

The BLOOM School Box

Learning Scenario

Don't waste your waste! - Raising bioeconomy awareness

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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Learning scenario summary

In this lesson plan, the students will understand the meaning of bioeconomy and how to raise awareness about bioeconomy in their community.

First, the students will explore the basics of bioeconomy through videos, discussions, online materials, and games (Lesson 1).

Afterwards, they will produce and test a bio-product carrying out a scientific experiment using renewable resources from their local community (Lesson 2).

They will also explore careers in the bioeconomy sector, by using online materials and by having a visitor working in the bioeconomy sector holding a presentation for them (Lesson 3). If possible, a visit to a local bioeconomy sector company will be organised.

Next, the students will test their product and organise a public presentation of their findings in order to raise awareness about bioeconomy in an “open day” event (Lessons 4 & 5). For this purpose, they will prepare a scientific poster, a presentation, flyers, and sell their bio-products to raise money for the school.

Subject	STEM
Topic	Raising Bioeconomy awareness through STEM activities
Age of students	12-16
Preparation time	1 - 2 days
Teaching time	11 to 12 class periods (4-5 weeks)
Online teaching material	<ul style="list-style-type: none"> • Kahoot • http://www.soe.uoguelph.ca/webfiles/agalvez/poster/step4_detail.pdf • https://www.ncca.ie/media/3446/colab_guidelinesforassessingcollaborativelearning_2018_pub.pdf • http://www.lapresenter.com/CoopEvalPacket.pdf
Offline teaching material	White vinegar, citrus peels, strainer, filter funnel, cup, airtight glass containers, plastic bottles, volumetric cylinder, distilled water, pieces of fabric, commercial cleaner (detergent), scales
Bioeconomy resources used	<ul style="list-style-type: none"> • http://www.bio-step.eu/fileadmin/BioSTEP/Bio_documents/BioSTEP_Flyer_final_email.pdf flyer on bioeconomy • https://www.youtube.com/watch?time_continue=52&v=2xvXkOMRTs4 video on bioeconomy “The bioeconomy starts here!” • https://www.youtube.com/watch?time_continue=26&v=ir3MgOSmvLg video on bioeconomy “The bioeconomy in our everyday lives”

- <http://www.fvaweb.eu/biochallenge/> online quiz for understanding the meaning of bioeconomy
- <http://www.fvaweb.eu/biowhat/> online game for understanding the meaning of bioeconomy
- <http://www.bioways.eu/>
- <http://www.bioways.eu/bio-learn/applications-factsheets/> examples of bio products
- https://www.youtube.com/watch?time_continue=53&v=XX6911pSoKg video on bioeconomy careers
- <https://www.energy.gov/eere/bioenergy/bioenergy-career-map> bioenergy career map
- <https://bloom-bioeconomy.eu/schoolnetwork/schoolbox/> bioeconomy-related school lessons

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
- **Edutainment:** Playful learning
- **Peer learning:** Students learn from peers and give each other feedback.
- **STEM Learning:** Increased focus on Science, Technology, Engineering, Mathematics subjects in the curriculum

Aim of the lesson

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

Students will:

- understand the meaning of bioeconomy
- explore careers in the bioeconomy sector
- conduct a research on renewable and non-renewable resources in their local community
- develop an understanding of the scientific method
- work cooperatively in groups
- produce a product based on the principles of bioeconomy
- create a scientific poster describing the experiment, the product, and their findings.
- hold a presentation about their findings and the product they made in order to raise awareness regarding bioeconomy in an “open day” event

Activities

<i>Name of activity</i>	<i>The detailed description of the activity</i>	<i>Time</i>
<p>Lesson 1: Introduction to bioeconomy</p>	<p>STEP 1: Introduction (15 min)</p> <p>The teacher will start the lesson by bringing oranges to the classroom and inviting students to make orange juice in order to get a boost of vitamin C. Since the activity will result in a large amount of orange peel that is supposed to be thrown away, the teacher will ask the students whether they can think of alternative solutions for handling the waste, rather than throwing it away. The teacher will then provoke the discussion about organic waste and reusable resources with the class being introduced to bioeconomy through the "Bioeconomy starts here!" video.</p> <p>STEP 2: Understanding bioeconomy (20 min) (Worksheet 1)</p> <p>Students will form groups of 5 and will be provided with the Worksheet 1 (see Annex I). For younger students, the teacher will assign one question per group (the students could be asked to choose a folded paper from a box in order to randomly choose their question). For older students, they can decide in their groups which members will be responsible for answering which question. They will all together watch again the video on bioeconomy but this time focused on answering the specific questions. (Ideally each group will have a device on which they can replay the video as many times as necessary.) The students will have 10 minutes to discuss the questions in groups and clearly write down their answers, which will be discussed with the rest of the class. (total 20 min)</p> <p>STEP 3: Bioeconomy in our lives (30 min) (Worksheet 2)</p> <p>Students will watch a second video, "The bioeconomy in our everyday lives", and will be given a question to answer in their groups while doing this (see Annex II), and a similar discussion will follow (10 min).</p> <p>The students will be asked to work on one of the following options (depending on age):</p> <p>Option 1: Students will carry out an online research of the webpage mentioned in the video to find out more about bioeconomy. After 10 minutes, they will share with the rest of the</p>	<p>(90 min) 2 classes</p>

<i>Name of activity</i>	<i>The detailed description of the activity</i>	<i>Time</i>
	<p>class what impressed them the most, including products they didn't know can be made from natural resources.</p> <p>Option 2: The teacher can have print-outs of several fact sheets which give examples of bioeconomy products and distribute them to the groups of students who need to go through all of them and pick three that influenced them the most and share it with the rest of the groups. The sheets can be downloaded here. The students can make their notes in Worksheet 2. The discussion and sharing of ideas will last for another 10 minutes.</p> <p>Possibility for homework:</p> <p>The teacher can also distribute the following flyer to provide students with more information about bioeconomy which they can discuss at home and report the results of their family knowledge about bioeconomy to the class.</p> <p>STEP 4: Playful assessment of our knowledge about Bioeconomy (15 min) (Online quiz, Kahoot game)</p> <p>Finally, the students will fill in an online quiz about bioeconomy (http://www.fvaweb.eu/biochallenge/). The answers will be discussed in the class with the teacher. Alternatively, for younger students a set of multiple-choice questions can be created by the teacher in the Kahoot online platform, so that students can answer them in a playful way at the end of the lesson for assessing their understanding of bioeconomy. In addition, younger students can play with this fun online game especially designed for understanding bioeconomy.</p> <p>STEP 5: Planning the following steps (10 minutes)</p> <p>The question remains: What can we do with the orange peels from the beginning of the lesson? The teacher will explain that one can make a bio-cleaner using orange (and citrus, in general) peels together with vinegar, which are both organic resources, and this experiment will take place in the class. The rest of the course can be presented by the teacher so that the students know what to expect.</p> <p>Extension: In this lesson, other bio-products in addition to the bio-cleaner suggested here can be used, and different groups can work on creating different bio-products depending on their age and their abilities. The teachers can find other bio-products that could be created in class. You can find such examples in the BLOOM School Box. Before next lesson, the students will go to the</p>	

Name of activity	The detailed description of the activity	Time
	<p>school restaurant to collect the citrus peels and put them in an airtight container which can be organized in the last step of the first lesson.</p>	
<p>Lesson 2: Creating a bio-product</p>	<p>In this lesson students will create a bio-product by using food waste from the school restaurant and vinegar. During this process they will have to design and conduct a scientific experiment, following the scientific method.</p> <p>Materials & equipment</p> <ul style="list-style-type: none"> • White vinegar, citrus peels, strainer, filter funnel, cup, airtight glass containers, plastic bottles, volumetric cylinder, distilled water, pieces of fabric, commercial cleaner (detergent), scales <p>Overview</p> <ul style="list-style-type: none"> • Collect and store citrus peels into airtight jars • Cover the peels with white vinegar • Wait for 2 weeks to get ready. The vinegar should be yellow and have a citrus odor • Strain the peels • Fill the bottle with the detergent <p>Procedure</p> <p>In order to complete the experiment, students will work in groups with WORKSHEET 3 - CREATING A BIO - PRODUCT (BIO - CLEANER) (see Annex III).</p> <p>The collected citrus peels are stored in the airtight glass containers and covered with white vinegar. Students keep a scientific diary with the starting day of their investigation and details about the ingredients they have used, ideas, observations, brainstorming notes, questions that they might want to explore during the following two weeks. Once a week they must weigh their cleaner and observe changes in colour. Students are asked to describe in detail the bio-cleaner production. The bio-cleaner takes at least two weeks to be ready. In the meantime, the students will explore careers in the bioeconomy sector.</p>	<p>(45 min) 1 class</p>
<p>Lesson 3: Exploring bioeconomy careers</p>	<p>In this lesson students will explore the opportunities arising from the green jobs of the future. A cluster of job titles will be explored,</p>	<p>(90 min) 2 classes</p>

Name of activity	The detailed description of the activity	Time
	<p>and the related skills will be discussed. The students will work in groups again.</p> <p>STEP 1: Biobased Economy - Potential in the Land (15 minutes)</p> <p>The teacher will hand over a set of questions to the students to answer while watching a video (see Worksheet 4 in the Annex IV) several times. In the end the groups will discuss their answers. (Again, for younger groups of students the groups can choose to work on a single question each.)</p> <p>STEP 2: My bioeconomy career map (30 minutes)</p> <p>The students will be asked to explore this online tool in which they will get the opportunity to find out about specific jobs in the bioeconomy sector. They will also see that no matter which career cluster they choose, and whatever their interests, there is always a way to work in bioeconomy. Afterwards, the following task will be assigned to the students:</p> <p>Come up with one or two possible careers options that you are interested in and present it to the rest of the class in a one-minute presentation including:</p> <ul style="list-style-type: none"> ● job title ● the description of the job ● why did you choose it ● what appeals to you most at this specific job <p>STEP 3: Invited professional from the bioeconomy sector (45 minutes)</p> <p>The teacher can show examples of bioeconomy sectors in the local community (here is an example from Greece, available on Facebook only) and an expert from that sector will be invited to present their work and to explain the conditions of starting a career in bioeconomy. A visit to the place of work can also be organized, which is strongly suggested. This can be organized in between the lessons.</p>	
<p>Lesson 4: Checking the product, and writing down the process</p>	<p>Materials & equipment:</p> <ul style="list-style-type: none"> ● Volumetric cylinder, Distilled Water, Pieces of fabric, Commercial cleaner (detergent) 	<p>(180 min) 4 classes</p>

<i>Name of activity</i>	<i>The detailed description of the activity</i>	<i>Time</i>
	<p>STEP 1: Creating bio-cleaners in different solutions (Worksheet 5-Annex V) (45 min)</p> <p>After 2 weeks the students will strain the peels and dilute the detergent with water and make solutions in different concentrations. In order to do this, they will be divided in groups and each group will try to dilute the solute (detergent) with different amounts of water. They will use mathematics to calculate the volume percent (volume / volume %) concentrations of their solutions.</p> <p>They will also learn, or revise (depending on age) the chemistry terms solute, solvent and solution and distinguish homogenous and heterogenous solutions. They will also be introduced to (depending on age) the concentration units mass percentage, volume percentage, parts per million (ppm) and parts per billion (ppb). Students are asked to answer the question why we use the volume percentage concentration unit in our calculations.</p> <p>STEP 2: Testing the effectiveness of the bio-cleaners (Worksheet 6) (45 min)</p> <p>Each group will keep their cleaners in separate bottles. In order to test the quality of the cleaner, each group will have to design an experiment. The detailed steps of this experiment are described in Worksheet 6 in the Annex VI.</p> <p>STEP 3: Creating a scientific poster (90 min)</p> <p>In the same groups the students will work on creating scientific posters to explain the experiment and what the results are. The best poster will be presented to the public during the “open day” that will be organized in the next lesson. The following resources will be used to help students with creating their posters:</p> <ul style="list-style-type: none"> • https://guides.nyu.edu/c.php?g=276826&p=1846154 • http://www.soe.uoguelph.ca/webfiles/agalvez/poster/ • http://www.soe.uoguelph.ca/webfiles/agalvez/poster/step_4_detail.pdf <p>The level of assistance from the teacher depends on the age of students. The students should have at least 1-2 periods in class to work on their posters, and possibly to spend some time outside the class. When the posters are ready, a peer assessment session will take place using this assessment tool. Each group will be given a poster from a different group and will be asked to check the</p>	

<i>Name of activity</i>	<i>The detailed description of the activity</i>	<i>Time</i>
	boxes in the assessment tool by judging the poster. The poster that ticks most boxes will be chosen to be presented in the “open day”.	
<p>Lesson 5:</p> <p>Organising an “open day” for the public in order to raise awareness about bioeconomy</p>	<p>In this lesson the students will organize the “open day” and prepare the agenda for the event. Together with the teacher, the class comes up with a potential date and schedule for the event and each group is assigned to their roles. (The group tasks can be adjusted depending on the number of groups and the age.)</p> <p>Group 1 tasks:</p> <ul style="list-style-type: none"> • Create an invitation in which you describe very briefly what the “open day” is about. (the aim is to describe the purpose and the main theme of the day, and possibly advertise a bio-cleaner product that was made by the students which can be bought) • Create a poster for advertising the event <p>Group 2 tasks:</p> <p>(The group of which the scientific poster was chosen to be displayed)</p> <ul style="list-style-type: none"> • Setting up the poster and, taking turns, presenting its content to the visitors. The students should prepare their presentation schedule (who presents which part and how) <p>Group 3 tasks:</p> <ul style="list-style-type: none"> • Presenting and displaying the actual product during the “open day” (explaining its purpose and the process of making) • Selling the product (if possible) to raise money for the class <p>Group 4 tasks:</p> <ul style="list-style-type: none"> • Creating informative leaflets and posters about bioeconomy • Preparing a presentation for the public describing bioeconomy is and how it affects our lives, and what are the possibilities for the future 	<p>(90-135 min) 2-3 classes</p>

Assessment

What are the main types of assessment used?

- Scientific poster assessment:
http://www.soe.uoguelph.ca/webfiles/agalvez/poster/step4_detail.pdf
- Understanding of bioeconomy assessment: Kahoot will be used to create some multiple-choice questions about bioeconomy
- Group work assessment: students will be assessed for their participation in group work and for their participation in organizing the event by using appropriate rubrics
https://www.ncca.ie/media/3446/colab_guidelinesforassessingcollaborativelearning_2018_pub.pdf
<http://www.lapresenter.com/CoopEvalPacket.pdf>
- Scientific experiments assessment: the worksheets of the students will be assessed by the teacher using appropriate rubrics according to age.

Annexes

Annex I:

WORKSHEET 1 - BIOECONOMY STARTS HERE!

Student name(s):

Watch the video [Bioeconomy Starts here!](#), and try to answer the following questions in your groups:

1. What is fossil-fuel and what are we making that is based on fossil fuels?
2. Why can't we rely on fossil fuels for much longer?
3. What alternative energy resources exist?
4. What is bioeconomy?
5. What are the positive changes in our lives that can be achieved by using bioeconomy?

Annex 2:

WORKSHEET 2 - BIOECONOMY IN OUR EVERYDAY LIVES

Watch the video [Bioeconomy in our everyday lives](#), and try to answer the following questions in your groups:

Student name(s):

Which everyday products that can be made from natural resources are mentioned in the video? Make the list of the products and the natural resource they are made from. If you know and/or have used any other products feel free to add them to the list!

Product	Resource
1.	
2.	
3.	
4.	
5.	
6.	
7.	

8.	
9.	

Annex 3:

WORKSHEET 3 - CREATING A BIO - PRODUCT (BIO - CLEANER)

Student name(s):

PROCESS STEPS:

1. **Collect and clean** an appropriate amount of citrus peels.



2. **Weigh** the citrus peels and **write down** the weight in **kg**:

.....

3. **Estimate** the amount of peels in **kg** that would be collected in the school restaurant in a month and in a year. Show your calculations. Comment on the result.



.....
.....
.....
.....

4. **Put the peels** into a plastic bottle of 500 to 1000 ml. **Fill it** with white vinegar. **Write down** the volume of the vinegar that you use **in ml**:

.....

5. **Close the bottle** firmly and keep it in a dark storage space **for two weeks**. Avoid exposing it to the sun.

6. Write down the **starting date** of your experiment:

.....

7. **Describe in detail** the color and odor of the solution:

Citrus peels color:

Vinegar color:

Solution odor:

Describing aroma guide - HOW DOES IT SMELL?

Anosmic - odorless, no smell at all.

Aromatic - sweet smell, pungent, usually pleasing - it is not odorless and unscented.

Comforting - pleasant aroma.

Delicate - subtle, faint, fine, elusive, tantalizing - never overpowering.

Fetid - rotten, smelly, moldy, smell of decomposing food - it does not smell fresh.

Fresh - the aroma is clean, clear, cool, refreshing, sweet and new - the smell does not feel insalubrious, moldy, stale or worse.

Heady - strongly aromatic, pungent, rich, intoxicating, spicy, piquant - not a mild smell.

Malodorous - scented, aromatic, redolent, fragrant, stinking.

Muscadine - something with the sweet aroma of this type of grape.

Odoriferous - it has a strong smell.

8. **Keep filling in information** on your observations in the following table. (Start today, revisit after one week, revisit after two weeks.)

Starting Date:	
Citrus peels colour:	
Vinegar colour:	
Solution odour:	
End of first week date:	
Citrus peels colour:	
Vinegar colour:	
Solution odour:	
End of second week date:	
Citrus peels colour:	

Vinegar colour:	
Solution odour:	

REFERENCES

Lemon peel Free PNG and Clipart https://pngtree.com/freepng/lemon-peel_1767704.html

Water bottle free image <http://clipart-library.com/clipart/845902.htm>

Describing Aroma <https://world-food-and-wine.com/describing-aroma>

Annex 4:

WORKSHEET 4 - BIOECONOMY CAREERSStudent name(s):

Watch the video [BioBased Economy - Potential in the Land](#), and try to answer the following questions in your groups:

1. What does “sustainable future” mean? Is there a need for a sustainable future? Why?
2. Could you implement bioeconomy in your preferable career? How?
3. Which future jobs are mentioned in the video and how are they related to bioeconomy?
4. Can you think of other jobs related to bioeconomy? List them here.

Annex 5:

WORKSHEET 5 - CREATE Bio-Cleaners in different solutions

Student name(s):

During this lab, we will dilute our bio cleaner and make the final bio products!

PROCESS STEPS:

A. Answer the following questions and get ready for action!

A1. You will use the bio-cleaner you have already produced and distilled water to make solutions with different concentrations.

Define which one is the solute and which one is the solvent:

Solute: Solvent:

B. Make detergent solutions with specific concentrations.

B. 1 Take a volumetric cylinder of **200 ml**. Dilute **50 ml** of the bio cleaner with water up to **100 ml**. Write the volume of solvent, solute and solution. Calculate the volume percent of your solution using the formula:

$$C = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100\%$$

Volume of solvent:	
Volume of solute:	

Volume of solution:	
$c = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100\%$	

B.2 Take a volumetric cylinder of **200 ml**. Dilute **80 ml** of the bio cleaner with water up to **200 ml**. Write the volume of solvent, solute and solution. Calculate the volume percent of your solution using the formula: $c = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100\%$

Volume of solvent:	
Volume of solute:	
Volume of solution:	
$c = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100\%$	

C. Label each of your bio-cleaner solutions, writing the volume percent.

Annex 6:

WORKSHEET 6 - TEST the Cleaner's performance

Student name(s):

Now it is time to test the effectiveness of your product against standard commercial cleaners!

PROCESS STEPS:

A. Stain a small piece of fabric with chocolate milk, tomato juice, mud and ink. Cut the fabric in two pieces, so that each piece has some stain on it. Test the bio-cleaner on one of the pieces, and a commercial cleaner on the other piece.

B. Design and Describe your experiment about cleaner's performance by answering the following questions.

B1. You want to compare your bio cleaner's efficiency. Is it essential to follow the same steps for both the cleaners?

B2. What should you consider during the experiment?

Amount of water:

Water temperature:

Amount of the cleaner:

Washing period (in minutes)

B3. Decide what are your steps to follow and fill in the table below.

You need to keep the same methodology for both cleaners.

Variables:	Type of stain:

C. State your hypothesis regarding the effectiveness of the cleaners:

D. Conduct your experiment and note down your data.

E. Compare the cleaner's performance

How well does each cleaner perform? Mark the performance using the rate 0-5 (0: did not clean the stain at all - 5: cleaned the stain).

Stain	Bio - cleaner performance (0-5)	Commercial - cleaner performance (0-5)

F. Suggest any corrections / improvements on your testing procedure.