

AllThings.Bio PRO

Teachers Handbook Mission BioHero

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AllThings.bioPRO - Game changer for the bio-based economy
H2020-BBI-JTI-2019



This project has received funding from the Bio-based Industries Joint Undertaking (JU) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 887070. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio-based Industries Consortium.

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1. Introduction

This handbook aims to help teachers use the freely available serious game “Mission BioHero” to teach children from ages 9 to 16 years old about sustainability topics surrounding the bioeconomy. The game was developed under the EU Horizon 2020 project ‘AllThingsBio.Pro’ and aims to educate non experts on the bioeconomy.

The game is structured in such a way that the level of difficulty increases as the game progresses with the topics to be dealt with. The game is divided into three phases with the following number of campaigns 1-5-2. In order to reach the next level of difficulty, the previous campaigns must be successfully completed. **For use in schools and vocational centres**, however, this can be circumvented with the help of a **cheat code**, so that you can choose freely from the eight campaigns. To do this, you must first create an account and register. Once you have gone through the introduction of the game, you can unlock all the campaigns by tapping more than 20 time on the ‘Happy Points’ at the top left of the screen. You can then select any campaign at the bottom right of the screen!

The handbook contains four scenarios written by four teachers from around Europe: Portugal, Turkey, Finland, and Greece as part of the Scientix team. These scenarios can be freely used directly as-is or used as inspiration or in combination with other sources under the Attribution ShareAlike CC BY-SA license.

The four scenarios are structured as followed:

- Author
- Summary
- Keywords
- Overview
- Aim of the lesson
- Trends
- 21st Century skills
- STEM Strategy criteria
- Lesson plan
- Assessment
- Student feedback
- Teacher’s remarks

	Scenario	Topic(s)	Age group	Preparation time	Teaching time
1	Be a BioHero and help to save our planet.	- Bioeconomy - Sustainability	14 – 16	1 h	10 h
2	Energy Conservation	- Environmental problems - Global warming - Energy transformation	15 – 16	3-4 h	4 h
3	How do we keep the right balance of Greenhouse gases in our atmosphere?	- Greenhouse effect - Greenhouse gas emissions - Carbon footprint - Sustainability	11 – 14	20 m	90 min
4	Let's destroy the planet!	- Climate change - Adopting everyday life habits	9 – 11	Not tested	7 periods

The Mission BioHero game consists of eight campaigns. The player first needs to finish the first campaign that includes an introduction to sustainability and the bioeconomy. Once the first campaign is completed, five other campaigns are unlocked, focusing on packaging, kids and school, fashion, jobs and career, and labels and certifications. Completing these campaigns unlocks the final two campaigns on end-of-life and greenwashing. Each campaign includes a mix of quizzes, tasks, and city-builder minigames. For more information see *chapter 7: Overview: Game structure*.

We hope that this handbook will inspire and inform teachers and students alike to shape a sustainable future:

“Many students continued the exploration of the app “Mission BioHero” at home. They were so engaged during the exploration of the game as “city builders”, that most of them continued to use the app after the lesson.”

-- Maria Henriques

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2. Scenario 1: Be a BioHero and help to save our planet.

Author

Maria Henriques

Summary

This learning scenario promotes environmental awareness and encourages students to think about their impact on the planet. The students will incorporate scientific concepts related to environmental issues, such as climate change, pollution, CO₂ emissions and bioeconomy.

The use of the MISSION BIOHERO app will engage students in solving environmental problems and recognize the importance of bioeconomy to reduce pollution and CO₂ emissions.

Throughout the process, students would apply scientific and interdisciplinary skills, as well as develop important skills such as critical thinking, communication, and teamwork.

Keywords

Bioeconomy, sustainability, climate change, recycling, CO₂ emissions.

Overview

Subject(s)	<i>Science, Biology, Geography, Economy, Environment, Social sciences</i>
Topic(s)	<i>Bioeconomy and sustainability</i>
Age of students	<i>14 – 16 years old</i>
Preparation time	<i>1 hour</i>
Teaching time	<i>10 hours</i>
Online teaching material	<i>Padlet, Kahoot, Jamboard, Google Classroom, Socrative, Canva, Mission BioHero game</i>
Offline teaching material	<i>Laboratory material, microscope, potatoes, corn starch, pan, stove, alimentary colors, spoons, drying net.</i>
Resources used	YouTube videos: - Let's Take Bold Steps Forward to Protect Our Planet National Geographic: https://www.youtube.com/watch?v=Er8YXskwIFE - Climate Change: It's Real. It's Serious. And it's up to us to Solve it. National Geographic: https://www.youtube.com/watch?v=Ok8rMT2KCyQ - Bioeconomy - What is that?: https://www.youtube.com/watch?v=DukP2Rbw46Q - A Sustainable Bioeconomy for Europe: https://www.youtube.com/watch?v=jjFv_OITW-c - Why we need sustainable bioeconomy: https://www.youtube.com/watch?v=QgtOaJw8qR0

- **Food Packing:** <http://www.allthings.bio/video/new-bio-packaging-food/>
- **Tutorial how to produce a bioplastic:** <https://www.youtube.com/watch?v=qnDnjBNC8cc&t=3s>
- **Virtual Tour of DTE Wind and Solar Parks:** <https://www.youtube.com/watch?v=CKZaBq1xkxs>

Links apps/sites

- **Mission BioHero game:** <https://play.google.com/store/apps/details?id=com.nurogames.MissionBioHero>
- **Carbon footprint calculator:** <https://footprint.wwf.org.uk/#/questionnaire>

Articles

- <https://www.allthings.bio/the-power-of-youth-educating-young-people-in-the-move-to-a-sustainable-future/>

Aim of the lesson

Students will understand how their daily activity translates into pollution and high emissions of CO₂ related with climate change. By learning about bioeconomy students can help to shape a more sustainable world.

Trends

- **Flipped Classroom:** students master basic concepts of topic at home. Time spent in the classroom is used to reflect, discuss, and develop topics.
- **Project-Based Learning:** students face problems to solve.
- **Collaborative Learning:** a strong focus on group work.
- **Outdoor Education:** learning outside of the school building in the “real” environment.
- **Active Learning:** students are actively engaged with the lessons through discussions, problem solving, experiments and other methods.
- **Game Based Learning & Gamification:** learning is mixed with games or with game mechanisms.

21st century skills

This lesson plan will enhance among the students the following skills, defined as 21st century skills:

- **Learning skills:** students will need **critical thinking** to know how we pollute the environment with their daily activity and how important is bioeconomy and circular economy. They will use **creativity** to design posters about how we can reduce CO₂ emissions. Throughout this process, they will **collaborate** with their colleagues and work together to achieve the best possible results, so communication is essential to learn to convey different ideas.
- **Literacy skills:** students will work with **information** about our topic and will know how to search on official or governmental websites and media (information and **media literacy**). In

addition, they must use new technologies, digital devices, and online applications to carry out the proposed activities.

- **Life skills:** students will have **flexibility** with their ideas, being capable of recognizing mistakes and learning from them. They will need **leadership** and **initiative** to change the things that they do not like in their activities.
- **Social skills:** students will make **connections** with people and talk to them about the importance of recycling, bioeconomy, and circular economy.

STEM Strategy Criteria

The learning scenario “Be a BioHero” develops STEM literacy and STEM capability by promoting STEM learning by teaching different curricular disciplines such as Biology, Geology, Geography, Arts and Physics in an interdisciplinary proposal.

The STEM concepts as bioeconomy, climate change, and emissions of CO₂ will relate to real-life examples which facilitate pupils' understanding and knowledge acquisition.

Learning is supported and enhanced with authentic, relevant use of technology in researching the emissions of CO₂ in our daily life, using the app “Mission BioHero”, and the students select the tools to create posters using their creativity and innovation.

The exhibition of the posters at school or in the community (public place) strengthen connections with parents and local institutions, includes knowledge acquisition, enhanced group collaboration and communication.

A school visit to a solar power station and recycling facility, either physically or virtually, provides opportunities for applied learning in professional STEM/STEAM workplaces and connecting with different professionals.

Learning activities are made available that are meaningful and relevant for the students. From the first day, they can select the theme of their interest and share their achievements with the other students. The students can try as many times they want the activities in the app “Mission BioHero”, learn on their own and take the time they need to achieve the best results.

Continuous assessment is the form proposed to evaluate student's progress throughout the learning scenario.

Flexible school leadership, high level of cooperation among staff, inclusive culture and school-supporting is essential to support teachers and students needs to pursue and complete STEM projects as “Be a BioHero”.

Elements and criteria	How is this criterion addressed in the learning scenario
Instruction	
Personalization of learning	This lesson is intended to address the different learning needs and interests of students. From the first day, they can select the theme of their interest. The students can try as many times they want the activities in the app “Mission

	BioHero”, learn on their own and take the time they need to achieve the best results.
Problem and project-based learning (PBL)	Students work on an open-ended question with no solution provided by the teacher.
Inquiry-Based Science Education (IBSE)	Problems and scenarios are presented to the students to solve them.
Curriculum implementation	
Emphasis on STEM topics and competencies	The lesson scenario curriculum emphasizes STEM key competences and STEM subjects.
Interdisciplinary instruction	We examine and implement a variety of activities in a broad spectrum of subjects, ranging from Biology (STEM subject) to Geography and Arts (non-STEM subjects).
Contextualization of STEM teaching	Lessons are connected to real world experiences by using the app <i>Mission BioHero</i> , during the outdoor activity and in every lesson, there are moments to reflect about the topic in the local
Assessment	
Continuous assessment	A formative evaluation is carried out, allowing a continuous improvement on the students’ progress.
Personalized assessment	The pace of learning and the instructional approach is optimized for the needs of each student.
Professionalization of staff	
Highly qualified professionals	Our teachers are specialized in STEM.
Existence of supporting (pedagogical) staff	Our support staff play an important role in ensuring students are learning in a safe and encouraging learning environment.
Professional development	Our school provides avenues for all staff’s professional development, specially, on teacher capacity building.

School leadership and culture	
School leadership	The school headmaster and her team encourage and support teachers and school staff to innovate and work together as a team.
High level of cooperation among staff	Staff is encouraged to support each other and work together.
Inclusive culture	We respect our colleagues' ideas; we share success and value each other's uniqueness.
Connections	
With industry	A visit to a facility will be scheduled, so that students can discuss directly with professionals about the importance to reduce CO ₂ emissions and bioeconomy.
With parents/guardians	The students are encouraged to share their knowledge with their family and calculate the carbon footprint with their parents.
With other schools and/or educational platforms	Project "Ciência Viva", collaboration with CCVnE "Despertar ConsCiências"
With universities and/or research centers	Connecting with specialists in the field of renewable energy and/or recycling in the visit scheduled, either physically or virtually, so students can directly discuss with professionals about the recent developments in the field.
With local communities	The exhibition of posters will encourage all the community to reflect on the importance of our daily actions in the environment.
School infrastructure	
Access to technology and equipment	The school is equipped with internet access, as well as computers and one projector per classroom. The students will use the computer, tablets, and their smartphones.
High quality instruction classroom materials	School provides high quality instruction materials, and the staff is encouraged to create personalized resources for

the students.

Lesson Plan

Students will become aware of the relations between bioeconomy, climate change, emissions of CO₂ and renewable energies and how to become more sustainable.

Lesson 1: Science/Biology Lesson (introductory lesson):

- Preparation at home: Watch select videos – 30 minutes.
- Students will discover what bioeconomy is, review concepts related to climate change and determine their carbon footprint – 50 minutes.

Lesson 2: Science/Biology Lesson

- Preparation at home: Download the app “Mission BioHero” – 5-10 minutes.
- Students will choose some daily products and investigate the emissions of CO₂ and consolidate their knowledge about climate change and the CO₂ emissions using the app “Mission BioHero” – 50 minutes.

Lesson 3: Arts (non-STEM)

Students will create posters to raise awareness about the emissions of CO₂ and Climate Change – 50 minutes.

Lesson 4: Science/Biology

- Preparation at home: Watch select videos – 10 minutes.
- Students will discover what bioeconomy is, review concepts related to climate change and determine their carbon footprint – 40 minutes.

Lesson 5: Science/Biology

- Preparation at home: Watch the video about packing and bioplastic – 10 minutes.
- Students in small groups produce their own bioplastic and share their activity with the other groups – 115 minutes.

Lesson 6: Geography (non-STEM)

- Students will use the app “Mission BioHero” as city builders – 60 minutes.

Lesson 7: Interdisciplinary activity

- Visit to a recycling facility and/or renewable energy station, physically or virtually – 110 to 250 minutes.

Name of activity	Procedure	Duration
Science/Biology Lesson (introductory lesson)		
Preparation of classroom	The students are encouraged to prepare the basic concepts that will be discussed in the classroom. Using the platform Padlet ,	

activity at home	Google Classroom or other collaborative work platform or app, the teacher will share the resources: - Climate Change: It's Real. It's Serious. And it's up to us to Solve it. National Geographic https://www.youtube.com/watch?v=Ok8rMT2KCy0 - Bioeconomy - What is that? https://www.youtube.com/watch?v=DukP2Rbw46Q - Why we need sustainable bioeconomy https://www.youtube.com/watch?v=QgtOaJw8qR0 https://www.allthings.bio/the-power-of-youth-educating-young-people-in-the-move-to-a-sustainable-future/	30 minutes
Brainstorming and discussion of basic concepts	Students present what they have learned and their ideas in pairs for 5 minutes- “Speed dating” and then discuss the main topics in large group. During the large group discussion, the students will summarize their ideas in a collaborative wall (for example Jamboard or Padlet) or in the classroom blackboard. The teacher will ask the questions: - What is the carbon footprint of our daily activities? - What can we do about it?	20 minutes
Investigation	The teacher explains that a carbon footprint is the amount of greenhouse gases (including carbon dioxide and methane) emission by one person if necessary and then propose to the students to calculate theirs with the WWF Footprint Calculator: https://footprint.wwf.org.uk/#/questionnaire. Each student can use a computer, a tablet or their smartphone to calculate it and takes a screenshot to share the results with their colleagues on a collaborative wall (for example Jamboard or Padlet) projected by the teacher. By analyzing the results of all the class, students discuss the different sections (home, food, stuff, and travel) of their footprint. The students may show this calculator to their families and go through the test with them to raise awareness at home.	30 minutes
Science/Biology Lesson		
Preparation of classroom activity at home	The students are encouraged to download to their phones the application “BioHero”. Using the platform Padlet, Google Classroom or other collaborative work platform or app, the teacher will share the link:	5 - 10 minutes

	For Android users: https://play.google.com/store/apps/details?id=com.nurogames.MissionBioHero For iPhone users: https://apps.apple.com/us/app/mission-biohero/id6443559708 Hint: When creating a user's account please restrain from using your real names. If you lose your password, you need to create a new account.	
Introduction	The teacher links to the discussion about the footprint and asks the students: What is the amount of CO₂ emissions produced directly or indirectly from our daily products? The students are oriented to know more about the amount of emissions of CO₂ directly or indirectly of some products we use in our daily life (for example: a cup of coffee, t-shirt, plastic bottle, travelling by car, etc). In small groups, the students choose some daily products and investigate the emissions using their computer, tablet or smartphone. They share their results in a collaborative tool (for example Jamboard or Padlet). If a Jamboard is used it can be created two columns for the products and the amounts of CO₂ emissions.	20 minutes
Gamification	Let's see if we can be a BioHero and help to save our planet! The students using the app "BioHero" will create their "avatar" and will be encouraged to go through the quizzes. This way they will be able to understand and consolidate their knowledge about climate change and CO₂ emissions.	30 minutes
Arts (non-STEAM)		
Introduction	The teacher shows the collaborative wall created during the previous lesson about CO₂ emissions directly or indirectly produce from our daily products and their main ideas about bioeconomy and climate change. This will be the starting point to create posters and organize an exhibition to raise awareness about these topics in the community. The exhibition can take place at the local library, local association, school's auditorium, hallway etc. Students will discuss about what information should be included in the posters (cause, consequence, QR code to more information, a short explanation, a <i>slogan</i> or phrase to reflect etc.) and it can attract the attention of the observers, a slogan that generates environmental awareness, different sizes	10 minutes

	and styles of letters as well as contrasting colors to highlight the information.	
Creative work	Each student creates a poster that collects the agreed information in Canva. The posters can be emailed to the teacher or uploaded in the online classroom. The students will evaluate their pairs posters using rubrics agreed between all students and the teacher.	40 minutes
Science/Biology lesson		
Preparation of classroom activity at home	The students are encouraged to prepare the basic concepts that will be discussed at classroom. Using the platform Padlet, Google Classroom or other collaborative work platform or app, the teacher will share the video about packing food and bioeconomy: http://www.allthings.bio/video/new-bio-packaging-food/	5 minutes
Introduction/ Brainstorming	The teacher starts by connecting with the video the students have watched at home and ask them: - How important is packing? Can we reduce the use of it? - How can investigation in new bioproducts help us? - Do you think we could produce bioplastics in the classroom? The teacher using the classroom video projector shows the tutorial about how to produce bioplastics: https://www.youtube.com/watch?v=qnDnjBNC8cc&t=3s	10 minutes
Hand on activity	After watching the tutorial, in small groups the students produce their own bioplastic, they can choose the color and the form of their final product.	90 minutes
Conclusion	The students present their results to the other groups and discuss how important is to reduce the use of plastic and find new ways to reduce our impact in the environment.	15 minutes
Geography (non-STEM)		
Introduction/ Brainstorming	To introduce the activity about city-builders with the app “Mission BioHero” the teacher shows a presentation with images of our city and explores with students the origin of the products used to build the different structures. Then ask the students: - If you could turn a city with a non-sustainable value chain into a clean and sustainable city, what should be done?	5 minutes
Gamification	To answer that question the students will use the app Mission BioHero as city builders.	

	The game allows us to think about themes that are part of our daily lives: food packaging, fashion & textiles, and jobs & careers. The game will engage students but can also be used as tools to aggregate their ideas related to bioeconomy and allow the young people to make a difference in the political agenda of the coming years. After the class the students can continue to play the game at home.	45 minutes
Conclusion	At the end of the class the teacher asks the students to share their difficulties in turning a city with a non-sustainable value chain into a clean and sustainable city. - How difficult was to control the pollution and the satisfaction of the community? The class will take note of the conclusions on a board (digital or the blackboard).	10 minutes
Interdisciplinary activity - Visit to a recycling facility and/or renewable energy station		
Preparation for the outdoor activity	The teacher will talk to the students about renewable energy stations and the importance of recycling. Discuss why it is important to move to low carbon greener sources of energy. The students will brainstorm questions about what they would like to learn during the visit.	20 minutes
Outdoor Activity	A school visit to a solar power station and recycling facility will be scheduled, either physically or virtually, so students can directly discuss with professionals about the recent developments in the field. During the visit the teacher encourages students to ask questions to the professionals and document their visit collecting data (photos, videos, interviews, etc.) <i>Note to the teacher:</i> If it is not possible to visit a power station/recycling facility in your area. Perhaps consider a virtual visit to a power station in a neighboring city or alternatively find relevant video, for example: https://www.youtube.com/watch?v=CKZaBg1xkxs	60 - 180 minutes
Conclusion and learning products	After the visit, the students will create a short film (3-5 minutes) reporting on the experience and the principal ideas. Their videos can be uploaded to the virtual classroom and later disseminated in the school and/or community.	30 minutes

Assessment

The assessment will be carried with the use of:

- Compilation of students' ideas shared in *Jamboard* and *Padlet* (or similar).
- Online research assignment about the carbon footprint of daily products.
- Creation of posters
- Oral presentation of the group work and results of the *Hands-On* activity "Bioplastics"
- Creation of videos of the visit
- The use of app Mission BioHero
- Online google form.

Initial Assessment: Before the learning scenario begins, the students will be asked to brainstorm the topic. The students will have an opportunity to share what they already know about the topic. During this time, the students will express their own ideas on the topic and areas that warrant further research.

Formative Assessment: The students will create learning products at each stage of the learning scenario. On reviewing the students' learning products, the teacher will be able to assess their level of engagement and understanding of the overall scenario.

The students will also be evaluated through the activities carried out during the different sessions:

- Participation in collaborative walls and discussions.
- Peer-reviewed posters and creativity to design them.
- Active participation in all the activities.
- Work in groups and in pairs.
- Involvement during the outdoor activity.

Final Assessment: During a final class discussion the students will reflect on the overall learning scenario they have conducted.

Student feedback

The students will add their opinion about the learning scenario on a *Padlet* (or a similar) in three columns. The three main questions (one on each column) they will answer:

1. *What aspect of the learning scenario you liked the most?*
2. *What should be changed?*
3. *List at least two new things you have learned from this learning scenario.*

The answers can be anonymous.

Teachers' remarks

The learning scenario went as expected, although some students required longer time to complete some tasks. Some activities can require more time, so may allow students to finish their work at home and bring them back to class. Many students continued the exploration of the app "Mission BioHero" at home. They were so engaged during the exploration of the game as "city builders", that most of them continued to use the app after the lesson.

The preparation time at home helps to engage the students in the topic of the next lesson. The resources used from the site of [Allthings.bioPRO](#) are presented in a friendly way and fully engaged the students.

During the implementation of the learning scenario the students' enthusiasm has increased as they were aware of the importance of what they were learning and understand the concept of bioeconomy. The practical activity to produce bioplastics were very important, the students didn't know that there were other ways to produce materials for packaging. It would be interesting to explore other materials and recipes to produce bioplastics, even with some local subproducts.

The students provided positive results for the lessons, especially the use of the game "Mission BioHero", enjoyed the different activities, learn about bioeconomy and the importance of being sustainable. A collaborative tool like [Padlet](#)* and [Mentimeter](#) was used to gather their opinions and the products created during the learning scenario.

I felt fulfilled as a teacher for being able to provide my students with enriching and meaningful experiences and apply gamification in class to learn important concepts.

3. Scenario 2: Energy Conservation

Author

Kamil Melih Akay

Summary

The purpose of this Learning Scenario is to make students aware of issues related to sustainable cities by carrying out an online research and using an application. Students are informed of key concepts on sustainability: they are guided to reflect on helping their environment to become greener and to make decisions on the way to turn cities more sustainable.

Keywords

Sustainability, carbon negative, problem solving, design and technology

Overview

Subject(s)	Ecology, citizenship, geography, English, engineering.
Topic(s)	Environmental Problems Global Warming Energy Transformation
Age of students	15-16
Preparation time	The implementation of this scenario requires teacher to spend 3-4 hours to make lessons available for the students
Teaching time	Three hours for classroom activities including online activities + one hour to create the final output
Online teaching material	www.skypeascientis.com Speak Out for Sustainability (https://www.pearson.com/english/about-us/pearson-and-bbc-studios-partnership.html) https://it.venngage.com/ for realizing the infographics
Offline teaching material	Materials: - paper cups - coloured ropes - wooden thin bars - cardboards in different colours - scissors - tape, glue - construction paper in different colours - coloured pencils and paints - ruler - motor - led-lamb - cords - tablets

Resources used

- Mission BioHero App:
Anroid:
<https://play.google.com/store/apps/details?id=com.nurogames.MissionBioHero>
iOS:
<https://apps.apple.com/us/app/mission-biohero/id6443559708>
- www.skypeascientis.com
- <https://www.pearson.com/english/about-us/pearson-and-bbc-studios-partnership.html>
- https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_en
- <https://footprint.wwf.org.uk/>
- [THE 17 GOALS | Sustainable Development \(un.org\)](https://www.un.org/sustainabledevelopment/)
- https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_en
- <https://www.pearson.com/english/events/webinars/2021/04/let-s-speak-out-about-sustainability-together.html>

Mobile Applications

Mission BioHero

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Aim of the lesson

The main aim of the current scenario was to provide a STEAM activity for the ninth-grade students and to determine its efficacy. The second aim of our study was to search and synthesize information by integrating previous knowledge to construct a creative design. Energy Conservation is a scenario that gives learners and teachers the opportunity to participate in a project designed to raise awareness and inspire interaction around key themes such as reducing our carbon footprint or avoiding water waste. With the environment being such a large focus of the UN’s Sustainability

Development Goals, the Energy Conservation scenario aims to provide an engaging learning experience through Mission BioHero. The purpose is to have students with a greener focus, help students become more aware of sustainability. Students conduct studies on energy transformation.

Science:

- Students explain the conservation of energy and deduce the fact that energy forms can transform from one type to another.
- Students explain the types of wind energy.
- Students conduct studies on energy transformation.

Mathematics:

- Students think in three dimensions.
- Students create propeller blades evenly by making calculations.

Technology:

- Students do research by utilizing technology.

Art:

- Students present an original product.
- Students ensure that the design looks aesthetic.
- Students add aesthetic details to the design.

Engineering:

- Students establish reason and result relationship while creating their products.
- Students come up with a design.
- Students analyses a system or a process for determining needs.
- Students present solution methods and choose the optimum solution.

Trends

Inquiry-based Learning, Project-based learning, Students-cantered approach

21st century skills

- Critical thinking – thinking of how to design a wind turbine in everyday life
- Problem solving – making experiments on physical properties of wind turbine
- Creativity – producing a creative product
- Initiative – making their own presentation about their product
- Innovation – thinking on how to design
- Productivity – making the model of wind turbine
- Communication and collaboration – the final group discussion

STEM Strategy Criteria

Elements and criteria	How is this criterion addressed in the learning scenario
Instruction	
Personalization of learning	In this learning scenario (LS), “student choice” will be used as a tool to differentiate learning.
Problem and project-based learning (PBL)	The LS incorporates a real world, authentic challenge: students will work in groups and utilize multiple sources of information in order to design the project’s outputs
Inquiry-Based Science Education (IBSE)	In the context of this LS, students will investigate facts about environment
Curriculum implementation	

Emphasis on STEM topics and competencies		Students' knowledge on math and physics will help them to generate creative designs.
Interdisciplinary instruction		The issue is not only social but also requires scientific knowledge to deal.
Contextualization of STEM teaching		The planned activities are connected to real world experiences.
Assessment		
Continuous assessment		At this step, students were expected to evaluate the products of all the other groups. Each group displayed their products and it was ensured for groups to be able to see the products of one another. Groups prepared presentation about their designs and explained why they chose to make such design. Some little notes were taken for each group about their designs on the board. The reasons why some groups did not achieve to get the expected results and why they came up with this failure were discussed.
Personalized assessment		Students can re-think about their choices.
Professionalization of staff		
Highly qualified professionals		Scientists from university can be help to engage high school students to the topic.
Professional development		Teachers can also develop themselves through the flow of the activities.
School leadership and culture		
School leadership		School administrators can use these topics to develop new projects
High level of cooperation among staff		Teachers should communicate to increase the success of the implementation
Connections		
With industry		LS provides students who have an interest in a particular industry area to develop and apply their skills, knowledge and understandings about how to create wind turbines,
With parents/guardians		An active participation of parents is possible through their involvement in the carbon footprint survey.
With other schools and/or educational platforms		Skype a scientist is a very user-friendly tool that can be used by other schools
With universities and/or research centers		Students will have chances to discuss sustainability goals with lecturers from universities by using skype a scientist.
With local communities		Within this LS, scientific knowledge is used to solve problems and inform personal and community decisions to create a sustainable life.
School infrastructure		

Access to technology and equipment	The research tasks will need the use of computers with internet access, tablets. In the distance learning approach students use their own devices.
High quality instruction classroom materials	Intellectual resources on the theme sourced from United Nations THE 17 GOALS Sustainable Development (un.org) website.

Lesson Plan

Name of activity	Procedure	Duration
Preparation	1. A webinar will be conducted on the topic by using Skype a Scientist about sustainable cities and sustainable lifestyles. Students will prepare a set of questions and use them during the online meeting. As an alternative you can watch Speak out for sustainability webinar (https://www.pearson.com/english/events/webinars/2021/04/let-s-speak-out-about-sustainability--together.html) with your students. 2. What is carbon footprint? Students are asked to define the meaning of carbon footprint and prepare mind map regarding the activities which make our carbon footprint larger. 3. By using the calculator from www.wwf.org web page, the carbon footprint of the class is calculated. 4. After collecting and evaluating data, a factsheet is prepared showing the carbon foot print results of the class.	30 minutes
Ranking Task	To be able to introduce the basic concepts and understandings, teacher asks students to download the application Mission BioHero and do the first quiz.	20 minutes
Web Investigation	The students will be asked to search for the meaning of carbon negative concept. Students will try to find the answers of the following questions: • What Does Carbon Negative Mean? • How Is Carbon Negative Different Than Achieving Net-Zero Emissions? • Is It Possible to Reach Carbon Negativity? • How Can Individuals Reach Carbon Negative Goals?	30 minutes
Reading Comprehension activity	https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_en The link stated above is given to the students on the long-term strategies and targets of EU about greenhouse gas emission reductions. The teacher asks students to analyze four factsheets and try to answer the questions: • What do these statistics refer to?	40 minutes

	• Which countries are among the 80%? • What ways to take actions against cruelty makeup are described in the infographic? • What surprised you about the information in the infographic? • Is there any information in the graphic, which you think may be incorrect or missing? • Who would you like to share the information in the infographic with? Why? How could you use what you learned from this infographic?	
Homework Assignment	Conduct an online research and try to find out materials, which are carbon negative and make a list of everyday products that can be produced by using carbon negative materials. For example, a dress which is tailored by using hemp yarn. Questions to answer: What are the effectiveness of these materials to reduce the amount of carbon emission? https://www.iea.org/reports/material-efficiency-in-clean-energy-transitions https://youth.europa.eu/get-involved/sustainable-development/how-reduce-my-carbon-footprint_en	40 minutes
Design Task	Now it is time to open application Mission BioHero and help the city of Amsterdam become greener. The focus point is to make a city more sustainable and greener. The students will be divided into groups and each group will try to turn Amsterdam into a green and sustainable city. There are 3 parameters and for each parameter the groups will try reach the desired goals. Groups will be given 15 minutes to understand the application and read the Tutorial. Groups will have 25 minutes to play the game online and get their results. The students need to make proper decisions to help their cities. Groups will prepare a report about their results that help cities to become greener and present it to the other students.	40 minutes
Design	The fact that hydroelectric power plants contaminate water resources and the risks of thermal and nuclear power plants to environment are getting increased have caused many reactions in your city. From now on, discussions have started on the necessity to use wind energy as an alternative. It was concluded that the conditions of our city were suitable to produce wind energy. You joined the project team who will construct wind turbine to use wind energy within the scope of sustainability project in your city.	

Things to consider in your design:

The design should be completed in the given time.

The cost of the design should be low.

Your design should be different and outstanding.

- What kind of information do you need to solve the give problem situation?
- It is necessary for you to be able to explain the following situations to design your wind turbine properly.
- What kind of design are you expected to do?
- What do you need to do before setting up the wind energy?
- Does energy transformation occur in wind turbines? Please explain.
- In your opinion, what are the parts of wind turbines? and how are their working principles?

You can do research by using internet via tablets for the information you need also by using the answers of the above questions. Please list of the ideas stated in your group about the assigned task.

Please, describe the best plan for your wind turbine.

Please, draw the shape of the wind turbine you are planning to do.

Now, Let's present our designs one by one and explain how we develop a solution strategy to our task.

LET'S ANSWER

1. What are the parts of your wind turbine?
2. Which wind turbine worked better? Why?
3. What are the factors that affect your wind turbine while working?
4. By thinking the designs made here, what should people consider while constructing a wind turbine to your city?
5. What would happen if energy could not be transformed from one type to another?
6. In which parts of your everyday life other than stated here does energy transformation take place? Please give examples.

Assessment

When implementing the activity, active participation of the students is ensured by engaging all of them into class discussions. The teacher is in the position of guiding and do not attend the process

as possible. Students are encouraged to think freely. They are allowed to use the any design they want.

Student feedback

Students who will make the designs. They will talk about their designs and choices.

'While developing activities to be used in the classroom, our teachers should create everyday life scenarios which make us feel like a mathematician, scientist, technology expert, engineer or an artist'

First of all, we should check whether the place where we are going to set up the wind turbine receives enough wind or not. After that, we should determine the size of propeller that will be constructed by making necessary calculations"

"We are going to construct the propeller. Let's do it from carton. This propeller should not be too big. We need to think about both the cost and the tower because it cannot carry it. We have to connect the motor to the propeller. We are going to build the tower from thin wooden bars."

"In order to prevent the turbine from flying due to the wind, the heaviest part must be the tower part. If we make a colourful turbine, we can draw the attention of other people, so that we can draw attention to the environmental problems."

4. Scenario 3: How do we keep the right balance of Greenhouse gases in our atmosphere?

Author

Tiina Kähärä

Summary

This learning scenario guides pupils to act in a sustainable way and to build a knowledge base for a sustainable way of thinking and acting. It will give the basic idea of what greenhouse gases are and how we can reduce their amount in the atmosphere.

Keywords

Greenhouse effect, carbon dioxide, carbon footprint.

Overview

Subject(s)	Environmental studies, science, chemistry.
Topic(s)	Greenhouse effect, greenhouse gas emissions, carbon footprint, sustainability.
Age of students	11-14
Preparation time	20 minutes • Check video and other links. • Upload the Mission BioHero app and get familiar to it so you can help the students in the beginning. • Make any other changes according to your students. • Think the homework and further tasks. • Have the timeline and tasks of the lesson on board/Classroom visible for students. That makes the lesson clearer for the students with special needs and students that are not native speakers.
Teaching time	Two lessons (90 minutes)
Online teaching material	Download the application Mission BioHero by Nurogames. You can download the game on your mobile phone. Android: https://play.google.com/store/apps/details?id=com.nurogames.MissionBioHero iOS: https://apps.apple.com/us/app/mission-biohero/id6443559708 Google Classroom

	Kahoot! Blooket Mentimeter
Offline teaching material	Paper (Science notebooks, if in use) and pencil for notes. In Finland pupils can have science book Pisara 6 chapter 31.
Resources used	- Information about greenhouse gases and how to keep a right balance of greenhouse gases in our atmosphere. You can also find extra activities here: https://climatekids.nasa.gov/greenhouse-effect-and-carbon-cycle/ - Examples of bioeconomy innovations for further research: https://www.biotalous.fi/ - Climate and nature solutions for further research: https://www.sitra.fi/en/topics/climate-and-nature-solutions/ - I compared these two Curriculums (<i>Finnish National Curriculum 2014, science grades 3-6 pages 239-245</i> and <i>National Curriculum in England KS1, 2 and 3, science programmes of study</i>) for designing this learning scenario: https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts Climate change impacts (to be discussed in the classroom for example) - f.a.q. for the warm-up of the lesson: https://archive.epa.gov/climatechange/kids/faq.html - Pisara 6, chapter 31: climate is changing, science book for primary school, Sanomapro - How to lower your carbon footprint animation video (1.26min) to be showed to the pupils: https://youtu.be/rByHiqc0K9k - Free carbon footprint calculator for challenging parents to calculate their carbon footprint and how to reduce it: https://www.carbonfootprint.com/calculator.aspx

Aim of the lesson

Helps the student to understand what the greenhouse gases are and how we can reduce them by our own behavior.

Trends

- **Project-Based Learning:** students get fact-based tasks, problems to solve and they work in groups. This kind of learning usually transcends traditional subjects.

- **Lifelong Learning:** learning does not stop when leaving school.
- **Game Based Learning & Gamification:** learning is mixed with games or with game mechanisms.
- **STEM Learning:** Increased focus on Science, Technology, Engineering, Mathematics subjects in the curriculum.
- **Edutainment:** playful learning. Learning while having fun.
- **Mobile Learning:** we get access to knowledge through smartphones and tablets. It is learning anytime, anywhere.
- **BYOD:** Students bring their own mobile devices to the classroom.

21st century skills

Life and career skills; learning and innovation skills; information, media and technology skills.

STEM Strategy Criteria

Elements and criteria	How is this criterion addressed in the learning scenario
Instruction	
Personalization of learning	Pace of learning can be optimized for each learner. Teachers can differentiate the material suitable for the group of learners.
Problem and project-based learning (PBL)	The pupils learn the subject through the experience of solving an open-ended problem found in trigger material. It allows for the development of other desirable skills, such as group collaboration and communication.
Inquiry-Based Science Education (IBSE)	Questions, problems and scenarios are presented to pupils in a form of a game including case studies and investigations.
Curriculum implementation	
Emphasis on STEM topics and competencies	Topics are aligned with both Finnish and English Curricula of science programmes. Sustainability and greenhouse effect is included in primary school grade 6 Curricula in Finland and Earth and Atmosphere, carbon cycle and effects on climate is included KS3 in UK Curricula. The National Curricula of Finland also requires a multidisciplinary inclusive project on science studies at the grade 6, which this LS would fulfill well.
Interdisciplinary instruction	Pupils will implement a variety of subjects and skills, such as sciences (STEM), Ethics, Social studies (non-STEM).

Contextualization of STEM teaching	This topic is very important in our societies and everyone must take responsibility for reducing their carbon footprint.
Assessment	
Continuous assessment	To get the information of students level of understanding, the teacher can ask herself/himself how the students can answer the following questions: How does the student understand the principles of sustainable development? Can the student describe by examples the threats of the future and how these threats could be avoided? Can the student form questions related to the topic? Can the student identify simple cause-and effect relationships and create a simple conclusion from the result?
Personalized assessment	Above mentioned questions can be examined by tests, artwork, questionnaires, group work or by simply asking the students individually.
Professionalization of staff	
Highly qualified professionals	Teachers should keep up their knowledge of what is happening in the World and how the World is changing. To be aware of job and career opportunities of the future to guide their pupils towards right decisions. Lifelong learning and continuing education increase wellbeing and help to cope with and enjoy the work.
Existence of supporting (pedagogical) staff	All supportive pedagogical staff should take part in this learning scenario by encouraging the pupils and sharing the same values with school culture.
Professional development	Lifelong learning increases motivation.
School leadership and culture	
School leadership	Shared leadership is 21 century leadership. This learning scenario is part of many countries' and schools' strategies.

High level of cooperation among staff	This learning scenario is part of school and countries strategy and therefore it is valuable for the pupils to learn and for the teachers to be well aware.
Inclusive culture	The school environment is open and validating for all students. The school environment is transparent and supports every student beyond the school day.
Connections	
With industry	In the context of this Learning Scenario pupils will realize how sustainability is taken into account in the future and how it creates job opportunities and how new inventions are needed.
With parents/guardians	As schoolwork is transparent and inclusive, parents are well aware of topics and issues taught. With this learning scenario pupils can encourage their parents to lower their carbon footprint and save energy by making right choices in everyday life.
With other schools and/or educational platforms	Achievements and lesson plans should always be shared through national channels to inspire colleagues.
With universities and/or research centers	University researchers and students often follow the channels where learning scenarios are shared to be involved in what is happening in their field.
With local communities	Schools are transparent and inclusive. Parents are always welcomed to visit the schools. Schools often collaborate with local communities and share the outcomes and arrange displays of schoolwork.
School infrastructure	
Access to technology and equipment	Nowadays almost all teenagers have their own mobile phones. This learning scenario needs mobile phones, since the game Mission BioHero is downloaded to their mobiles.
High quality instruction classroom materials	This learning scenario needs an internet connection, projector to reflect the screen to the board and individual mobile phones.

Lesson Plan

This lesson plan is designed for three lessons (3x 45 minutes lessons) and there are few breaks between, depending on your schedule. You can also divide the lessons (one lesson/week schedule):

1. Introductions and videos 2. group works and presentations 3. Mission BioHero game

Name of activity	Procedure	Duration
Warm-up	Showing a picture of climate change (example): https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts Question examples (with answers): Is climate change the same thing as global warming? No. "Global warming" refers to an increase in the average temperature near the Earth's surface. "Climate change" refers to the broader set of changes that go along with global warming, including changes in weather patterns, the oceans, ice and snow, and ecosystems. Most experts now use the term "climate change" because it gives a more complete picture of the changes that are happening around the world Why is climate change happening? The main reason the climate is changing is because people are adding greenhouse gases to the atmosphere. The most important greenhouse gas is carbon dioxide, which is released whenever people burn fossil fuels to do everyday activities like driving cars, heating buildings, and making electricity. As greenhouse gases build up in the atmosphere, they cause the Earth to trap extra heat, making the planet warmer. More questions: https://archive.epa.gov/climatechange/kids/faq.html	10-15 min
Greenhouse gas and carbon footprint/ groupwork	What are greenhouse gases and how can we reduce them? Watch video (2.30 min) https://youtu.be/SN5-DnOHQmE This video animation is explaining what the greenhouse effect means. And second video (1.27 min) https://youtu.be/rByHiqc0K9k This video animation is explaining how you can reduce your carbon footprint. Teacher should stop the video now and then to help pupils to understand it, ask questions and let your pupils explain. After that students are divided into groups of 3-4 and will work explaining what greenhouse gases are, how humans impact the greenhouse effect and what reduces the greenhouse effect on Earth? What is the carbon footprint and how can we	15-20 min

	reduce it? They can write, draw, create a play, slide show, poem etc. Teacher encourages and gives positive feedback and helps the students, but also assesses the work by asking questions and marking notes for assessment. Tasks for the groups should be visible on the board, so students know what they are doing. Group presentations: Groups will present their work for their peers. Encourage your pupils to give feedback!	15-30min 10-20 min
Preparations	Students download the App Mission BioHero on their own mobiles - Android: https://play.google.com/store/apps/details?id=com.nurog.ames.MissionBioHero - iOS: https://apps.apple.com/us/app/mission-biohero/id6443559708	10-15 min
Mission Bio Hero	Mission BioHero is a game to learn about bio-economy and sustainability in a fun and engaging way. Pupils can play at their own pace and teacher will help and encourage the pupils. About the game: The player assumes the role of a godly being sent to Earth to destroy it, having deemed by its elders that it cannot be saved. The character arrives on Earth and experiences a change of heart, instead deciding to help the humans save their planet. Disapprovingly, the elders strip the player's character from their powers, which they must regain throughout the game. Both this and helping mankind to save the world serve as the main goals of the story. The game is divided into campaigns, each revolving around one major subject that relates to sustainability, and bio-economy. Finish those game missions to save the planet!	20 min
Ending the lesson and the quiz	Evaluation/Homework/further studies Let your pupils to tell (you can use Mentimeter) how they liked the lesson/self evaluate by asking questions like: - What part did you like the most? - What was difficult? - Did you learn something new? And what? If you want you can tell them to fill a small quiz (annex) or just ask the questions from individuals or groups. Set the homework or further study: Examples:	10 min

1. Students reduce their carbon footprint for a week and take notes (food choices, walk rather than ride a car, take bus rather drive, recycle, fix torn clothes, re-use items, shorten hot showers, save water/electricity etc) After the week the notes will be shared and discussed in the class.

2. Students prepare a small research/Slide show, which will be shared with other students/class next week.

3. Students prepare artwork/posters to the wall encouraging people to reduce their carbon footprint.

Tips:

- Involve parents by **challenging them** to reduce their carbon footprint for a week. You can use free carbon calculator here:
<https://www.carbonfootprint.com/calculator.aspx>
- Depending on your students, you can add more gamification and play Kahoot! or Blooket! Search with “Greenhouse Effect” and you will find plenty.

Assessment

Formative: To get the information of students level of understanding, the teacher can ask herself/himself how the students can answer the following questions (If the pupils can answer these questions that indicates good level of understanding):

- How does the student understand the principles of sustainable development?
- Can the student describe by examples the threats of the future and how these threats could be avoided?
- Can the student form questions related to the topic?
- Can the student identify simple cause-and effect relationships and create a simple conclusion from the result?

Summative example: Pupils can write a small summary about what they have learnt (on their notebook or Google Classroom if they are using that). Pupils should answer the following questions (which are visible for them) in their summary:

- **What are greenhouse gases (3)?**
 - Carbon dioxide, methane, nitrous oxide
- **What is the greenhouse effect?**
 - Greenhouse gases trap heat. During the day, the sun shines through the atmosphere, warming the earth's surface. At night the earth's surface cools, releasing heat back into the air. But some of the heat is trapped by the greenhouse gases in the atmosphere.

- **What is the carbon footprint?**

- A carbon footprint is the total amount of greenhouse gases that are generated by our actions.

- **What are the Threats of carbon emission?**

- Hotter temperatures. As greenhouse gas concentrations rise, so does the global surface temperature. ...
- More severe storms. ...
- Increased drought. ...
- A warming, rising ocean. ...
- Loss of species. ...
- Not enough food. ...
- More health risks. ...
- Poverty and displacement.

- **Examples on how we can lower carbon emissions?**

- Insulate your home. ...
- Switch to renewables. ...
- Buy energy efficient. ...
- Use less water. ...
- Change your diet. ...
- Turn off the lights. ...
- Cycle to work. ...
- Reduce, reuse, recycle.

Student feedback

You can use [Mentimeter](#) and ask questions like:

- What part did you like the most?
- What was difficult?
- Did you learn something new? And what?

Teachers' remarks

Teacher comments: Group Work needed more time than expected and a lot of help from the teacher. Depending on your pupils it might be a good idea to form the groups beforehand, so nobody will be left alone and the creativity will be spread. Be sure to have all the answers ready, pupils might ask some tricky questions.

Downloading the app was difficult. The Internet seemed to collapse with so many attempts and we had to play the game in groups. Also a good idea is to choose the passwords beforehand and give them written on a paper to pupils.

Quiz questions

Annex 1:

Quiz:

1. **What are greenhouse gases (3)?**
2. **What is the greenhouse effect?**
3. **What is the carbon footprint?**
4. **What are the Threats of carbon emission?**
5. **Examples on how we can lower carbon emissions?**

Answers:

1. Carbon dioxide, methane, nitrous oxide
2. Greenhouse gases trap heat. During the day, the sun shines through the atmosphere, warming the earth's surface. At night the earth's surface cools, releasing heat back into the air. But some of the heat is trapped by the greenhouse gases in the atmosphere.
3. A carbon footprint is the total amount of greenhouse gases that are generated by our actions
4. Hotter temperatures. As greenhouse gas concentrations rise, so does the global surface temperature. ...
More severe storms. ...
Increased drought. ...
A warming, rising ocean. ...
Loss of species. ...
Not enough food. ...
More health risks. ...
Poverty and displacement
5. Insulate your home. ...
Switch to renewables. ...
Buy energy efficient. ...
Use less water. ...
Change your diet. ...

Turn off the lights. ...

Cycle to work. ...

Reduce, reuse, recycle.

F. A. Q.

1. Is climate change the same thing as global warming?

No. "Global warming" refers to an increase in the average temperature near the Earth's surface. "Climate change" refers to the broader set of changes that go along with global warming, including changes in weather patterns, the oceans, ice and snow, and ecosystems. Most experts now use the term "climate change" because it gives a more complete picture of the changes that are happening around the world.

2. Why is climate change happening?

The main reason the climate is changing is because people are adding greenhouse gases to the atmosphere. The most important greenhouse gas is carbon dioxide, which is released whenever people burn fossil fuels to do everyday activities like driving cars, heating buildings, and making electricity. As greenhouse gases build up in the atmosphere, they cause the Earth to trap extra heat, making the planet warmer.

3. What is the greenhouse effect, and how does it affect the climate?

The greenhouse effect is a natural process that helps make the Earth warm enough for us to live. It works like this: The Earth gets energy from the sun, heats up, and then gives off energy in a different form, called infrared radiation. Greenhouse gases in the atmosphere trap some of this energy before it escapes to outer space, warming the atmosphere. But people's activities are adding extra greenhouse gases to the atmosphere, so the greenhouse effect is becoming stronger and the Earth is getting warmer.

4. Does the "ozone hole" have anything to do with climate change?

Not really. The "ozone hole" refers to a decrease in the layer of ozone gas found high in the Earth's atmosphere, which helps to shield the planet from the sun's harmful ultraviolet rays. The ozone layer has become thinner because of chemicals that were once commonly used in products ranging from spray cans to foam furniture cushions. While a thinner ozone layer allows more ultraviolet rays to reach the Earth, increasing the risk of sunburns and skin cancer, it doesn't cause climate change.

5. Hasn't the Earth's climate changed before? What's different about climate change today?

Yes. The Earth's climate changed many times in the distant past as a result of natural causes, but today's climate change is different because people's activities are the main cause. This is also the first-time modern society has had to deal with such large, widespread changes in climate. Rising sea level, stronger storms, droughts, and other effects of climate change will pose major challenges for people around the world.

6. Why is it a problem if the Earth's average temperature gets a little warmer?

Temperature plays an important role in how nature works, and even a small change in average temperature can have a noticeable impact on plants, animals, and other natural processes. For example, just a one- to two-degree increase in global temperature can lead to a much greater risk of wildfires. Some parts of the world are warming a lot more than average, which means the effects are much more dramatic.

7. How can the Earth be getting warmer if it's colder than usual where I live?

The average temperature around the world is rising, and 2001–2010 was the warmest decade on record. But that doesn't mean we won't still have occasional cold spells. To see why, it's helpful to understand the difference between weather and climate. "Weather" refers to day-to-day conditions, such as a rainstorm or today's temperature. In contrast, "climate" refers to the average weather conditions you would expect to find in a certain place, based on patterns over many years. Day-to-day weather will always have its ups and downs, and there will always be a chance of extreme cold events. But as the Earth's climate gets warmer over time, most places will experience more days with record high temperatures and fewer days with record low temperatures.

8. What are the most visible signs of climate change?

You can't see the signs of climate change from one day to the next, but if you compare from year to year, the clues are everywhere! For example, as the Earth has become warmer, the average sea level around the world has risen by nearly seven inches in the last 100 years, glaciers all over the world are shrinking, and many bird species are shifting northward. Some of the most obvious changes are happening in the Arctic, where the amount of ice in the ocean has decreased dramatically.

9. Can climate change harm plants and animals?

Yes. Any change in the climate of an area can affect the plants and animals that live there. Some animals might adapt or move elsewhere, but others could have trouble surviving. For example, if the ice in the Arctic Ocean disappears, the animals that depend on this ice won't have anywhere else to go. Climate change also alters plants' and animals' life cycles. For example, some flowers are blooming earlier in the spring, while some animals are migrating at different times.

10. What can we do to stop climate change?

There are lots of things you, your friends, and your family can do each day to reduce greenhouse gas emissions. A major way that greenhouse gases get into the atmosphere is when people burn coal, oil, and natural gas for energy. Here are some simple steps you can take to use less energy:

- Turn off the lights when you leave a room.
- Turn off your computer and other electronic devices when you're not using them.
- Drive less. Instead, walk, ride your bike, or use public transportation if you can.
- Use less water.
- Create less waste.
- Recycle used paper, cans, bottles, and other materials.

Reference: <https://archive.epa.gov/climatechange/kids/faq.html>

5. Scenario 4: Let's destroy the planet!

Author

Nektarios Farasopoulos

Summary

All students are members of the secret alien organization named PlanetDestroyers. They have one single goal! Destroy the earth!

They have to split in small groups and try to spy on earth. They have to learn humans' habits using the app, Mission BioHero. In order to achieve their goal, they have to create posters/videos and spread them all around the Earth to persuade humans to continue ruining the environment until they finally achieve their ultimate goal: to destroy the planet!

Keywords

Climate change, emissions, environment

Overview

Subject(s)	Natural Sciences, Social Sciences, English, Arts
Topic(s)	Understanding the reasons that cause Climate change and adopting everyday life habits that help to reduce the consequences of climate change.
Age of students	9 - 11
Preparation time	Not tested
Teaching time	Natural Sciences: three periods Social Sciences: two periods English: one period (depending on the age of the students and their English level) Arts: one period
Online teaching material	• https://ideaboardz.com/ • www.sli.do • www.kahoot.it Google/Microsoft Forms • https://www.canva.com/ • www.padlet.com • https://app.videobit.io
Offline teaching material	Papers, scissors, crayons, glue etc.

Resources used

- Mission BioHero, game for smartphones:
Android:
<https://play.google.com/store/apps/details?id=com.nurogames.MissionBioHero>
iOS:
<https://apps.apple.com/us/app/mission-biohero/id6443559708>
- Our planet, our future
<https://ec.europa.eu/clima/sites/youth/>
- Guidelines on how to create a video:
<https://www.youtube.com/watch?v=wcepHDSdPgA>

Aim of the lesson

Students will:

- Understand what climate change is.
- What causes climate change.
- Calculate their CO₂ emissions.
- Understand the most environmentally-friendly means of transport.
- Create posters to campaign against Climate Change.

Trends

Project-Based Learning: Students face problems to solve.

Collaborative Learning: A strong focus on group work and interaction.

21st century skills

- **Creativity:** students can develop their creativity through making videos.
- **Collaboration:** by working in small groups (3 – 4 students each) students can learn how to work together, exchange ideas and learn from their peers' comments.
- **Communication:** students can enhance their communication skills by presenting their conclusions to their classmates (and local community) in a successful way
- **Problem solving:** Students will face a real-life problem and will develop the ability to find answers.
- **ICT Literacy**

STEM Strategy Criteria

Elements and criteria	How is this criterion addressed in the learning scenario
Instruction	
Problem and project-based learning (PBL)	Students work on an open-ended question with no solution provided by the teacher.
Curriculum implementation	

Interdisciplinary instruction	We examine and implement a variety of activities in a wide spectrum of subjects, ranging from Natural Sciences (STEM) to English and Arts (non-STEM).
Assessment	
Continuous assessment	Formative evaluation is carried out, allowing a continuous improvement on the students' progress.
Professionalization of staff	
Professional development	Our school provides avenues for all staff's professional development, especially, on teacher capacity building.
School leadership and culture	
School leadership	Existence of a governing board and management teams.
High level of cooperation among staff	Staff is encouraged to support each other and work together, having the space and time to do so.
Connections	
With industry	A school visit to a recycling center or/and a power plant will be scheduled, either physically or virtually, so that students can directly discuss with professionals about the recent developments in the field.
School infrastructure	
Access to technology and equipment	School is equipped with internet access, as well as at least one computer/laptop and one projector per classroom. Tablet or mobile phone.

Lesson Plan

Name of activity	Procedure	Duration
1. Problem	Students receive a message written, filmed, recorded etc., from the headquarters of PlanetDestroyers and the teacher reads/plays/shows it to the classroom. Their new mission has just arrived. They will be spies on earth and see what the most common human mistakes are and what some of them are doing to protect earth's environment. The first part of the mission is to download their enemy's app on their tablets. Using the app Mission BioHero, they will find inside information about earth's problems and how they can make them worse.	10 minutes

	Also, the School Principal says that the school will stop all the field trips! Due to the climate change, there are no suitable places for the school to visit and if nothing changes, the pupils will never have the opportunity to go on a field trip again. Teacher can use this message https://share.pixton.com/q642era or create another one (in paper, video or any other form he/she likes) with similar content. <i>Note to teacher: if your school is not organizing excursions – make an announcement from a city mayor or president saying that vacations and family trips are not allowed, because of climate change.</i>	
2. Discussion	After reading/showing the message of their new mission the pupils and the teacher discuss on how we can make things on earth even worse. Do the students like it? Do they want to do something about this? The ideas are noted down on the board or an app like https://ideaboardz.com/ (also suitable for online classes)	10 minutes
3. Pre-evaluation	Using an online (e.g., Google Forms, Microsoft Forms etc.) or offline (pen and paper) tool teacher asks students to answer some questions about the pollution, the energy consumption etc, so he/she can understand what they already know about this matter (example questions on the Annex II).	10 minutes
4. Investigation 1: Mission BioHero	Depending on the equipment of the class: - If there is only one tablet or smartphone available the teacher casts the screen to a television or a computer with a projector so all the students can see the Mission BioHero App. - If there are more devices available (smartphones or tablets), students use the Mission BioHero App. Each group can follow their path in the app and try to succeed in a campaign.	60 minutes
5. Investigation 2: Our planet, our future (Optional)	If the students need more information about the causes of the climate change, they can study this material: https://ec.europa.eu/clima/sites/youth/causes_en If there is only a computer and a projector available, the whole class watches it together. If there are more devices available (laptops, pcs, tablets), students study the materials in small groups.	30 minutes
6. Brainstorming	Using an online (e.g., Mentimeter, Slido etc.) or offline (pen and paper, board) tool teacher asks students to express their opinion: ▪ How can we raise the emissions of CO2? ▪ How can we consume more energy? ▪ What can we do to make the climate change worse?	10 minutes
7. Poster/ video campaign	After realizing that there many things that can destroy the earth's environment, the spies start working on their mission. Separated in small groups they create posters and short videos in order to persuade humans to follow their plan. The posters and the videos are full with advices for humans to cause an	135 minutes

even more serious effect on the environment and eventually destroy the planet.

Pupils in small groups (3-4 students each) create offline posters using paper, glue etc. and/or online posters using an app like <https://www.canva.com/>.

The size of the posters depends on the available materials (papers, cartons etc.). The online posters is a good option if there are enough pcs/tablets for every group of students.

The main themes of the posters should be:

- Global warming
- Climate Change
- Means of transportation
- Energy consumption

If there are more than four teams in the class, more teams can work with the same theme.

During the preparation of the posters, the students can use the Mission BioHero app again at any time, especially the lexicon.

Note to teacher: if your students never developed posters during lessons, explain them shortly how the task should be done. Explain that they should first think of an idea of what they want to show, to think of main text/slogans and where it will be created, are there any attributes needed, etc.

Pupils in small groups (3-4 students each) create small videos like ads using an app like <https://app.videobit.io>.

The duration of the video should be 20 – 30 seconds so that they are easy to watch and share online.

The main themes of the videos should be:

- Global warming
- Climate Change
- Means of transportation
- Energy consumption

If there are more than four teams in the class, several teams can work with the same theme.

At any time during the production students can use again the app Mission BioHero and especially the Lexicon.

Note to teacher:

If there is only one camera/phone/tablet for taking photos, you might need more time for the productions of the films.

Depending on the age of the students they might be able to create videos at home, as an assignment.

There is a rubric for peer review in the assessment section.

Do not forget to take into account the GDPR rules <https://gdpr.eu/what-is-gdpr/> and ask parents' permission (if the students appear in the video).

	For easy online sharing of the videos is highly recommended to create all the materials you need and not use pictures and files you find on the internet. For music and sounds you can use this site https://www.freesfx.co.uk/ that provides sounds that can be used for free in any commercial, non-commercial, broadcast multimedia/audio visual production.	
8. Test presentation	Every group presents their work (videos) to their classmates and they will receive feedback. Make changes if needed. You can use an app like https://www.tricider.com/ so students can write their opinion on their classmates' work. <i>Note to teacher: before presentation and sharing feedback session, explain students on how to provide feedback on videos. Discuss with them what criteria they would evaluate and remind not to criticize student's work only to provide constructive feedback.</i>	15 minutes
9. Presentation	Students present their work to the school community, trying to persuade students, parents, and teachers etc. to continue their habits in order to destroy the planet as soon as possible.	15 minutes
10. Online Campaign	Teachers help students to promote their work and organize an online video campaign. They can post the videos on the school website, send them to the local media and even post them on social media. <i>Note to teacher: Do not forget to take into account the GDPR rules https://gdpr.eu/what-is-gdpr/ and the creative commons licenses https://creativecommons.org/.</i>	n/a
11. Post evaluation	Using the same questionnaire as activity 3, teacher asks students to answer the questions about the topic of the learning scenario, so he/she can understand what they learned after implementing the learning scenario (example questions listed below). Also, students can evaluate their classmates' work with a questionnaire (online or offline).	25 minutes

Assessment

Using an online app like Kahoot, Quizziz, Google/Microsoft forms etc. or just pen and paper, the students can answer the following questions:

- The global temperature is rising.

a. **True**

b. **False**

- Climate refers to short term atmospheric conditions.

- a. True
- b. **False**

- Climate is the weather of a specific region averaged over a long period of time.

- a. **True**
- b. False

- Only plants can be called biomass.

- a. True
- b. **False**

- It takes millions of years to form fossil feedstock.

- a. **True**
- b. False

- In order to reduce the greenhouse gases it is better to stop walking and always use a car.

- a. True
- b. **False**

- It is not concerning that the temperature on Earth is rising.

- a. True
- b. **False**

- Using bio-based products can help the environment.

- a. **True**
- b. False

- It is important to reduce our carbon footprint.

- a. **True**
- b. False

- Sustainable development combines economic development with environmental protection and social justice.

- a. **True**
- b. False

Peer evaluation

Criteria	Very good	Good	Developing
Research and collecting information.	They collected a lot of information from various sources.	They collected some information from a few sources.	They collected a little information from a few sources.
Sharing	They always shared information or ideas with all the team members.	They sometimes shared information or ideas with all the team members.	They shared a little information or ideas with all the team members.
Completing Tasks	They met all deadlines.	They met most deadlines.	They missed many deadlines.
Contribution	They always helped the team with all tasks .	They sometimes helped the team with some tasks .	They didn't help the team with any task .
Listening to other group members	They always listened to ideas and suggestion from the team.	They sometimes listened to ideas and suggestion from the team.	They didn't listen to ideas and suggestion from the team.

Student feedback

Teacher asks students to add their opinion for the learning scenario on a padlet (or a similar app) in three columns. The three main questions (one on each column) they have to answer are:

1. What aspect of the learning scenario did you like the most?
2. What should be changed?
3. List at least two new things you have learned from this learning scenario.

The answers can be anonymous.

If the access to pc and tablets is limited, the answers can be written down on paper.

6. About AllThings.BioPRO and Scientix

AllThings.Bio PRO

The **Allthings.bioPRO** consortium constitutes a multidisciplinary and competent partnership to address the challenges posed by the objectives of the project. Partners are coming from different countries in Europe including Germany, the Netherlands, Italy, Belgium, Estonia and Sweden. All partners are active in projects and other activities related to the bioeconomy and bio-based products, and are working regularly in multi-stakeholder settings with special emphasis on citizen engagement and participation.



Scientix, the community for Science Education in Europe, promotes and supports a Europe-wide collaboration among STEM (Science, Technology, Engineering and Mathematics) teachers, education researchers, policymakers, and other STEM education professionals. If you need more information, check the [Scientix portal](#), or contact either the Scientix National Contact Point or Scientix Ambassadors [in your country](#).

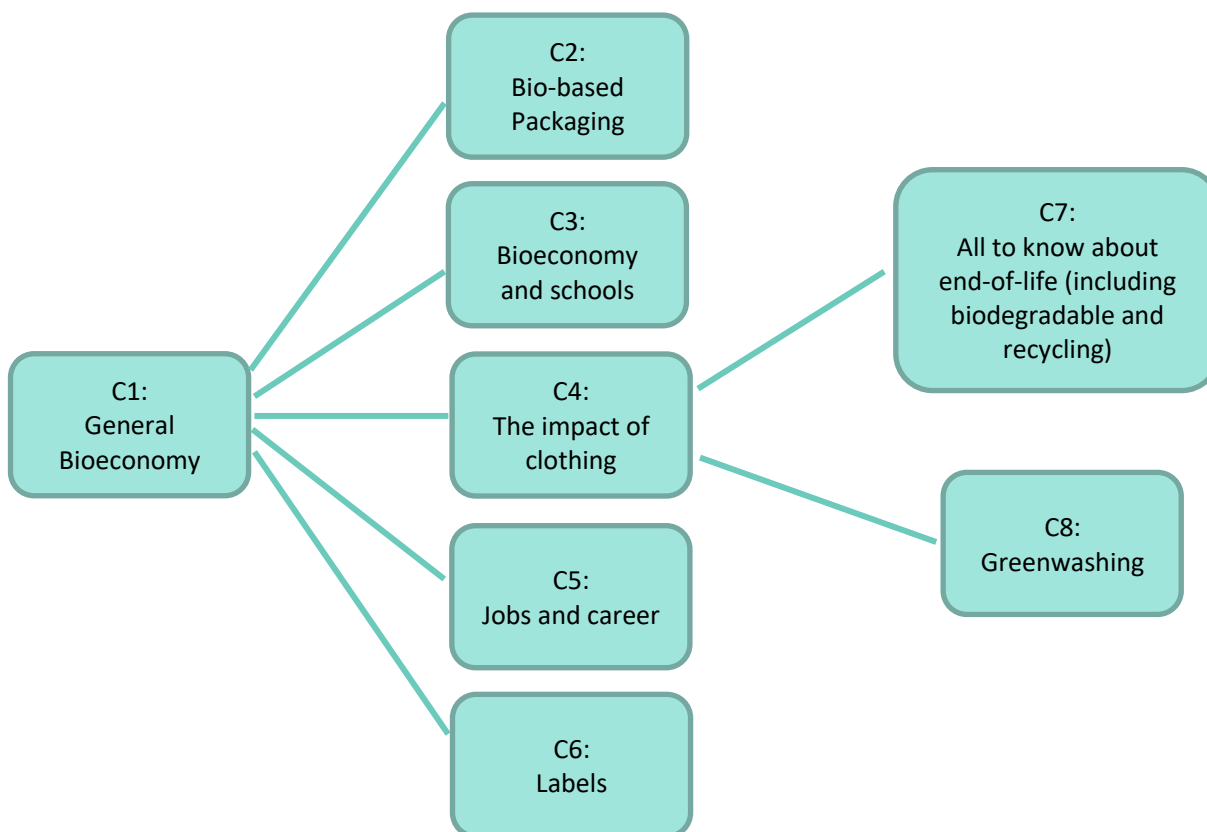
Download the Mission BioHero game here:



This project has received funding from the Bio-based Industries Joint Undertaking (JU) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 887070. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio-based Industries Consortium.

7. Overview: Game structure

The serious game Mission BioHero is divided into eight campaigns. Each campaign consists of quiz questions, in-game and real life tasks and mini-games that are so called city-builders where the player has to turn a fossil-based value chain into a bio-based one in order to make the city greener and more sustainable. The game is structured in such a way that the level of difficulty increases in the course of the game with the topics to be dealt with. Thus, the game is divided into three phases with the following number of categories 1-5-2.



The game starts with the first campaign “General Bioeconomy”. Only after finishing all quizzes, tasks, mini-games and the special skills, campaign 2 - 6 are unlocked. Out of these five campaigns, the player can decide which one to play next. Once the first six campaigns have successfully been played, the remaining two campaigns “End-of-life” and “Greenwashing” are unlocked.

- Quiz questions: in general multiple-choice questions.
- Tasks: require the player to perform something in real life and in-game.
- City Builder: mini-games with the goal to turn a city with a non-sustainable value chain into a bio-based one.
- Special skills: award specific abilities and in-game points.
- Lexicon: summarises important definition.

8. Correct answers for the quizzes within the Mission BioHero game

Campaign 1: The general bioeconomy

Quiz: General Bioeconomy

Q1: Which discovery is the oldest?

A: Paper for example comes from at least 105 CE and the oldest silk material is more than 5000 years old!

Q2: How much agricultural land is currently used in the world to produce all these bio-based products?

A: 2.1% of the agricultural land is currently needed for material use. This is very small if you compare it for example to 70% required for pasture.

Q3: Why are bio-based products always better for the environment?

A: Most bio-based products are better for the environment than their fossil-based equivalents, but it's not guaranteed.

Q4: How about the properties of bio-based products compared to current fossil-based products?

A: Bio-based products can be identical to fossil-based products or even outperform them. In theory they can also have worse properties, but these usually require an additional benefit to enter the market. For example, some bio-based lubricants are less stable, but compensate this by being biodegradable.

Quiz: Why is the World dead

Q1: We all heard of climate change. But what are some of the expected effects?

A: Well done! Sea levels are expected to rise by 30 cm on average by 2050 due to melting of ice sheets and glaciers. Rising water temperatures will destroy coral reefs and marine life. Storms, droughts and heat waves will increase worldwide.

Q2: And what are the impacts of climate change?

A: Storms, floods and wildfires are threatening our homes and affecting our outdoor activities. Global warming destabilises ecosystems and increases allergies and health risks.

Droughts, storms and rising sea levels are shrinking arable land and making drinking water scarce.

Q3: What is causing climate change?

A: The burning of fossil resources releases carbon dioxide, methane and other greenhouse gases. Cutting of trees additionally releases tonnes of carbon dioxide into the air that was stored a hundred or more years. The increased concentration of carbon dioxide disrupts the natural regulation of temperature and atmosphere.

Q4: Which of these countries CURRENTLY contributes most to climate change?

A: China is the world's largest contributor to greenhouse gas emissions with 28% share. But China has a greater population and many of the products made in China are sold around the world. The USA is second with 15% and has higher greenhouse gas emissions per person. The EU is responsible for about 9% today but for about 18% of global greenhouse gas emissions since the beginning of the industrial revolution.

Campaign 2: Bio-based packaging

Quiz: Packaging – current state and bio-based solutions

Q1: How many cars cause roughly the same amount of CO₂-emissions as the global food packaging?

A: It is about 14% of all passenger cars in the world!

Q2: Can you estimate how much of all types of packaging waste an average European produces per year and how much of that is recycled?

A: An average European produces 180 kg of packaging waste per year, of which 66% is recycled.

Q3: There are many bio-based solutions for packaging available. Of all these bio-based options, can you recognise which are synthetic bio-based polymers?

A: Synthetic polymers can be recognised by their acronym starting with P for 'poly'.

Quiz: When not to package

Q1: What are some of the functions of food packaging?

A: Proper food packaging preserves quality and ensures food safety. It not only makes the product more attractive to consumers, but also provides product information and facilitates the transport of the product.

Q2: With all those tasks that packaging performs, it is important to package all types of food.

A: There are plenty of examples where not using any packaging for food is the better solution.

Q3: What are some benefits of not packaging food?

A: By providing loose items, consumers can buy the exact amount they want, thereby avoiding food waste and the need for additional packaging material.

Q4: Which of these items can safely and easily be sold without packaging?

A: All fruit and vegetables can in principle be safely sold unpackaged. In some countries, such as France, this is enforced by law.

Campaign 3: The bioeconomy and schools

Quiz: Bioeconomy as a solution

Q1: How can the bioeconomy help reduce greenhouse gas emissions?

A: By replacing fossil-based products with renewable bio-based products, no more fossil resources are used and no fossil-based carbon enters the atmosphere. As an added benefit, locally produced products avoid transport emissions.

Q2: How can bio-based solutions help with plastic polluting the oceans?

A: Even though the bioeconomy does not bring a solution to the plastic pollution on its own, it can be part of a solution.

Q3: Which of these are real effects of a sustainable bioeconomy?

A: The bioeconomy can have several positive effects on the social and economic aspects of people's life. But, if done poorly, the bioeconomy can also have negative effects.

Q4: How far along are we to make the bioeconomy a reality?

A: Many bio-based products are already here, but we still have a long way to go.

Q5: What can I do to help the bioeconomy?

A: Increasing demand for sustainable and bio-based products is helpful, but governments can also make a big contribution through improved policies and regulations, and individuals can set an example to others through their actions.

Q6: When should you choose a bio-based product over a fossil-based product?

A: Every step in the right direction helps. Bio-based products are a new development and may not solve all the problems in their first version. Only by keeping promoting the more sustainable products can we reach a fully sustainable bioeconomy. But being bio-based does not mean anything if it is not better for the environment.

Quiz: Bioeconomy items at school

Q1: Which of the following things you find at school can be fully made bio-based?

A: Text books, desks, pens, backpacks and even the school building itself can be fully made bio-based.

Q2: Which of these toys are mostly made out of bio-based materials?

A: Puzzles, trading cards, playing books. There are already a lot of bio-based toys available!

Q3: Why should we educate children on the bioeconomy?

A: The bioeconomy is a fun and important topic to teach at school and it will play a large role in the future.

Q5: Which of the following is true?

A: Children are the future and they already have an impact on our society. However, the responsibility to transition to a sustainable circular bioeconomy does not rest on their shoulders alone!

Campaign 4: The impact of clothing

Quiz: Environmentally friendly use of clothing – Part 1

Q1: What purpose do chemicals serve in the manufacture of clothing?

A: In the fashion industry, around 8,000 synthetic chemicals are used in the production of clothing. Many of them are harmful as they are carcinogenic, hormone disrupting and can be absorbed by human skin. Insecticides are used to grow conventional cotton, but chemicals are also used to make clothes weatherproof, stain-, wrinkle-, bacteria- and odour-resistant, and are also a component of dyes.

Q2: Which of the following are true on microfibres?

A: Microfibres are hundreds of times finer than human hair and come from all textiles. Thousands of fibres are released during the production, washing, drying and wearing of clothes. Worrying is if the clothing is synthetically based, as it is then part of the plastic pollution. Synthetic microfibres break down over time into tiny particles called microplastics,

which can be found all over the world as few washing machines filter them out and some still pass through sewage treatment plants.

Q3: How can we make the way we wash our clothes more environmentally friendly?

A: It helps to wash synthetic clothes at lower temperatures, to use protective washing bags or to integrate filtering devices into the washing machine. Collected microplastics can be disposed of properly. Air-drying is always better than tumble-dry and so is a plastic free washing detergent.

Quiz: Environmentally friendly use of clothing – Part 2

Q1: Which choice is more environmentally friendly?

A: It is always better to wear second-hand clothes, as no new resources have to be used for the production of new clothes. Even if the second-hand garment might not be bio-based, it is a form of sustainable consumption to extend its life cycle.

Q2: What are some examples of bio-based materials used in the fashion industry?

A: Cotton and wool are among the oldest fibres in the world. Leather is also one of the oldest forms of clothing material and remains important, especially for footwear and accessories. Cellulose fibres are originally made from cellulose extracted from natural resources (e.g. bamboo or trees), then crushed, ground and converted into fibres in a process similar to the production of polyester. Bast fibres, such as flax, nettle and hemp, are also bio-based.

Q3: Which labels indicate that the product is fully organic throughout every stage, from the production to the labelling of the product?

A: The Global Organic Textile Standard (GOTS) is an officially and internationally recognized standard, indicating that the product is definitely organic, covering all aspects of manufacturing, from the use of biodegradable and toxin-free dyes to environmentally friendly waste treatment and water supply systems in the factories, fair labour practices, and final products that are free of allergenic or toxic chemical residues.

Quiz: Clothing our clothing industry – Part 1

Q1: How fast did the fashion industry grow in the last forty years?

A: Fashion is one of the fastest-growing industries on the planet. 400 % more new pieces of clothing are sold every year than just forty years ago. Americans alone are buying five times more garments than in 1980.

Q2: How many clothes are produced each year worldwide (in pieces)?

A: Around 100 billion new garments are produced worldwide each year. And this quantity is only set to increase each year.

Q3: Which countries are the top garment manufacturers worldwide?

A: Garments are mainly manufactured in Asia, with China being the top manufacturer followed by Bangladesh, India and Vietnam. Especially in Bangladesh and Vietnam and other developing countries, textiles make up a large part of their exports.

Q4: What are the downsides of fast fashion?

A: Nowadays clothes are mainly produced in developing countries under poor working conditions and poor wages. The chemicals used in textile production are mostly disposed of untreated into the environment. To increase profits, fast fashion brands push for an increasingly high turnover, which results in cheaper and lower quality of textiles that are worn for only one season.

Quiz: Clothing our clothing industry – Part 2

Q1: How does the fashion industry endanger our environment?

A: The fashion industry is considered the second most polluting industry in the world after the oil industry. Textile production generates more CO₂ than all international flights and maritime shipping combined. It contributes around 20 % of global industrial wastewater. Clothes release microfibers into the environment during manufacturing, wearing, washing and drying. Clothes made of synthetic fibres contribute to the plastic pollution.

Q2: What are our clothes mainly made of nowadays?

A: 64 % of all new textiles are made of synthetic fibres, whereby the most common materials used are polyester, but also nylon, acrylic polypropylene and elastane. Many garments consist of a mix of cotton and synthetic fibres.

Q3: What share of discarded clothes are re-used or recycled?

A: Only about 1 % of the clothing collected worldwide is actually recycled into new yarns and fibres. Recycling chemicals used in textile production is a particular challenge. About 20 % is reused as used clothing or ground up and made into insulation and carpeting. 80 % is disposed of in landfills or incinerated.

Q4: What are important steps to transform the fashion industry?

A: To transform the fashion industry, several steps are needed: phasing out harmful substances and materials, changing the public perception of clothes as disposable item, adapting the quality, design and distribution of clothes, using resources efficiently, increasing recycling, and improving recycling technologies.

Campaign 5: Jobs & Careers

Quiz: Bioeconomy jobs

Q1: Which of these jobs are related to the bioeconomy?

A: A microbiology lecturer deals with living organisms that are too small to see with your eyes. A beverage taster, a kitchen assistant and a food technologist are in contact with food and beverages made of biomass (fruits and vegetables) on a daily basis.

Q2: Most of the new workers entering the bioeconomy sector followed education labelled “bioeconomy”

A: Only 3% of the higher education programmes in 10 EU countries concern dedicated bioeconomy curricula.

Q3: In the bioeconomy, the metaphor of the “T-shaped professional” is often cited. Do you know what this means?

A: The top of the letter T represents broad knowledge and boundary- crossing competences, where the foot of the T represents deep knowledge and skills in one discipline. T-shaped professionals are in high demand for jobs in the bioeconomy!

Campaign 6: Labels

Quiz: Ecolabels – Part 1

Q1: What is an ecolabel?

A: An ecolabel is a label, which identifies overall environmental performance standards of a product.

Q2: What are the objectives of ecolabelling?

A: Ecolabelling serves all the mentioned purposes. The awarding of ecolabels protects the environment. Certifying for ecolabels, businesses can establish a positive image among consumers. And ecolabels help build consumer awareness of environmental issues.

Q3: More ecolabels on the market means a bigger push for sustainable products, right?

A: Having multiple ecolabels in the same product category can lead to two main problems. Too much duplication leads to wasted resources in terms of transaction costs, verification work, etc. And there is the danger of a race to the bottom, meaning creating ecolabel criteria that almost everyone can meet.

Q4: Despite the large number of ecolabels around, is it still possible to find the ones that matter to you?

A: Online you can find various tools and platforms to inform you and to help you make a sustainable choice, including apps, guides, and (road-)maps. Some examples: Ecolabel Guide; Keurmerkenwijzer (in Dutch); Standards Map; Ecolabel Index. For products that are bio-based, you can use our companion app Label BioHero.

Quiz: Ecolabels – Part 2

Q1: How many ecolabelling programmes are there in the world today?

A: Currently, there are more than 250 active sustainability standards and more than 450 ecolabels in close to 200 countries.

Q2: Which type of products (goods or services) are covered under ecolabelling schemes today?

A: Today ecolabels are covering almost everything, from food and beverages to cosmetics and personal care items to appliances, furniture, and even companies themselves.

Q3: Nowadays, many ecolabelling schemes cover a wider range of sustainability aspects. Which of these attributes can be covered in an ecolabel?

A: Environmental attributes, health-related issues, socio- economic aspects, and even cultural aspects can be covered in ecolabelling schemes, and the scope of their coverage has been gradually expanded over time.

Quiz: Textile Labels

Q1: Various labels are applied to textile products. Which of the following is mandatory across the EU?

A: Only the product composition label is mandatory in the EU for textiles intended for sale to the end consumers.

Q2: Which of the following labels are exclusively used for textiles made from organically produced raw materials?

A: The Global Organic Textile Standard (GOTS) certifies that the textile is made from organically produced raw materials.

Q3: How can I recognise bio-based clothing when buying?

A: The product composition label informs about the fibres used in clothing, in decreasing percentage order. You do need to know which fibres are bio-based.

Campaign 7: End-of-Life

Quiz: Recycling and recyclable

Q1: What type of domestic waste has globally increased the most in the recent years?

A: Electronic waste (e-waste) is the fastest growing waste stream worldwide. Due to technological developments in recent years, more than 57 million tonnes of e-waste were produced in 2021, increasing at an average rate of about 2 million tonnes per year.

Q2: Is the following statement true or false: “Recycling e-waste is challenging and time consuming and should only be carried out in a safe environment.”

A: Electronic devices contain various materials, many of which are hazardous or rare resources. A safe and correct recycling process is complicated, costly and time-consuming, as components have to be disassembled piece by piece and there is a lack of standardised recycling strategies. New equipment is often very short-lived, which further complicates matters by creating more waste than can be recycled in the same amount of time.

Quiz: Recycling of clothes

Q1: What quantity of used textiles is shipped overseas from developed countries every year, e.g. to Ghana, Chile or India?

A: Every year, 4 million tonnes of textiles, consisting mainly of unsold or donated clothing from the Global North, are shipped mainly to the Global South (multiple African countries, Chile or India). Many of these countries receive on a weekly basis the amount of garments it would take to dress their entire population. They simply do not have a need for all these clothes, and lack the capacity and infrastructure to dispose of them. These countries become a dumping ground for the world’s surplus textiles.

Q2: Do you know what kind of materials can be recycled?

A: Cotton, wool, polyester and nylon can be recycled. However, recycling polyester and nylon is difficult due to high costs and because most garments are made of fiber blends which cannot (at present) easily be separated. Blended fabrics can therefore not yet be recycled.

Q3: Enzymes are part of the bioeconomy. They help with chemical reactions that take place in nature. How can we use enzymes to produce and prolong the quality our clothing?

A: Enzymes are used in the production, maintenance and end-of-life of textiles, reducing water and energy consumption and allowing clothing to be worn longer.

Campaign 8: Greenwashing

Quiz: Identify greenwashing examples

Q1: Can you recognise which of these products are being greenwashed?

A: Using an official looking logo gives the impression a third party validated the product, which is not the case and therefore falls under greenwashing

Q2: Can you recognise which of these products are being greenwashed?

A: Hiding the plastic packaging with paper creates the expectation that the entire packaging is paper based, which is greenwashing.

Q3: Can you recognise which of these products are being greenwashed?

A: Plastic straws are banned in the EU and therefore the statement is irrelevant and considered greenwashing.

Q4: Can you recognise which of these products are being greenwashed?

A: The bag makes an irrelevant claim, where they ask the consumers for action in order to put themselves in a green light. This is greenwashing.

Q5: Can you recognise which of these products are being greenwashed?

A: The logo shows a happy cow that is standing outside. Without giving information on the living conditions of the cow, the logo gives a misleading impression that the cow is living outside in the fields as a happy cow. Giving a misleading impression is greenwashing.

Quiz: What is greenwashing

Q1: What is greenwashing?

A: A form of deceptive marketing where the public is persuaded that an organisation's products, aims and policies are environmentally friendly.

Q2: What are potential effects of greenwashing, even when done unintentionally?

A: When greenwashing is exposed it can harm the business reputation, the consumers will lose trust in the brand or business or might even buy fewer real sustainable and bio-based products. Consumers are often unaware of the real impact of their purchasing behaviour on the environment.

Quiz: When is it bad

Q1: Next to greenwashing, what are other methods that can slow down a switch to a bioeconomy?

A: To make the change happen we need systemic changes now and we should not let the perfect be the enemy of the good.

Q2: Why should we start using bio-based products now?

A: The following are all good reasons to make an immediate switch to bio-based products:

- Even when they do not answer all sustainability issues, they are better than fossil-based products.
- To prevent dramatic consequences from global warming, we cannot wait for new innovations and must focus on scaling up the innovations that are already available.
- By adopting a bioeconomy, we can learn and improve it faster

Q3: Instead of starting with bio-based solutions now, which are not yet perfect, why can we not improve the sustainability of fossil-based products?

A: The only sustainable future is without the use of fossil feedstock.