The BLOOM School Box

Learning Scenario

Let's talk about bioenergy and our lives!

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.

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Table of contents

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Learning scenario summary

This learning scenario introduces students to the general concept of bioeconomy and bioenergy. Students research the impact of fossil fuels and bioenergy and how their daily decisions about energy will affect their quality of life, personally and globally.

Subject	**Physics, Technology, Engineering, Environmental Education, Chemistry, Statistics**
Topic	**Bioeconomy, bioenergy**
Age of students	**11-15**
Preparation time	**60 minutes**
Teaching time	**3 classes of 50 minutes**
Online teaching material	• Draw.io / MindMup / Canva / any mind map software • Google forms • Google Docs / OneDrive • Canva • Padlet • Edmodo
Offline teaching material	Drawing materials (pens, pencils, markers, etc.) Graph paper or millimetre paper
Bioeconomy resources used	• http://ecologicalfootprint.com/ • https://footprintcalculator.henkel.com/en • https://www.footprintnetwork.org/resources/ (Global Footprint Network) • https://wcshumanfootprint.org/ (Dryad Digital Repository - Global terrestrial Human Footprint maps for 1993 and 2009) • https://www.youtube.com/watch?v=RfRN_hHeIKk • https://www.youtube.com/watch?v=RKlUiaNhYDU (Bioenergy Explained. The work of EBRI at Aston University) • https://www.youtube.com/watch?v=rhRc7PHt2NE (Sustainable Bioenergy) • https://www.energy.gov/eere/bioenergy/educational-resources-bioenergy-classroom • https://www.ieabioenergy.com/wp-content/uploads/2013/10/13_task38faq.pdf • http://www.bio-step.eu/ • https://www.energy.gov/eere/education/downloads/cell-wall-chemistry-biofuel

- https://news.nationalgeographic.com/2016/08/human-footprint-map-ecological-impact/
- http://www.earthrangers.org/wp-content/uploads/2016/08/how_big_is_my_ecological_footprint.pdf
- https://www.nrel.gov/docs/gen/fy08/42236.pdf
- http://www.ei.lehigh.edu/learners/energy/biofuels/biofuels2.html
- http://learnbiofuels.org/biofuels-lessons
- https://www.energy.gov/eere/bioenergy
- https://www.energy.gov/education-toolbox/search?f%5B0%5D=im_field_topic_term%3A349
- https://www.shell.us/sustainability/energize-your-future-with-shell/stem-classroom-activities.html
- https://eli.lehigh.edu/

Relevant trends

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

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

Collaborative Learning: a strong focus on group work.

Flipped Classroom: students master basic concepts of topic at home. Time spent in classroom is used to reflect, discuss, develop topic.

Mobile Learning: we get access to knowledge through smartphones and tablets. It is learning anytime, anywhere.

Peer Learning: students learn from peers and give each other feedback

STEM Learning: Increased focus on Science, Technology, Engineering, Mathematics subjects in the curriculum

BYOD: students bring their own mobile devices to the classroom.

Aim of the lesson

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

The aim of this lessons is to encourage and enable students to evaluate the environmental and social impacts of energy and bioenergy. They will investigate and understand the

interdependence of science, technology and society, including benefits, limitations and implications.

In these lessons, the students are introduced to the bioeconomy in general and to bioenergy in particular. The students research the impact of fossil fuels and bioenergy and how their daily decisions about energy will affect their quality of life, personally and globally.

Activities

Name of activity	***The detailed description of the activity***	***Time***
Orientation	Students are introduced into the bioeconomy and bioenergey watching the following videos: 1. https://www.youtube.com/watch?v=RfRN_hHeIKk (Bioeconomy – The next phase of economic development) 2. https://www.youtube.com/watch?v=2xvXkOMRTs4 (The Bioeconomy starts here!) 3. https://www.youtube.com/watch?v=RKlUiaNhYDU (Bioenergy Explained. The work of EBRI at Aston University) Students learn about bioeconomy and the human footprint and to what extent humans have influenced Earth. They use data from Dryad Digital Repository to study the human footprint on Earth (https://wcshumanfootprint.org/). In 2002 the Wildlife Conservation Society has published the first comprehensive human footprint analysis. The authors (Venter O. et al) used various kinds of satellite data to analyse eight different categories of human impacts, including the extent of built environments, cropland and pasture land, population density, night time lights, roads, railways, and navigable waterways. Each category was scored according to its impact on the environment relative to the other categories. Students discuss with the teacher and peers based on the following questions: 1. What areas are less impacted by human activity? 2. In which area is the degree of human impact greatest? 3. Which categories of human impact are likely to change over time? 4. Will areas with lower degrees of human impact remain this way? 5. What connections can you make between areas of greater impact and geographic factors such as climate or physical landscape?	30 minutes

Name of activity	***The detailed description of the activity***	***Time***
	The students are organized into groups.	
Conceptualisation	Students learn more about the concepts related bioenergy watching the following video and writing down all the concepts and keywords that they think are related to the topic: 1. https://www.youtube.com/watch?v=rhRc7PHt2NE (Sustainable Bioenergy) Students discuss with the teacher and peers based on the following questions: 1. What is energy? What is bioenergy? What is biomass? What is biofuel? 2. What are different types of biofuels? (Biodiesel, sugarcane ethanol, cellulosic ethanol, corn ethanol, algal biofuel etc.) 3. What are the advantages and disadvantages of biofuels? 4. What are the environmental impacts of bioenergy? The teacher presents the inquiry question: Which biofuel is the best?	20 minutes
Investigation	Students establish the toolkit criteria for each type of biofuel: sources, obtain method, density, flash point, kinematic viscosity, calorific value, solubility in water etc. Then they proceed by carrying out their investigations and collecting data and information. Students discuss with the teacher and peers how they will carry out their investigation in order to confirm or reject their hypothesis. Every team will investigate one type of biofuel according to the criteria established.	40 minutes
Conclusion	In this phase the students will use the concepts they learned in the previous phases in order to create a concept map about bioenergy and biofuels. Students discuss with the teacher about the conceptual map which they created collaboratively online in Draw.io (or OneDrive, Google Drive, MindMup, etc). Students will use their previous work (information, hypothesis, data etc.) and form the conclusions. Each group has to make a poster (using Canva, Google Drawing etc.) about their conclusions.	40 minutes
Discussion	Students share their conclusions. This involves either describing, evaluating and discussing the whole process of investigation or just a specific phase. Each group presents their findings to the rest of the class.	20 minutes
Extension	Students divided into teams will test the ability of yeast to ferment different biomass (Annex 4). After two weeks, based on the experiment, they will decide which biomass type would they choose, and why.	2 weeks

Assessment

What are the main types of assessment used?

Pre-Assessment:

1. KWL chart (Annex 1)
2. Bioeconomy Vocabulary

Formative assessment:

1. **3-2-1 Countdown** (Annex 2)
2. **Daring Doodles:** Challenge students to use a drawing rather than words to show their understanding of a concept. This exercise helps those who have difficulty speaking out in class.
3. **Peer/Self Assessments:** Two stars and a wish (Annex 3)
4. **Exit Ticket:** students can fill in an evaluation form created by the teachers. This method preserves their anonymity. Questions could be:
   - What's one important thing you learned in class today?
   - Did you feel prepared for today's lesson? Why or why not?
   - What would help make today's lesson more effective?

Summative assessment:

1. Self-evaluation rubric
2. Collaboration rubric
3. Scoring rubric for Mind Maps
4. Poster rubric

Annexes

Annex 1: KWL chart

Name _____ Date:_____

KWL Chart

Before you begin your research, list details in the first two columns. Fill in the last column after completing your research.

TOPIC:		
What I Know	*What I Want to Know*	*What I Learned*

Annex 2: 3-2-1 Countdown

Name _____ Date_____

1. **Three** things you learned:

2. **Two** things that interest you that you'd like to learn more about:

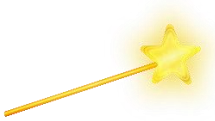
3. **One** question you still have:

Annex 3: Two stars and a wish

Two stars and a wish[1]

Task: Use the two stars and the wish box to tell:

- Two things you really liked about your work
- One thing that you wish could be improved

[1]Image by OpenClipart-Vectors and by Angeles Balaguer from Pixabay.

Annex 4: Student laboratory worksheet

Student laboratory worksheet[2]

Which biomass is the best source of energy?

Team: _____
*Name:*_____
Date: _____

AIM:

MATERIALS:

- *different types of biomass (corn kernels, soybeans, sugar, fruit, potatoes, paper, cooking oil, etc.)*
- *soda bottles (500 ml);*
- *yeast, 2 grams per bottle;*
- *balloons, one per bottle;*
- *calculator;*
- *measuring tape;*
- *scale;*
- *mortar and pestle.*

PROCEDURE

Step One:

1. With group members, select 5 different types of biomass to test.
2. Label one bottle for each of the different biomass types.
3. Measure and place 2 grams of yeast into each bottle.
4. For each type of biomass, use your grinding instrument and a scale to measure 15 grams. Place the 15 grams of biomass in each respective bottle.
5. Add warm water into each balloon until it starts to expand slightly.
6. Place the balloon on top of the soda bottle so that the warm water goes into the soda bottle and the balloon forms a seal on top.
7. Repeat for each bottle.
8. Mix the ingredients around in each bottle by shaking slightly.
9. Place the bottles in a warm place.
10. Record the size of each balloon with measuring tape.

Step Two:

1. The fermentation process may take several days. Observe the bottles and record what you see each day. You can visually observe the expansion of each balloon or measure each day. You can also record other observations like gas bubbles or differences in the liquid.

Step Three:

1. After about a week, record your final observations for each biomass. Note that the balloon expansion comes from a mix of carbon dioxide and ethanol. To use the by-product for fuel, ethanol must be distilled, but the expansion of the balloon gives you some idea of the amount of ethanol being produced by the fermentation of each biomass.
2. Draw on millimetre paper the histogram of balloons expansion measurements for each biomass.
3. Compare the ethanol production of each biomass.
4. Draw conclusions about which biomass is the best.

[2] https://www.shell.us/sustainability/energize-your-future-with-shell/stem-classroom-activities.html

No.	Biomass	Date	Balloon Expansion Measurement	Additional Observation
5.				
6.				
7.				
8.				
9.				
10.				
11.				

No.	Biomass	Date	Balloon Expansion Measurement	Additional Observation
1.				
2.				
3.				
4.				
5.				
6.				
7.				

No.	Biomass	Date	Balloon Expansion Measurement	Additional Observation
1.				
2.				
3.				
4.				
5.				
6.				
7.				

No.	Biomass	Date	Balloon Expansion Measurement	Additional Observation
1.				
2.				
3.				
4.				
5.				
6.				
7.				

No.	Biomass	Date	Balloon Expansion Measurement	Additional Observation
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Step Four:
Based on this experiment which biomass type would you choose, and why?