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	<u>Food Loop</u> <input checked="" type="checkbox"/>	Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	<u>Forestry</u> <input type="checkbox"/>	Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	<u>Life Below Water</u> <input type="checkbox"/>	Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

2.24. Scientific Paper on Recommendation for Educational Narratives in Bioeconomy Strategies

Organisation: UH

Country: Germany

Topic: Educational Narratives in Bioeconomy Strategies

Narrative: The forthcoming perspective paper explores the role of narratives in bioeconomy strategies and policy documents within the context of societal transformations. It highlights the challenges of communicating bioeconomy concepts and argues that profound societal change cannot be driven solely through a top-down approach. Instead, the authors argue that sustainable transformation requires new forms of innovation and adapted communication tools to convey systems, normative, and transformative knowledge. In this regard, the paper presents narratives as essential science communication tools that enable a more nuanced and effective articulation of bioeconomy-related concepts.






Methodology/ies: Train the trainer, Awareness-building

SDG: -

Age group: All age groups

Curriculum integration: -

The following themes are addressed by this material:

	<u>Interconnectedness</u> <input type="checkbox"/>	<p>Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.</p>
	<u>Outdoor learning</u> <input type="checkbox"/>	<p>Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.</p>
	<u>Food Loop</u> <input type="checkbox"/>	<p>Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.</p>
	<u>Forestry</u> <input type="checkbox"/>	<p>Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.</p>
	<u>Life Below Water</u> <input type="checkbox"/>	<p>Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.</p>

2.25. Resource Don't GO game

Organisation: UH

Country: Germany

Topic: Playful education for sustainable resource use.

Narrative: The board game Resource Don't Go! was developed by international students as part of a summer school on the topic "How is bioeconomy going to shape our world?" at the University of Hohenheim in order to give interested parties playful insights into the possibilities and challenges of a sustainable and circular bioeconomy. The game is suitable for use in schools as well as at universities. The learners can create playing cards themselves and present them to the other players. The game can thus be used in various courses that deal with the topic of bioeconomy.

Several versions of the game have been created based on external collaborative input:

- **Resource Don't GO - Parental Engagement Edition**

Based on input from Dr. Judit Horgas (Parents International Association) the Resource Don't GO - Parental Engagement Edition was created to include a novel set of playing cards with a special

emphasis on parental engagement. This novel edition of the game is accompanied by a 1-hour video course on parental engagement in the bioeconomy.

- **Resource Don't GO - Cross Fertilisation Edition**

Through collaboration with other EU-funded projects related to the bioeconomy, including Hoop Project, Circalgae, GenB, CEE2ACT, REDWINE, Phenolexa Project, Lowinfood, VIVALDI and the NeoGIANT Project as well as LENA a novel set of playing cards was created, which integrates findings and discussion inputs from each of the projects.






Methodology/ies: Gamification

SDG: 7 (Affordable and clean energy), 10 (Reduced inequalities), 11 (Sustainable cities and communities), 12 (Responsible consumption and production), 13 (Climate action)

Age group: 10+ years

Curriculum integration: Interdisciplinary

The following themes are addressed by this material:

	<u>Interconnectedness</u> ☒	Interconnectedness reflects the role of the biosphere and natural environments in human well-being and holistic health and the undisputed ecological interconnectedness of all living things.
	<u>Outdoor learning</u> ☒	Outdoor learning is active learning in the outdoors where participants learn through what they do, through what they encounter and through what they discover.
	<u>Food Loop</u> ☒	Food Loop encompasses farming, hospitality, retail, and energy production sectors. In terms of the circular economy, it focuses on the efficient use of by-products, and the overall reduction of food waste.
	<u>Forestry</u> ☒	Whilst forestry products are increasingly attractive in terms of sustainability, and are a major part of the circular economy, there are massive global disparities in the governance of forestry activity.
	<u>Life Below Water</u> ☒	Life below water refers to the conservation and sustainable use of all water bodies (like oceans, and marine resources but also rivers and lakes) for sustainable development.

It has to be noted that the Resource Don't GO game was presented to a diverse set of stakeholders across several events, including:

- University of Hohenheim open day: The Resource Don't GO game was presented to students, parents and members of the general public.
- Teacher training: The Resource Don't GO game was presented to teachers interested in learning about the bioeconomy on two occasions.
- BioBeo Festival: The Resource Don't GO game was presented at the BioBeo Festival where education meets the bioeconomy organised by OVAS (Odisee), a satellite event to the European Commission's Bioeconomy Changemaker Event on March 15, 2024.

- GreenOffice Kick-off: The Resource Don't GO game was presented to all present staff members of the University of Hohenheim at the University of Hohenheim's GreenOffice kick-off event.
- Visit of Minister Haydon to Hohenheim: The Resource Don't GO game was presented to Minister Haydon during his visit to the University of Hohenheim.
- Welcome week at the University of Hohenheim: Resource Don't GO game was presented within a workshop for the new bachelor's students enrolled in different disciplines at the University of Hohenheim, particularly in the programs of Agricultural Sciences and Renewable Resources and Bioenergy, with the goal of introducing students to the university's research activities.
- ESD symposium: The Resource Don't GO game (together with a general introduction of the BioBeo project) was presented during the state-wide symposium for education for sustainable development (Fachtagung BNE) hosted by the Center for School Quality and Teacher Education Baden-Württemberg (Zentrum für Schulqualität und Lehrerbildung Baden-Württemberg) on Nov 12th, 2024. A total of 45 copies of the game were distributed amongst teachers that attended the event.

2.26. LENA Lebendige Naturschule Göppingen

Organisation: UH

Country: Germany

Topic: Foundation of a primary school with main focus on Bioeconomy

Website: <https://www.lena-gp.de/>

Narrative: A new primary school has been established in collaboration with the BioBeo project team from the University of Hohenheim. BioBeo partner UH is also co-developing the bioeconomy curriculum, which will then be offered to other schools across Germany. The curriculum is designed to be used either as a whole or as elements that can be integrated into existing curricula.

LENA (Lebendige Naturschule) is a reform-oriented school initiative in Göppingen, Germany, designed to expand the local educational landscape with a focus on holistic learning. It is planned as a half-day primary school where children learn in mixed-age groups without grades or exam pressure. The school's concept emphasizes Montessori and nature-based pedagogy, combined with core principles known as the "red thread": peace education, mindfulness, democracy, ethics, and sustainability. Learning at LENA integrates theoretical knowledge with practical experiences in nature and social environments. The school views nature as both a developmental space and a learning companion, allowing children to explore biodiversity, environmental cycles, and sustainable practices. This approach fosters creativity, communication, and problem-solving skills while promoting respect for the environment.

LENA aims to equip students with competencies for addressing global challenges such as climate change and resource scarcity. It emphasizes relationship-building, self-organization, and personal growth to prepare children as active participants in shaping a sustainable future. Students are encouraged to follow individual learning paths while adhering to the curriculum. The school plans to start with 10 students in grades 1-2 and gradually expand to accommodate up to 80 children across primary and secondary levels. During its initial three years, LENA will rely on self-financing through donations, social contributions, and crowdfunding.

LENA's activities include outdoor learning sessions, interdisciplinary projects, and partnerships with organizations like the University of Hohenheim through the EU BioBeo project. The school fosters a culture of lifelong learning in a democratic, inclusive environment that values emotional and social development alongside academic achievement.

SDG: 7 (Affordable and clean energy), 10 (Reduced inequalities), 11 (Sustainable cities and communities), 12 (Responsible consumption and production), 13 (Climate action),

Age group: 5+ years

2.27. Erasmus BioBeo Blended Intensive Programme

Organisations: Maynooth University, Odisee University of Applied Sciences, Rotterdam University of Applied Sciences, University of Hohenheim.

Countries: Ireland, Belgium, Netherlands

Topic: Erasmus BioBeo Blended Intensive Programme (BIP)

Narrative: The Erasmus Blended Intensive Programme (BIP) is an innovative educational initiative designed to foster the internationalisation of higher education by combining online and in-person learning experiences. The BioBeo BIP, focused on bioeconomy and sustainability, provided students with opportunities to engage in interdisciplinary, transdisciplinary, and intercultural learning. This initiative encouraged the development of critical skills in a global context and promoted sustainable solutions to complex environmental challenges. Through the collaboration between Maynooth University, Odisee University of Applied Sciences, and Rotterdam University of Applied Sciences, University of Hohenheim, Stichting International Parents Alliance, the programme highlighted the importance of creating strong academic partnerships across borders in the field of bioeconomy education. The BioBeo BIP exemplified a modern, flexible approach to education that ensured accessibility for all partners involved, allowing students to engage meaningfully with one another and the concepts of sustainability and bioeconomy. With components completed in Ireland and the Netherlands, the programme will conclude with a BIP in Belgium shortly, ensuring full participation across the three institutions. This approach enhanced global cooperation and intercultural dialogue and contributed to the long-term goals of fostering inclusive and sustainable international education beyond the project's conclusion.

The BioBeo Blended Intensive Programme (BIP) was conducted in March 2024 at Maynooth University and in March 2025 at Rotterdam University of Applied Sciences to enhance participants' understanding of bioeconomy concepts. The programme's strategic focus is to empower educators, particularly those working with children, to convey bioeconomy principles effectively. To assess its effectiveness, a Google Forms survey was administered, gathering feedback from attendees regarding their comprehension and confidence in discussing bioeconomy concepts.

The survey results revealed notable improvements in participants' understanding of bioeconomy concepts. Initially, only 12.5% reported having an excellent grasp of the subject, while 50% had an excellent understanding, and 25% showed a good level of comprehension. Post-programme, these figures shifted dramatically; 68.8% of participants reported an excellent understanding, and 25% indicated a very good understanding, illustrating the programme's success in enhancing knowledge.

Moreover, confidence levels in explaining bioeconomy concepts saw a significant increase. Prior to the programme, 81.3% of participants felt confident in their ability to articulate these concepts, which reflects the positive impact of hands-on activities and practical examples utilised throughout the training. The interactive nature of the programme—including workshops and real-world applications—was crucial in facilitating this learning.

Participants engaged in various hands-on activities that enriched their learning experience. Notable activities included lectures on bioeconomy in primary schools, the "88 Challenge," interactive workshops, and outdoor activities like forest bathing. Feedback from the survey indicated that these experiences were essential in making complex bioeconomy topics more accessible and relatable to educators and students alike.

The BIP also emphasised the importance of equipping educators with practical teaching strategies. An impressive 87.5% of respondents felt that the programme prepared them to implement effective teaching methods, particularly those incorporating outdoor learning and connecting bioeconomy concepts to children's everyday lives. This focus on practical application is crucial, enabling educators to foster a deeper understanding of sustainability within their students.

In terms of engagement, in-person sessions were highly regarded, with 68.8% of participants reporting excellent comprehension and engagement. This highlights the effectiveness of face-to-face learning in fostering a dynamic educational environment.

A critical outcome of the BIP was its influence on participants' perspectives regarding sustainability and environmental stewardship. All respondents (100%) indicated that the programme significantly impacted their views, leading to increased efforts to adopt sustainable practices in their personal and professional lives.

Methodology/ies: Blended learning (combination of online and in-person components), Interdisciplinary collaboration, Cross-cultural exchange, Outdoor Learning, Transdisciplinary collaboration.

SDG: Quality Education (SDG 4), Reduced Inequalities (SDG 10)

2.28. Bioeconomy Education and Sustainability Teachers (BEST) network

Organisations: All Partners, all subscribers to BioBuzz Newsletter.

Countries: International

Topic: Bioeconomy Education, Sustainability Education.

Ongoing Educational Impact: The BEST network, an extension of the BioBeo project, is a community of bioeconomy educators that will continue to foster communication through the Bioeconomy Newsletter, which will include a dedicated section for network updates. The BEST network was officially launched in March 2025 through the Bioeconomy newsletter and the inaugural meeting was held at the BioBeo Blended Intensive Programme in Rotterdam in March 2025. The network will host an annual BEST meeting where educators can share best practices in bioeconomy education. Educators involved in the BioBeo Blended

Intensive Programme will serve as the steering committee of the BEST network, actively recruiting new members from the BioBeo electives in their institutions and Blended Intensive Programmes for student teachers. This initiative ensures long-term collaboration, enabling continued learning and the dissemination of bioeconomy and sustainability content in educational settings.

Dedicated Space: A specific space within the newly renamed BioBeo Bioeconomy Newsletter to 'BioBuzz Newsletter' will be dedicated to the BEST Network. This dynamic community of educators, home educators, and anyone passionate about Education for Sustainable Development (ESD) and bioeconomy will have access to ongoing updates, key educational initiatives, and resources for teaching and learning about bioeconomy and sustainability. To join the BEST network, individuals can simply sign up for the BioBuzz Newsletter, making membership to the network automatically accessible. This section will highlight immersive learning, real-world experiences, and the growth of a global network, serving as a valuable resource for those dedicated to fostering a sustainable future through education.

Sustained Collaboration and Network Growth: The strong, ongoing relationship between the partnering institutions continues to thrive, contributing to the success of the BEST network. The steering committee comprises members from University College Dublin, Ireland, Maynooth University, Ireland, Rotterdam University of Applied Sciences, The Netherlands, and Odisee University of Applied Sciences, Belgium and their collaboration ensures the continued growth of the network. All members of the BioBeo Consortium who have signed up for the BioBuzz Newsletter will automatically be members of the BEST network, fostering a global community of bioeconomy and sustainability educators. This continued partnership strengthens the network, ensuring that educators can share research, best practices, and ideas for a sustainable future.

The BEST network will continue to play a vital role in advancing bioeconomy and environmental sustainability education, providing educators with the tools, resources, and connections needed to make meaningful changes in the classroom and beyond. The integration of sustainability concepts into education is essential for equipping the next generation of leaders to tackle the pressing challenges of our time.

2.29 BioBeo Bioeconomy Puppet Show

Organisations: MU and UCD

Countries: International

Topic: Bioeconomy Education, Sustainability Education.

The world's first bioeconomy puppet show, developed by students from Maynooth University (MU) and University College Dublin (UCD), marks a pioneering achievement in integrating sustainability education with heritage language and cultural traditions. This innovative project, launched in April 2025, was created as part of the BioBeo 2.5 credit elective module at MU, where students not only designed and built the puppets and stage from biobased materials but also embraced traditional native crafts like knitting and crochet. These heritage crafts were carefully selected to create the puppets, making the show an exceptional blend of modern environmental education and traditional Irish skills, connecting sustainability with cultural preservation.

In this collaborative project, the students not only contributed to sustainability efforts by choosing biobased materials for the puppets but also helped to revive and preserve Irish cultural traditions by using crafts that have been passed down through generations. The inclusion of knitting and crochet wasn't just a craft choice - it was a deliberate effort to weave cultural heritage into the heart of sustainability. These age-old skills tied into the broader themes of the show, highlighting how bioeconomy practices can coexist with time-honoured traditions, underscoring the importance of sustainable living and cultural continuity.

The puppet show itself is based on the BioBeo comic *Answering the Curlew's Call*, which tells the poignant story of Ireland's endangered curlew bird. This comic, and by extension the puppet show, uses a combination of biocultural education to raise awareness of both biodiversity conservation and sustainable practices. The show brings to life the characters of Beo and Raja, whose journey to save the curlew is depicted using puppetry and performance. By incorporating elements of the Irish language, the puppet show not only teaches children about the importance of sustainability but also fosters a deeper connection to their cultural roots. The use of native language in the performance serves as a reminder that our heritage, language, and culture are deeply interconnected with the health of the environment.

The BioBeo Puppet Show has already reached over 300,000 children globally, engaging young minds in an educational experience that blends fun, creativity, and sustainability. The project has resonated deeply with audiences because of its unique approach, blending artistic expression with environmental awareness and cultural engagement. The performance was not only showcased in schools and festivals but also released on digital platforms, allowing it to reach a wider audience and inspire a global conversation about the importance of both sustainability and heritage preservation.

To further amplify its impact, teacher guidance notes have been developed, providing educators with the tools and resources to replicate the puppet show in classrooms around the world. These notes outline how to create the puppets using biobased materials and how to incorporate both sustainability and cultural education into the lesson. This will allow the educational model to be replicated in various educational settings, ensuring that the core message of bioeconomy and cultural heritage is passed on to future generations.

The BioBeo Puppet Show is a trailblazer in bioeconomy education, not only for its innovative use of sustainable materials but also for its successful fusion of cultural heritage and environmental awareness. It stands as a prime example of how interdisciplinary education -combining the arts, science, and culture-can create a powerful, lasting impact on young learners. By embedding sustainability in heritage practices and engaging students with hands-on, creative learning, the BioBeo Programme is setting a new standard for how education can foster both environmental and cultural stewardship. This first-of-its-kind initiative demonstrates that education for sustainability can be deeply enriched when cultural traditions are honored

and integrated into the learning process, ensuring that both bioeconomy knowledge and heritage preservation remain part of the conversation for years to come.

2.30. BioBeo Library

1. Finding Beo
<https://researchrepository.ucd.ie/entities/publication/d0a0d9ca-1c54-476b-92a3-0828538202c3>
2. Back to the Future with Beo and Raja: A Tale from the Early Bioeconomy
<https://researchrepository.ucd.ie/entities/publication/09dd2b78-4068-4569-8baf-fe2f983e120d>
3. Answering the Curlew's Call: A Beo and Raja adventure
<https://researchrepository.ucd.ie/entities/publication/1c321794-2108-4e9c-9c52-9348df6d8d15>
4. There's Something about Ammonia
<https://researchrepository.ucd.ie/entities/publication/5bbd9ab0-34bc-4277-a8c7-01d20580a03d>
5. BioBuzz
<https://www.biobeo.eu/biobeo-buzz-newsletter/>
6. How to Grow Mushrooms - a BioBeo Teachers' Manual
https://www.static.tu.berlin/fileadmin/www/10002031/Projekte/ManualMushroom_BioBeo_final.pdf

2.31. Leabharlann BioBeo

1. Tóraíocht Bheo
<https://researchrepository.ucd.ie/entities/publication/a4d6ced9-bd57-4a6b-831c-3e7264015dd6>
2. Ar Ais chuig an Am atá le Teacht le Beo agus Raja: Scéal ón mBithgheilleagar Fadó
<https://researchrepository.ucd.ie/entities/publication/015d32a0-f632-47e7-bc4a-1c53bc59374a>
3. Ag Freastal ar Ghlaio an Chrotaigh: Eachtra Le Beo agus Raja
<https://researchrepository.ucd.ie/entities/publication/c8a63a9e-80d9-4f43-997e-671e7d8d1218>
4. Amóinia? Amóinia? Cad faoi Amóinia?
<https://researchrepository.ucd.ie/entities/publication/5fe39d43-ca90-4dbc-a462-4c30d08bc51a>

2.32. BioBeo Videos / Físeáin BioBeo

1. BioBeo: Answering the Curlew's Call. A Beo and Raja Adventure
<https://www.youtube.com/watch?v=uTyOQ3uXOvo>
2. BioBeo What is Bioeconomy Teacher Intro Video
<https://www.youtube.com/watch?v=oYSOcp5hiO8>
3. An Talamh Bhláfar - Connecting Communities to the Bioeconomy
<https://www.youtube.com/watch?v=k6i6wsYFFF4>
4. Bioeconomy in Fabulous Forests
<https://www.youtube.com/watch?v=h1CevPst9Yc>
5. Beo's Bioeconomy Sing-Along
<https://www.youtube.com/watch?v=GAuu3bJ3DGI>
6. Sparkling Seas: A Bioeconomy Adventure
<https://www.youtube.com/watch?v=cmKVO7RvUt0>
7. Nature Detective Work in a Bioeconomy
<https://www.youtube.com/watch?v=7zP3EfO8L70>
8. Sustainable Fish in a Bioeconomy
<https://www.youtube.com/watch?v=6EtRh6O7eSI&t=1s>
9. Organic Magic: Bioeconomy Explorers
https://www.youtube.com/watch?v=BbL_QtxjUbU
10. All About eTwinning!
https://www.youtube.com/watch?v=4_Pnwsh6lwc
11. The BioBeo Festival
<https://www.youtube.com/watch?v=oicEqTk1JzY>
12. The BioBeo Integration in School and Univeristy Curricula
<https://www.youtube.com/watch?v=BIVxCR7Uw5E>
13. BioBeo "Resource Don't Go!" Boardgame
<https://www.youtube.com/watch?v=tpY5tuXt-tE>
14. AgroCycle Kids Animated Video
<https://www.youtube.com/watch?v=Y4ARYtj11nY>

3. Piloting and Implementation

The BioBeo Education Programme has undergone extensive piloting across diverse educational contexts to assess its effectiveness, adaptability, and relevance. The piloting phase evaluated learner and educator engagement, collected feedback for iterative improvements and tested resource applicability across various environments.

3.1. Introduction to Piloting

The piloting phase was pivotal to the BioBeo Education Programme's development. It provided a platform for trialling educational resources in real-world settings, allowing for refinement based on user feedback and measurement against objectives to enhance bioeconomy literacy and sustainability.

3.2. Pilot Locations and Contexts

The programme's pilot initiatives spanned schools, community organisations, and higher education institutions, encompassing multiple European countries, including:

- Belgium: Piloting of secondary education resources that integrated all 5 BioBeo topics including outdoor learning sessions and place-based education methodologies in diverse Flemish secondary schools. At OUAS (Odisee) the BioBeo Festival where education meets the bioeconomy was organised with 200 participants, half of them pupils from secondary schools.
- Ireland: Piloting of primary education resources that integrated outdoor learning sessions and place-based education methodologies in primary schools diverse in nature including a special school and remote island school.
- Netherlands: Execution of the Bioeconomy Project Week in secondary schools, overseen by Rotterdam University of Applied Sciences.
- Greece: Implementing workshops and resource demonstrations at events like the Athens Science Festival, facilitated by E3STEM.
- Germany/Europe: eTwinning project "Resource – Don't Go!" (RDG) was created to twin schools across European countries, fostering collaborative learning about the essence of bioeconomy
- Germany: LENA primary school was co-founded by BioBeo project members of University of Hohenheim and is now welcoming its second cohort. This private primary school is piloting and championing a bioeconomy focussed curriculum based on Montessori and will develop teach the teacher training opportunities as well as a curriculum equivalent to secondary school in the upcoming years.

3.3. Activities during Piloting

Key activities and events served as testing grounds for BioBeo resources:

- Bioeconomy Project Week: Secondary students engaged in thematic workshops covering forestry, food loops, and aquatic ecosystems, culminating in a Bioeconomy Market Day where student projects were showcased.
- Athens Science Festival: BioBeo resources, including interactive workshops, were introduced to secondary students and educators, focusing on STEM engagement with bioeconomy topics.
- Environ 2024 Conference: The BioBeo team presented educational initiatives through musical and visual mediums, stimulating discussions about the bioeconomy among diverse audiences.
- Resource Use in Primary Schools (Ireland) and Secondary Schools (Belgium (Flanders)).

The piloting phase yielded critical insights that have informed the BioBeo Education Programme's trajectory:

- Over 50 European events have incorporated BioBeo resources, significantly amplifying outreach and engagement.
- Resources such as the BioBeo App and storytelling comics received positive feedback, indicating strong potential for broader implementation and integration within educational frameworks

4. Evaluation of BioBeo Education Programme

4.1. Maynooth University, Ireland (MU)

Introduction & Overview

In 2023–2024, Maynooth University piloted the BioBeo Primary Education Programme across five diverse and inclusive school settings in Ireland, including DEIS, Gaelscoil, Special, Island, Rural, and Urban schools. A total of 176 children and 28 educators (including principals, teachers, SNAs, and caretakers) participated in six outdoor learning sessions delivered over four months.

All five school principals expressed high satisfaction with the programme's educational quality, delivery, and student learning outcomes. Feedback demonstrated a strong interest in continued participation and growth within BEST. The BioBeo Primary Programme was published in Irish and English in April 2024, and participating schools received the BioBeo Interconnectedness Award during the BioBeo Festival in Brussels.

Programme Aims and Structure

MU's central objective is to enhance environmental literacy and foster understanding of the circular and sustainable bioeconomy. The six interdisciplinary lesson plans integrate five key themes:

1. Interconnectedness
2. Outdoor Learning
3. Forests
4. Life Below Water
5. Food Loop

Children engaged in hands-on, outdoor learning experiences that were phenomenon-based, creative, and sensory-rich. Activities included ecological games, tree and pond creation, natural artmaking, composting, and biodiversity investigations. Children responded to their learning through artistic expression, including painting with bio-based materials. A key resource was the original BioBeo Song, co-written by the MU team. The song proved popular and pedagogically effective. It integrated scientific and environmental vocabulary with music and language learning.

Learning Session Objectives Summary

Each lesson was aligned with specific learning goals:

- Session 1: Understanding ecological interconnectedness
- Session 2: Observing circular systems in local forests
- Session 3: Exploring water conservation and life below water
- Session 4: Creating edible gardens and reducing food waste
- Session 5: Expressing learning through natural art
- Session 6: Consolidating vocabulary, envisioning green careers, and preparing for the BioBeo

Festival

The sessions were designed to be flexible, inclusive, and adaptable across diverse school settings and learner needs.

Engagement with Students and Educators

A teacher-researcher with 20 years of experience, led the BioBeo programme and facilitated engaging outdoor sessions across all schools. The sessions provided meaningful opportunities for students to explore BioBeo themes using a constructivist, inquiry-based approach. Students experienced ecological learning in tangible and enjoyable ways, such as planting trees, identifying species, and building miniature ecosystems. Teacher and school feedback emphasised that students became more confident, curious, and knowledgeable about sustainability and bioeconomy topics. For many, it was their first experience engaging with the natural world in such an active and informed way.

Curriculum Development & Feedback Integration

The BioBeo curriculum was continuously refined during the pilot, informed by feedback from educators and pupils and observations made during classroom visits. The 30 teaching days allowed time for iterative improvements and responsive adjustments. Teacher feedback highlighted the programme's accessibility, interdisciplinary relevance, and positive impact on student engagement. The schools integrated BioBeo learning into broader curriculum planning and desired further resources and support in outdoor education. Educators in the Special School setting noted robust responses from their students, reporting that outdoor learning "brought science to life" for children who otherwise might not engage with such material.

Impact Assessment and Participant Reflections

Pupil feedback demonstrated:

- Increased awareness of environmental issues
- A clear understanding of interconnectedness and sustainability
- The desire for more outdoor learning opportunities -ideally daily

Children's feedback included comments like:

"Everything is connected; we want to care for nature."

"I never knew about lichens or how frogs survive in winter!"

"I am going to build a vegetable garden with my dad."

Parents also reported a noticeable change in children's attitudes toward the environment. In a parent survey, 86% said their child understood the circular bioeconomy and sustainability much better.

All teachers noted improvements in vocabulary, engagement, and collaborative learning. Several commented that terms like 'interconnectedness' and 'bioeconomy' became meaningful and understandable through experience-based learning.

Teacher and Principal Reflections

Quotes from educators include:

- *"The children are teaching themselves - connecting the dots. It makes sense to them now."*
- *"BioBeo ticks every box. We would love to see it continue."*
- *"This is the best ecological education we have done. It is relevant and inspiring."*

All five school principals have confirmed interest in continuing BioBeo-related education and supporting further initiatives linked to the circular economy. The schools now form a growing national network for bioeconomy education in Ireland - BEST.

Conclusion

The MU-led pilot of the BioBeo primary programme shows that:

- Children respond enthusiastically and meaningfully to outdoor and bioeconomy-based learning.
- The programme improves environmental literacy, vocabulary, and hands-on science education.
- Educators value BioBeo's flexible, practical, and interdisciplinary approach.
- The circular bioeconomy can be effectively taught in primary contexts using creative, sensory, and inclusive resources.

Recommendations include:

- Expanding support and CPD for outdoor education and circular bioeconomy themes.
- Continuing collaboration between BioBeo schools, policymakers, and educators via BEST.
- Deepening the integration of the five BioBeo themes into national curricula via our work in the new Department of Agriculture, Food and the Marine AFM funded project CBEC (Circular Bioeconomy Education Centre).

This pilot has laid a strong foundation for building a sustainable, connected future through education. The BioBeo programme demonstrates that even young learners can engage with complex ecological issues when learning is grounded in experience, creativity, and curiosity.

4.2. Universitaet Hohenheim, Germany (UH)

The materials developed by UH were mainly piloted in the LENA school, which started in autumn 2024. After an initial integration and pilot phase, it became clear that the materials needed to be further refined and fully integrated into a new primary school curriculum. During the piloting phase, the teachers and the two founders of LENA School identified the most relevant aspects: at the primary level, bio-economy education is about teaching the underlying principles, such as circularity, but also the interconnectedness with nature. This was very close to the five themes of BioBeo. As a next step, the curriculum has been updated and will be ready by May 2025 for the next cohorts. This curriculum is based on the existing curriculum for primary schools in the German state of Baden-Württemberg and now integrates bioeconomy aspects in a more subject-related way. As a result of the BioBeo project, an updated introductory video for teachers was produced and further suggestions for the integration of bioeconomy aspects in existing subjects were developed for the BIP in Rotterdam.

Furthermore, LENA has now also designed an entrepreneurship element for the primary school, which builds on reflection on the underlying principles and includes a continuous task for each cohort to take on a long-term project, which also teaches a new understanding of 'failing' as continuous feedback and learning.

4.3. Rotterdam University of Applied Sciences, Netherlands (RUAS)

Piloting Phase & Objectives of the educational materials

In the piloting phase of the educational materials focused on Blue City and the bio-based economy, secondary schools in Oud Beijerland, South Holland, were selected to test these resources. The programme aimed to engage students with real-world sustainability issues and raise awareness about the bio-based economy through interactive activities and resources.

Programme Success and Objectives

The piloting phase was largely successful in meeting its objectives. The field trip to Blue City, with circular start-ups added greatly to the results. The materials and activities were well-received, as they provided students with an in-depth understanding of bioeconomy concepts in an accessible and engaging manner. The resources, including video content, worksheets, and hands-on activities, helped students grasp the importance of sustainable practices and the circular economy, which was one of the core aims.

Engagement of Students and Educators

Both students and educators showed significant engagement with the resources. Feedback surveys indicated that 85% of students found the materials interesting and felt they enhanced their understanding of sustainability and the bio-based economy. Teachers also reported a high level of satisfaction, particularly with the structured lesson plans that integrated easily into their existing curricula. Educators noted that the resources sparked meaningful discussions among students about sustainability in their communities.

Amendments and Improvements

Some amendments were made to the content based on feedback from the piloting phase. A few students mentioned that certain sections were difficult to follow without more context, particularly when discussing technical bio-based materials. In response, additional explanatory notes and visual aids were added to clarify complex concepts. Teachers also requested a greater emphasis on local case studies, so references to Blue City and other regional initiatives were expanded to make the content more relevant.

Data and Feedback

A number of students participated in the pilot across several schools, and a significant portion provided feedback. Key findings from the feedback include:

Many students expressed increased interest in sustainability topics.

A large proportion of students felt they had gained a deeper understanding of the bio-based economy.

Teachers reported high levels of satisfaction with the resources and would recommend them for future use.

Insights and Conclusions

The piloting phase revealed that educational materials that combine theory with practical examples from local projects, such as Blue City, are highly effective in engaging students. Teachers and students both appreciated the focus on real-world applications of bioeconomy principles. However, the feedback also highlighted the need for more interactive and locally relevant examples to ensure deeper engagement and better comprehension of abstract concepts.

Additional Relevance

The piloting phase demonstrated that these educational resources have the potential to be expanded in broader regions expressing interest in adopting the programme. Fee also used the material to make

separate lessons of it. The success of this initiative has opened doors for further collaboration between schools, universities, and sustainability-focused organisations, providing students with valuable learning experiences that could shape their understanding of the future of our planet's economy.

In conclusion, the piloting phase proved that the BioBeo resources are a promising tool for fostering knowledge and interest in sustainability and bioeconomy, with further refinements to enhance clarity and engagement in future implementations.

Curriculum Changes in the Netherlands:

Emphasizing Sustainability and the Biobased Economy

The Netherlands is undergoing significant updates to its secondary education national curriculum, with an increased focus on the biobased economy, climate change, and sustainability. These changes reflect the growing importance of addressing global environmental challenges and equipping students with the knowledge and skills to contribute to a more sustainable future. The revisions cover a wide range of subjects, including geography, biology, economics, and citizenship, and are part of the broader *Curriculum.nu* project, which aims to make the national curriculum more relevant and aligned with current societal needs.

Biology Curriculum Changes

In biology, the updated curriculum places a strong emphasis on sustainability, biodiversity, and climate change. Students will explore the impact of climate change on ecosystems and biodiversity, as well as the role of sustainability measures in improving the health of the planet. There was some influence of the BioBeo Project, because the Dutch partner was asked to review the proposed changes in several stages of the process. Key areas of focus include:

- **Sustainability & Climate Change:** Students will learn how climate change affects ecosystems and biodiversity, as well as the role of human activities in these processes.
- **Research & Methodology:** A greater emphasis is placed on developing students' research skills, with a focus on real-world applications such as the BioBeo project, which investigates sustainable practices in biology.
- **Biobased Economy:** Although the concept of the biobased economy is not explicitly mentioned in the biology curriculum, it is integrated into broader discussions on biodiversity, circularity, food production, and climate change. Students will learn about the importance of renewable resources, recycling, and sustainable production processes.

In addition to the environmental focus, the curriculum also includes traditional topics, such as the formation of landscapes, survival in different habitats, and the properties of substances and materials. Students will gain a deeper understanding of the complex relationships between living organisms, their environments, and the ways in which human actions impact the natural world.

Geography Curriculum Revisions

The geography curriculum is being revised to better address key environmental issues, with a particular focus on sustainability and climate change.

The revised curriculum includes the following key themes:

1. **Sustainable Development:** Students will explore how human activities impact the Earth, including the ecological footprint and ways to live more sustainably.
2. **Climate Change:** The curriculum delves into the causes and consequences of climate change, as well as the roles played by governments, businesses, and citizens in mitigating its effects.
3. **Energy and Environment:** Topics such as renewable energy, CO2 emissions, and the environmental impacts of industry and transport are also included.

These changes align with global initiatives, such as the United Nations' Sustainable Development Goals (SDGs), and reflect a commitment to providing students with the tools to understand and address the complex environmental issues facing the world today. Although the biobased economy is not a specific core objective yet, it is integrated within broader topics such as:

- **Renewable Energy and Raw Materials:** Introducing students to biomass and biobased products as alternatives to fossil fuels.
- **Circular Economy:** Focusing on the reuse of natural resources to promote sustainability.
- **Agriculture and Industry:** Examining how agriculture contributes to the production of biomass and the role of biobased solutions in various industries.

The Curriculum.nu project is guiding these updates, and some schools may offer specialized modules on the biobased economy in partnership with external organisations, such as colleges and companies. As sustainability continues to be a central focus, the biobased economy is expected to play an increasingly significant role in future curricula.

Economics Curriculum changes

In addition to changes in the secondary education curriculum, the teacher training program for economics is also being updated. The revised curriculum includes new subdomains and indicators designed to deepen students' understanding of economic concepts and the challenges posed by modern society.

Key changes in the economics curriculum include:

1. **Discussing Limitations:** This subdomain encourages students to critically evaluate the limitations of traditional economic models, such as assumptions about rational behaviour, selfishness, and profit maximisation. Teachers are expected to discuss ethical dilemmas and the tension between normative and positive economics in real-world situations.
2. **Basic Principles of Economic Thought:** Teachers will provide students with a deeper understanding of core economic principles, such as cost/return reasoning, and the long-term consequences of economic decisions. For example, students will explore economic choices (e.g., going to the cinema) by considering both visible and hidden costs, as well as the broader impacts of those decisions.

Citizenship Curriculum Revisions

The curriculum for citizenship education is also undergoing updates, with a new core objective focused on social issues. This core objective aims to help students develop a critical understanding of the world around them and explore ways to address pressing social challenges. Key aspects of the revised curriculum include:

- **Core Objective: Social Issues:** Students will explore various social and planetary issues, such as sustainability, health, and technological advancements. They will learn to identify the interests and

perspectives involved in current issues and reflect on how personal beliefs and values influence their actions.

- **Real-World Applications:** Students will engage in projects and discussions on topics like future-proof neighbourhoods, the impact of personal lifestyles on the planet, and societal inequalities. They will also use digital tools and mathematics to analyse global issues, such as income disparities and climate change.

This approach encourages students to consider both individual and collective contributions to solving social issues, fostering a sense of responsibility and empowerment in addressing the challenges of the 21st century.

Conclusion

The national curriculum updates in the Netherlands reflect a growing recognition of the need to equip students with the knowledge and skills to address the environmental and social challenges of the future. By integrating sustainability, climate change, and the biobased economy into various subjects, the revised curriculum aims to prepare students to be active, informed citizens who can contribute to building a sustainable, equitable world. As these changes are implemented, the biobased economy is expected to become an increasingly prominent theme in education, providing students with a solid foundation for addressing the complex issues facing society.

4.4. ODISEE University of Applied Sciences, Belgium (OUAS)

Piloting Phase & Objectives

OUAS teacher educators and bachelor of education students co-created and piloted the BioBeo Secondary Education Programme. The programme enhances understanding and engagement across society regarding 'circularity' and the bioeconomy, using five bioeconomy themes: food loop, forestry, interconnectedness, life below water and outdoor learning.

The programme was piloted in a diverse set of 7 Secondary schools in the Dutch-speaking part of Belgium. The programme includes lessons on all 5 BioBeo topics. It was published in Dutch and translated into English and French.

The piloting happened in two phases: in the first phase, the lessons were given as they were originally designed. In the second phase, the lessons were adapted based on teachers and pupils feedback.

Engagement with Students and Educators

The BioBeo Secondary Education Programme has made substantial progress in promoting Bioeconomy education. Its inclusive approach and comprehensive resources have been well-received, laying a strong foundation for future expansion and sustainability in promoting and disseminating the bioeconomy concept.

Feedback & Suggestions for Improvement

The initial programme was adapted upon teachers and pupils' experiences. The level of some lessons was

adjusted to better match the students' prior knowledge. Evaluative instructions were added. All lesson plans and worksheets are designed for lower secondary education pupils. For application in higher secondary, the material need to be designed in a more advanced way.

Data and Metrics Collected

The BioBeo Secondary Education Programme was initially published in Dutch. Later on translations in English and in French were made to reach a broader audience. In Flanders 7 schools piloted the programme. Reaching around 200 pupils and 20 education professionals (class teachers and teacher trainees). Although no formal quantitative data were collected, qualitative feedback was used to improve the programme. Teachers reported that the following of the programme increased their pupils' interest in the bioeconomy.

Insights and Conclusions

The BioBeo's educational goals align strongly with the SDG's. The programme brings pupils into contact with sustainability and bio-economy at an early stage, which is important when it comes to behavioural changes or adaptations. In Flanders the programme is particularly suitable for usage in teaching STEM subjects.

4.5. Hellenic Education Society of STEM, Greece (E3STEM)

The piloting phase of E3STEM's BioBeo project was conducted through two distinct workshops, targeting different educational levels to assess the effectiveness of the five developed educational scenarios. The workshops aimed to introduce bioeconomy themes and evaluate the educational materials' impact.

- **Aegean College Workshop:** This 2-hour workshop, "STEM and Bioeconomy in action - The BioBeo Project," targeted 45 college students during Biology Week. Students engaged with the BioBeo board game, using online and physical dice, and nuts and beans as pawns to illustrate the circular concept of raw material transformation. The use of the board game, and physical materials was a good way to engage the students, and the before and after questionnaires provided good data.
- **Athens Science Festival Workshop:** This series of 40-minute workshops, "BioBeo STEM Bioeconomy Workshop," reached secondary education students across three groups of 30 students (total 90 students). The workshops featured three stations: BioBeo board games, comix, and leaflets; hands-on activities like bioplastic creation and automated soil moisture control, and activities from the "Bees" scenario; and demonstrations of the Smart Food Cabinet and BioBeo Robot. The variety of activities allowed for a wide exposure to the educational scenarios and gained valuable feedback.

Overall, the piloting phase successfully implemented the BioBeo education program and resources, besides E3STEM's educational Scenarios. The workshops provided a valuable foundation for future implementation in various educational settings. The objectives to introduce bioeconomy concepts and test the collaborative STEM bio-economy activities were met. The use of hands-on activities was very successful, especially the bioplastic creation, and the automated soil control. The BioBeo robot, and Smart

food cabinet were also very engaging. The use of the BioBeo board game was also successful, and the physical materials such as the nuts and beans were very effective in demonstrating the circular concepts. The before and after questionnaires that were given to the college students, showed a marked improvement in the student knowledge of the subject.

The resources and activities demonstrated a high level of engagement among both college and secondary education students.

- The BioBeo board game, with its interactive elements, effectively engaged college students, fostering teamwork and understanding of bioeconomy principles.
- At the Athens Science Festival, the hands-on activities, such as bioplastic production and automated soil moisture control, captivated secondary education students. The Smart Food Cabinet and BioBeo Robot also sparked significant interest.
- The use of the comix, and leaflets, provided good supporting information.
- The diversity of activities across the five educational scenarios ensured that students with varied interests and learning styles were engaged.
- The use of physical materials to supplement the digital content, proved to be very effective.

The collaborative nature of the activities and the integration of computational thinking principles contributed to the engaging learning experience.

Based on observations and feedback during the piloting phase, several refinements were identified.

- The before and after questionnaires showed the need for more clear definitions of some of the bioeconomy terms.
- The time allocated for each station at the Athens Science Festival was very short, and longer times would be beneficial.
- The need for more translated material for a wider audience was noted.
- The workshops highlighted the need for adaptable lesson plans that can be tailored to varying time constraints and educational levels.
- The data from the college student questionnaires, will be used to improve the BioBeo board game.

The following data was collected during the piloting phase:

- Participation rates: 45 college students and 90 secondary education students actively participated in the workshops.
- Pre- and post-workshop questionnaires: Administered to college students to measure knowledge gain. The data showed a significant improvement in the college students' understanding of the bioeconomy concepts.
- Qualitative observations: High levels of engagement were observed during the hands-on activities and demonstrations at the Athens Science Festival.
- Informal feedback was gathered from the students, and teachers during the workshops.

Overall Strengths and Conclusions:

- The hands-on, interactive nature of the educational scenarios effectively engaged students.
- The integration of computational thinking and collaborative learning fostered a deeper understanding of bioeconomy concepts.
- The diverse range of activities catered to different learning styles and interests.

- The use of physical materials such as the nuts and beans, and the bioplastic creation was very effective.

The piloting phase successfully demonstrated the potential of the BioBeo educational scenarios to engage students and promote bioeconomy education. The collaborative approach and the integration of STEM principles were particularly effective. The project's impact extends beyond the workshops, providing valuable resources for educators to integrate bioeconomy concepts into their curricula. The project is a valuable tool for the dissemination of information about the bioeconomy, and also a good tool to encourage students to pursue careers in the life sciences.

4.6. Foundation for Environmental Education, United Kingdom (FEE)

Piloting Phase and Objectives

The objective of Activity 1: Climate Ready through Bioeconomy in the 2024 Global Action Days was to introduce participants to the bioeconomy by asking them to find items in their daily lives linked to the bioeconomy such as cloth bags, woollen clothing, organic food, etc. Participants were then asked to share images and photos on social media reflecting on their learning.

Educational materials produced in BioBeo were adapted and disseminated across the LEAF network via the website, newsletters and social media.

Engagement with students and educators

70,558 participants from 578 settings in 60 countries registered to participate in the BioBeo Global Action Days activity. From the five activities, the BioBeo activity unfortunately had the least number of registered participants however the post-campaign survey indicated that 25,317 participants from 307 settings across 47 countries completed Activity 1. This made it the most completed individual activity for participants who chose not to do all five activities (a majority of participants did complete all five activities).

A two-part online workshop series was held in early 2025 to introduce FEE's educational programmes network (LEAF, Eco-Schools and YRE). More than 275 participants registered for each workshop.

Feedback and suggestions for improvement

It was interesting to observe that despite perhaps an initial lack of interest, the BioBeo activity proved to be quite successful. As such, it was decided to include another BioBeo bioeconomy activity in the 2025 Global Action Days campaign. The theme is ecosystem restoration and participants will be asked to learn about bioeconomy practices from the past by speaking with elders in their community.

The online workshops went well, and we received good engagement from participants (majority of whom were educators). During the workshop, participants identified the advantages to bioeconomy education as well as the barriers.

Advantages included:

- A really great way to make big concepts and actions required for climate change tangible for younger people
- Students would be more aware of the impact they have on daily life
- Hands on projects in our classrooms will empower our learners more in terms of sustainability
- More innovation and freedom
- Holistic view of the environment

Barriers included:

- Lack of general knowledge of what it [bioeconomy] is, difficulty overall to meaningfully integrate environmental education into curriculum
- time to fulfill the projects
- lack of funding, resources and support
- Teacher's capacity and/or knowledge
- the national curriculum

The barriers raised by participants in the workshops are often associated with implementing environmental education and ESD. In order to address these, it's important to support teachers in recognizing the interconnectedness of bioeconomy and how this can allow them to integrate it into their teaching practices in line with the curriculum demands and without a significant investment of additional time.

4.7. Technical University Berlin, Germany (TUB)

Piloting Phase and Objectives

The Objective of the "Teachers' Manual - How to Grow Mushrooms" was to provide an informative manual that supports teachers to grow mushrooms sustainably on spent coffee grounds in class with regard to practical aspects. In addition, it includes aspects like mushroom taxonomy, morphology, applications (food and non-food), potential mushroom substrates, comparison to environmental impact of meat and nutritional aspects, while sustainability concepts and circular bioeconomy are the main themes throughout the manual.

Parts of the manual such as the mushroom cultivation and cooking and tasting the recipes were piloted in student teacher courses at TU Berlin.

Engagement with students and educators

The manual, especially the practical tips and the recipes, are based on teacher education courses having taken place at TU Berlin. The students as well as educators were so enthusiastic about the topic that they extended it and included mushroom gathering in forests of the Berlin area. Results from the courses such as dishes and a poster walk were presented at the Long Night of Science 2023 at TU Berlin.

Feedback and suggestions for improvement

At the moment, the materials and lesson plans are designed for a younger age group (primary and lower secondary). For application in higher secondary, the material needs to be designed in a more comprehensive and more advanced way.

The material could be adapted to vocational education e.g. culinary education and include more practical tips on storage, preparation, seasoning and flavor profile of mushrooms as well as their application as meat alternative (minced meat, burger patties etc.).

4.8. University College Dublin, Ireland (UCD)

Piloting Phase & Objectives

The initial piloting of *Choco Chase*, developed under the BioBeo project, took place at the *Cearclann Oideachais: BioBeo and BiOrbic Bioeconomy Education Workshop* (20 February 2025), where it was interactively demonstrated to educators, researchers, and students. Due to time constraints, full gameplay was not conducted at this event. However, the game was later played during the BioBeo Module, where participants actively engaged with it and demonstrated thoughtful decision-making.

The game's core aim—to make circular bioeconomy and sustainability concepts accessible through an engaging format—was well received. Attendees appreciated its structured, stage-wise learning approach and effective integration of Life Cycle Assessment (LCA), aligning strongly with BioBeo's educational themes.

Engagement with Students and Educators

The game was highly successful in **generating interest and engagement**. Participants actively interacted with the materials, reviewed the game board, dashboard, decision/event cards, and quiz stages. They acknowledged the game's **scientific robustness and creativity**, and many remarked on its **strong potential as a teaching tool** for secondary-level learners.

Feedback & Suggestions for Improvement

- The **player dashboard** could benefit from additional **pictorial or visual cues** to enhance clarity and make tracking more intuitive, especially for younger players.
- The **quiz-based Stage 3** could be made more dynamic by allowing students to **trade questions across difficulty levels**. This suggestion aligns with the principle of **cerebral equity**, ensuring players of different learning levels are equally challenged and engaged.

These ideas can be considered for future iterations of the game.

Data and Metrics Collected

While no formal quantitative data (e.g., participation scores or impact metrics) were collected, qualitative feedback was consistently positive. Educators indicated interest in piloting the game in classrooms, and several requested digital and printable versions for wider testing.

Additionally, surveys and pre-post assessments can be prepared for future gameplay sessions to measure:

- Knowledge retention (e.g., understanding of LCA and sustainability).
- Behavioural intent (e.g., decision-making and awareness of sustainable practices).
- Engagement and enjoyment as compared to traditional classroom methods.

Insights and Conclusions

● **Strengths:**

- Scientifically informed design based on LCA and sustainability models.
- Strong alignment with curriculum and BioBeo's educational goals.
- Modular gameplay that scaffolds learning across four progressive stages.

● **Areas for Improvement:**

- Enhancing **visual accessibility** of game materials (e.g., dashboards, tokens).
- Allowing **flexibility** in gameplay to support inclusive learning strategies (e.g., question trading, simplified cards for younger players).

Additional Notes

- A **presentation of the game was also showcased at ENVIRON 2025** with good participation from the audience.
- A detailed **manual and shorter classroom version** of the game has been developed.
- The game has also been submitted to the **2nd Geogames Symposium** for showcasing under "Geogames in Environmental Education."

4.9. Youth in Science and Business Foundation, Estonia (YSBF)

Piloting Phase & Objectives

YSBF's contributions to the BioBeo Project under Tasks 2.3 (Engagement of Youth in Policy Making) and 3.2 (Development of Digital Toolkit) were piloted to engage youth in bioeconomy education and policymaking. The piloting of Task 2.3 resources took place at several schools in Tallinn, Estonia, where educational materials were demonstrated to educators and students. The primary objective was to inspire young people to develop creative bioeconomy-based solutions for local challenges (e.g., school, neighborhood, or regional issues) and facilitate their interaction with policymakers. For Task 3.2, digital tools—including seven animated bioeconomy videos and the BioBeo App—were developed and rolled out to make bioeconomy concepts accessible and engaging, with usage tracked as of April 1, 2025. Both sets of resources aimed to foster understanding of sustainability and circularity, aligning with BioBeo's overarching educational goals.

Engagement with Students and Educators

Task 2.3: Engagement of Youth in Policy Making

The piloting of resources such as the *BioBeo Creativity Techniques* (available in long detailed, long, and short versions), *Experiments to Try* (featuring activities like making bioplastics and grass paper), *Guidelines for Ideas*, and a *Policy Pitch Video Example* was successful. Students actively participated, showing enthusiasm for tackling issues like climate change, waste, and pollution through creative thinking. Educators valued the flexibility of the materials, integrating them into lesson plans as needed, and found them effective for teaching bioeconomy concepts and policy engagement skills. Post-pilot, these resources will hopefully continue to be used, reflecting sustained engagement.

Task 3.2: Digital Toolkit

The seven animated bioeconomy videos, available on YouTube with subtitles in consortium partner languages, have garnered significant interest. As of April 1, 2025, the animations had up to 279 views per animation (most popular: *Sing along with Beo and Friends*). These videos, covering topics like waste circularity, ocean conservation, and forest sustainability, effectively engage students through storytelling.

The BioBeo App, has recorded over 1500 visitors by April 1, 2025, offering interactive trails and quizzes across 10 countries (e.g., Austria, Estonia, Ireland). Accompanying BioBeo Dashboard has been used to create 28 routes with 147 points of interest (POIs) and 418 questions, enhancing localized bioeconomy learning.

Feedback & Suggestions for Improvement

Task 2.3: Feedback from the Tallinn pilot was positive. Some amendments were made at initial stage, based on feedback from educators. Generally feedback and piloting experiences suggest that resources are well-suited to their purpose.

Task 3.2: No specific piloting feedback was detailed for the animations or app, but their usage metrics suggest strong initial uptake. Suggestions for improvement could include increasing app interactivity (e.g., gamified elements beyond quizzes) or expanding video content to cover additional bioeconomy themes.

The dashboard could benefit from user-friendly tutorials to maximize educator adoption.

Data and Metrics Collected

Task 2.3: During the piloting phase, a total of 218 ideas were collected. No formal quantitative data (e.g., participation rates or impact scores) were recorded, though informal positive feedback highlights the resources' appeal.

Task 3.2: The animated videos achieved notable viewership by April 1, 2025: *Bioeconomy in the Wild Outdoors* (206 views), *Valorisation of Organic Residue* (98 views), *Circular Fish Production* (85 views), *Importance of Clean Oceans* (86 views), *Bioeconomy in Forest* (101 views), *Sing along with Beo and Friends* (279 views), and *Answering the Curlew's Call* (193 views). The BioBeo App had over 1500 visitors.

Insights and Conclusions

Task 2.3: Practical resources and flexible formats empowered students and educators to explore bioeconomy creatively and engage with policy, fostering real-world application.

Task 3.2: Digital tools like animations and the app offered accessible, engaging learning experiences, with usage data reflecting broad reach.

Alignment with BioBeo goals: Both tasks effectively promoted sustainability and circularity, aligning with the project's mission and the Sustainable Development Goals (SDGs).

4.10. An Taisce, Ireland (AnT)

An Taisce co created the BioBeo Newsletter with MU and UCD, first titled BioBeo Buzz in March 2024 and has led in the monthly creation and publication of the newsletter.

The aim is to inform and engage students, teachers and all members of the community from primary to third level on all things related to the Bioeconomy. The newsletter encourages curiosity about new concepts and research in the bioeconomy and connects to our past and present with nature based activities and eco friendly solutions.

Piloting Phase

The initial piloting phase of the newsletter took place from March to June 2024. During this time the newsletter was released monthly. The focus of the newsletter content was news and updates from the BioBeo project, interactive nature based activities for students to participate in, engaging material including jokes and riddles and links to further reading and activities including podcasts and comics.

Feedback and Improvements

During July and August, while schools and universities were closed, we engaged with feedback from stakeholders and made some adjustments to the newsletter. Feedback was very positive on the newsletter thus far but recommendations included:

- Incorporating the voices of young people and other members of the community to allow for a variety of perspective and more inclusive content.
- Adding a new focus on careers in the bioeconomy that showed clear paths for young people and a variety of opportunities in the bioeconomy.

Additional content was sought from students and young people. From September, 2024 articles were included each month that had been written by students in Universities and at Primary level and from researchers, members of the community and business owners. These articles ranged from articles on bioeconomy based research and innovative bioeconomy businesses to ideas for sustainable action and activities.

Students contributed nature based photography, poetry and other inspirational material designed to engage and enthuse readers.

We also began to include monthly career profiles from a range of professionals working in the bioeconomy, at a range of stages of their careers. This demonstrated the variety of career opportunities, education and skills needed and the different paths to these positions.

Statistics and Conclusions

The newsletter has continued to be published monthly. It has steadily grown in the number of subscribers to 400 and has become a valuable tool to promote the outcomes and achievements of the BioBeo project as well as giving a voice to all of those working, studying and engaging in the bioeconomy. In March 2025, the title of the newsletter was changed to BioBuzz to facilitate the continuation of the newsletter after the conclusion of the BioBeo project, in particular to support the new BEST network and to continue to engage with the community of all those in the world of the Bioeconomy.

5. Conclusion

Table 5.1 Key Highlights from the BioBeo Education Programme Impact

Category	Metric
Global Reach	Presence in 15+countries (e.g.,Ireland,Belgium,Germany,Netherlands,Greece, Colombia,South Korea)
Total Participants (Cumulative)	75,000+ learners, educators, policymakers and community members
BioBeo Song+An Talamh Bhláfar	790 views
Animated Video Series	1,014 views
Comic Series Downloads	1,984 total downloads
Workshop (Feb20,2025)	85 attendees (50 online + 35 in person)
Science Blast 2025	12,775 pupils from 277 schools engaged
Science Blast-Judges	263 judges

Table 5.2 Key Highlights from the BioBeo Engagement Activities and Impact.

Engagement Title	BioBeo Engagement Description	Date of Engagement	Number of participants
BioBuzz	Monthly newsletter & dissemination pathway for BEST network (Bioeconomy Education&Sustainability Teachers).	Mar-2024 (11 publications to date)	Over400subscribers&members of BEST network.
Back to the Future with Beo and Raja:A Tale of the Early Bioeconomy	Back to the Future with Beo and Raja: A Tale from the Early Bioeconomy Comic exploring the bioeconomy by linking communities to sustainable practices from early medieval Ireland.	Published Mar-2024	English version:966 downloads Irish version:59downloads
BioBeo: Answering the Curlew's Call	Comic endorsed by Curlew Action and internationally renowned singer David Gray raises awareness for Ireland's endangered curlew.	Published Feb-2025	English Version: Views-307 Downloads-211 Irish Version: Views 260 Downloads- 38
BioBeo Song	Song using music and animation to promote bioeconomy.	Live Version	Views:404
An Talamh Bhláfar	Song blending tradition, culture and sustainability to help communities understand bioeconomy research.	Published Dec-2024	Views:339
Organic Magic: Bioeconomy Explorers	Video showing how organisms transform waste into resources, promoting bioeconomy.	Published Jun-2024	Views:99
ChocoChase	Board game that teaches circular bioeconomy through chocolate-making, promoting systems thinking and sustainability.	Showcased Feb-2025	Played by 150+community members.
Sustainable Fish in a Bioeconomy	Video focusing on sustainable fish production within urban areas, using innovative systems like aquaponics.	Published Jun-2024	Views:87
Bioeconomy in Fabulous Forests	Video where communities learn about the sustainability of wood-based products and the importance of preserving forest ecosystems.	Published Aug-2024	Views:102

Sparkling Seas: A Bioeconomy Adventure	Video emphasising the role of the bioeconomy in ocean preservation.	Published Aug-2024	Views:88
Beo's Bioeconomy Sing-Along	Musical animation exploring bioeconomy concepts.	Published Aug-2024	Views:282
BioBeo: Answering the Curlew's Call Video	Video supported by David Gray highlights the fight to save Ireland's endangered curlew.	Published Mar-2025	Video Views:93 (in 2 weeks)
BioBeo Blended Intensive Programme (BIP)	WEBSITE PDF The 5 credit BioBeo BIP united educators, students and policymakers to co-create circular bioeconomy content through hands-on, cross-sector collaboration.	Ireland: Mar-2024 Rotterdam: Mar-2025	100+participants
BioBeo Festival	Festival engaged youth, educators and policy makers in cross-cultural bioeconomy learning through workshops, music and a bioeconomy comedy show.	15.3.2024	Event count:5382
BioBeo & BiOrbic Education Workshop	Hybrid workshop united educators,policymakers and researchers with EU keynote Dr John Bell, featuring youth panels and bilingual, inclusive bioeconomy learning.	20.2.2025	80
Teachers in Residence Bioeconomy Workshop	Online sessions introducing teachers to bioeconomy research.	Dec-2023, Dec-2024	30 educators
ESB Science Blast	ESB Science Blast is a leading STEM programme, inspiring primary children through class-led investigations and interactive showcase events.	Mar-2025	13,000+
Bioeconomy Puppet Show	A first-of-its-kind BioBeo bioeconomy puppet show, created by UCD and MU students using biobased materials, brings Answering the Curlew's Call to life through performance and sustainability. Published on 8 April 2025, the	April 2025	300,000 children engaged with BioBeo bioeconomy puppet show.

	show is supported by teacher guidance notes for classroom use worldwide.		
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The BioBeo Education Programme stands as a beacon of innovation, creativity, and collaboration in the global movement towards sustainability and bioeconomy literacy. From classrooms to communities, across cultures and continents, BioBeo has inspired a new generation of learners and leaders through a dynamic blend of science, storytelling, and song. With over 75,000 individuals reached globally - across 15 countries, through comics, videos, music, games, workshops, and high-impact public events - BioBeo has transformed bioeconomy education into an inclusive, accessible, and deeply engaging experience.

The programme’s creative outputs have captured hearts and minds. Educational comics such as Back to the Future with Beo and Raja and Answering the Curlew’s Call achieved nearly 2,000 downloads and engaged audiences through bilingual storytelling. Music and animation, including The BioBeo Song and An Talamh Bhláfar, have garnered 790 views, while the BioBeo Animated Video Series reached over 1,000 viewers, blending culture, science, and sustainability into memorable learning moments. The ChocoChase board game has sparked hands-on learning for more than 150 community members, and the BioBuzz newsletter now connects a growing network of 400+ educators and stakeholders across Europe.

Flagship events like the BioBeo Festival, with 5,382 attendees, and the Blended Intensive Programme, uniting 100+ participants from Ireland to the Netherlands, have fostered deep, cross-sector collaboration. The programme’s presence at major forums -from ESB Science Blast (reaching 12,775 pupils) to BioEconomy Week Ireland, the CBE JU Stakeholder Forum, and international conferences - has amplified its impact on policymaking and public awareness. The inclusion of Irish language initiatives, DEIS (Delivering Equality of Opportunity in Schools) schools, and special education classrooms further highlights BioBeo’s commitment to equity and access.

The BioBeo Puppet Show is a world-first, groundbreaking educational initiative, developed as part of the BioBeo 2.5 credit Elevate module at MU in collaboration with UCD. Inspired by the comic Answering the Curlew’s Call, students designed and performed the entire production - constructing the puppets, crafting the stage frame, and acting out the story using sustainable, biobased, and biodegradable materials. Launched in April 2025, this unique puppet show has already engaged over 300,000 children across schools, festivals, and digital platforms, bringing bioeconomy and biodiversity education to life in a creative, accessible format. The show highlights the urgent need to protect Ireland’s endangered curlew, using the arts to foster empathy and awareness. To support its continued impact, detailed teacher guidance notes have been created, enabling schools around the world to recreate the experience in their own classrooms. As the first initiative of its kind globally, the BioBeo Puppet Show stands as a powerful testament to youth-led innovation, hands-on learning, and the transformative potential of education for sustainability.

Beyond numbers, BioBeo has sparked a movement. Through partnerships with organisations like Curlew Action UK, and with endorsements from cultural figures such as David Gray, the programme has united voices across science, education, and the arts in defence of our shared planet. As Mary Colwell of Curlew Action

powerfully stated, “It takes everyone, everywhere, to understand and care”—a belief that lies at the heart of BioBeo’s mission.

Crucially, BioBeo’s legacy is secured through the establishment of the BEST (Bioeconomy Education and Sustainability Teachers) Network - a vibrant, transnational community of educators committed to advancing bioeconomy education long after the programme’s formal end. With its steering committee, annual gatherings, and a permanent home in the BioBuzz newsletter, the BEST Network ensures that the momentum of BioBeo continues to grow.

As we look to the future, the BioBeo Programme leaves behind more than outcomes -it leaves a movement. A movement built on the conviction that education is the catalyst for a just, bio-based transition, and that by empowering individuals with knowledge, creativity, and community, we can nurture a generation ready to lead in the face of environmental challenges. BioBeo has not only answered the call—it has set a standard, inspired action, and sown the seeds for a more sustainable tomorrow.