The BLOOM School Box

Learning Scenario

Biofuel production from fruit waste

This learning scenario is part of the BLOOM School Box, which consists of a set of learning scenarios combining bioeconomy into science, technology, engineering and mathematics (STEM) subjects.

This resource was developed as part of the BLOOM "Teach bioeconomy!" competition and is one of the winning entries that have been evaluated by an international team of bioeconomy experts and expert teachers. This learning scenario has been developed as part of the BLOOM project.

Authors:

Mustafa Bozoglan

Table of contents

BLOOM has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 773983. Neither the European Commission nor any person acting on behalf of the Commission is responsible for how the following information is used. The views expressed in this publication are the sole responsibility of the authors and do not necessarily reflect the views of the European Commission.

Learning scenario summary

Using different teaching methods such as digital classroom, collaborative, visual and search learning, students discover the basic concepts of bio-based fuels and fruit waste, conduct experiments in a laboratory environment, and continue to learn outside school.

Subject	**Science, Biology, Chemistry, Physics**
Topic	**Waste management and bio-recycling**
Age of students	**12-16**
Preparation time	**80 minutes**
Teaching time	**4classes (40 minutes each)**
Online teaching material	Padlet, Kahoot, Canva, Google, PowerPoint, Excel, GeoGebra
Offline teaching material	Fruit waste, blender, jars, yeast, beaker, volume meter, glass cylinder, Erlenmeyer flask, PC, mixer, distillation apparatus
Bioeconomy resources used	• Johnson, Francis X. *Biofuels, Bioenergy and the Bioeconomy in North and South,* Ind Biotechnol (New Rochelle N Y). 2017 Dec 1; 13(6): 289–291. Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5743105/ • Marie Trydeman Knudsen, John E. Hermansen, Line Beck Thostrup (October 2015): *Mapping Sustainability Criteria for the Bioeconomy Aarhus University, Department of Agroecology*. Retrieved from: https://www.scar-swg-sbgb.eu/lw_resource/datapool/_items/item_25/mapping_final_20_10_2015.pdf • http://www.bioways.eu/bio-learn/applications-factsheets/

Relevant trends

Relevant trend(s) the Scenario is intended to respond to. E.g. at http://www.allourideas.org/trendiez/results

Digital Classroom: students learn the basic concepts of bio-based fuels while watching videos at home, in the library or outside the classroom. They reinforce and reflect on what they have learned in class.
Collaborative Learning: students conduct experiments as a group in a laboratory environment.
STEM Learning: focus on Science, Technology, Engineering and Mathematics.
Lifelong Learning: learning does not stop when leaving school
Mobile Learning: we get access to knowledge through smartphones and tablets. It is learning anytime, anywhere.
Visual Search and Learning: images and multimedia are more powerful than verbal stimuli.

Aim of the lesson

What are the main objectives? What will students achieve by the end of the lesson?

By the end of the lesson, students will be able to:

- Recognize bio-based products. Understand the concept of bioeconomy
- Use subject-specific words and terms
- Learn about the production of biofuels
- Recognize the equipment and laboratory materials used in the laboratory work
- Learn that fruit waste can be converted into alcohols by fermentation of polysaccharides in starch and cellulose by carrying out experiments and observations
- Learn how to measure, record and present thermal data through mathematical calculations and graphs

Activities

Name of activity	***The detailed description of the activity***	***Time***
1. Learning in the Digital Classroom	**Activity Space:** Digital Classroom **Aims:** The students should be able to: • Recognize bio-based products • Learn the concept of bioeconomy • Use subject-specific words and terms	**40 min.**
1A	The teacher presents bioeconomy and biobased fuels. The teacher also explains the purpose of the activity and the rules of the digital workshop.	5 min.
1B	The teacher divides students into three groups, which will work on three different themes. Each team is required to investigate their topic by using Google, YouTube, pen and paper, and articles in bioeconomy, biofuels and biotechnology.	10 min.
1C	The first group is asked to conduct research on biobased fuels and their production from raw materials, the second group researches the use of bioeconomy in the energy sector and the third group investigates renewable energy and biofuels.	10 min.
1D	Students turn the research results into a poster by using a simple design tool (e.g. Canva). **Homework:** Participants prepare answers to the questions in Annex 1 by researching on the internet at home and including their answers on an online collaboration space (e.g. Padlet).	15 min.
2. Experiment in the Laboratory	**Activity Space:** Chemistry Laboratory **Aims:** The students should be able to: • Understand the production of biofuels. • Recognize the equipment and laboratory materials used in the laboratory work.	**80 min.**

Name of activity	***The detailed description of the activity***	***Time***
	• Learn by making experiments and observations that fruit waste can be converted into alcohols through the fermentation of polysaccharides in starch and cellulose.	
2A	The teacher starts the session by asking students to participate in a Kahoot quiz by taking into account the assignments and posters the students have shared online during the previous assignment.	10 min.
2B	The teacher divides pupils into groups of 3-4 people for the laboratory work, presents required solutions and test materials, explains the laboratory rules and the safety regulations for the chemicals to be used in the experiment.	10 min.
2C	All students prepare the first part of the biofuels production experiment, using different types of fruit waste. (in Annex 2)	50 min.
2D	Participants take the time to clean the working environment and decontaminate the laboratory equipment in accordance with the rules.	10 min.
3. Analysis in Digital Classroom	**Activity Space:** Digital Classroom **Activities Aims:** The students should be able to: understand how to measure and present thermal data collected from measuring the efficiency of the biofuels produced.	**40 min.**
3A	The efficiency of the biofuels obtained from the different fruit wastes is calculated according to the "Testing your Biodiesel" experiment from the Bloom your school with your biofuel and soap lab learning scenario. Students are asked to introduced their measurements in tables and to generate graphs using Excel and Geogebra.	20 min.
3B	Students are asked to prepare PowerPoint presentations with the information obtained in during the three activities.	20 min.

Assessment

What are the main types of assessment used?

Evaluation will be carried out via a Kahoot quiz; students are also asked to carry out presentations including the information they learnt during the different course activities.

Annexes

Annex 1: Assignments

Assignment 1
Examine the biological structure of the industrial plants used in the field of biotechnology. Specify the properties of the fermented substances.

Assignment 2
Explain the production steps of bio-based fuels.

Annex 2: Biofuels production in Laboratory

The fruit waste is collected in the container and broken down thoroughly with the help of the blender. The water from the fruit waste is filtered by the filter fabric and funnel and separated from the solid parts by the physical methods. 1: 1 boiled and cooled (distilled) water is added. The mixture is added into glass jars with sterilized mouth lids. 20 gr. of dry yeast (Saccharomyces cerevisiae) is added to the jars and mixed well to dissolve. The opening of the jar is filled with no gaps. The jars are left in a dark and cool environment for 4-5 weeks. After the fermentation, the pure biofuel is separated from the mixture in the process of distillation.