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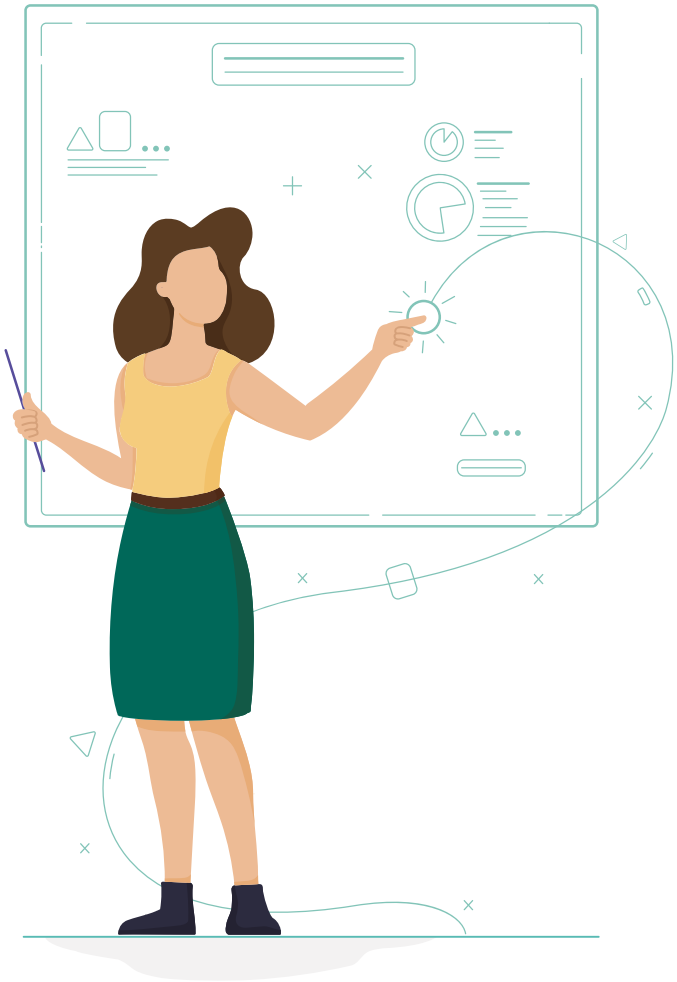

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Girls Go Circular

Teacher Guidebook Part 1:
Introduction to the Project and the Circular Learning Space

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1. What is the Girls Go Circular project?

According to the European Commission's Women in Digital Scoreboard 2019, women represent only **34%** of STEM graduates *(Science, Technology, Engineering and Mathematics)* and **18%** of ICT specialists[1] (Information and Communications Technology).

The **Girls Go Circular** project aims to equip at least **40,000** schoolgirls aged 14-19 with digital and entrepreneurial skills by 2027 through an online learning programme on the circular economy. The project supports *Action 13 – Encourage women's participation in STEM* of the European Commission's Digital Education Action Plan[2] and contributes to closing the gender gap when it comes to the number of women active in the digital and entrepreneurial sectors in Europe. Dismantling gender stereotypes and raising awareness of the opportunities that STEM disciplines offer is crucial to change the current perception of the digital industry and STEM disciplines amongst girls and young women. This endeavour will not only contribute to a more inclusive Europe but also invite innovative perspectives, leading to better opportunities for everyone.

At the core of the project is the **Circular Learning Space (CLS)**. An online learning platform including multiple modules that impart digital skills while exploring the circular economy from different angles. While the activities proposed challenge students to use digital tools to complete assignments, the focus on the circular economy provides knowledge about the big challenges of our time, empowering students to become agents of change in the socio-ecological transition.

[1] https://digital-strategy.ec.europa.eu/en/library/women-digital-scoreboard-2020
[2] https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en

- Although the project focuses on girls, boys are also invited to participate in the learning programme, especially in mixed learning environments: we all learn together to deconstruct gender stereotypes and biases, and we all need digital skills for our lives and careers. When presenting the project activities to a mixed class environment, your male students might ask you: why only girls? Is the project excluding us? This is an understandable reaction and an excellent opportunity to address the topic. While it is needed that the project targets specifically girls to shed light on the problem and deconstruct gender stereotypes, it will have a greater impact if girls and boys work together to build a fairer and more equal society.

1.1 Project's objectives and Scope

The Girls Go Circular project aims to:

- Substantially contribute to EU gender diversity policy objectives by equipping girls with digital and entrepreneurial competencies. The project aligns with the EU Digital Competences Framework 2.2[3], the European Entrepreneurship Competence Framework (EntreComp), and the European Sustainability Competence Framework (GreenComp).
- To: Improve students' digital skills in alignment with proficiency levels 1-8 of the EU Digital Competence for Citizens Framework 2.2.[3]
- Teach the competencies needed to tackle sustainability challenges and support girls aged 14-19 in understanding the role of STEM disciplines in fostering sustainability.
- Advance digital education in the EU by complementing school curricula and supporting teachers with tools to facilitate learning in the classroom.

We encourage teachers to discuss gender equality with the students and to help them understand the importance of supporting the essential goal of closing the gender gap.

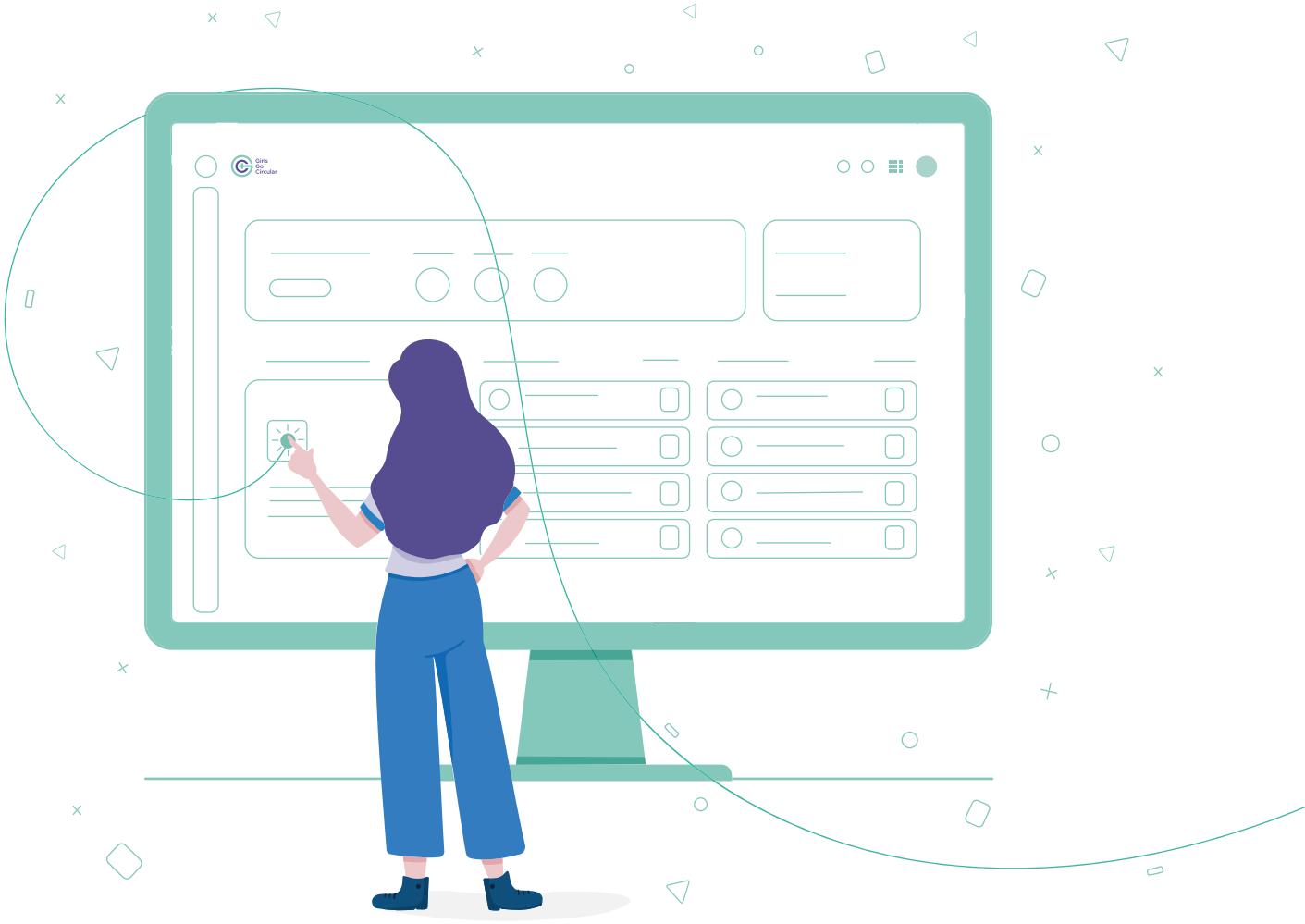
Having mixed working groups can lead to more efficient work. Collaboration between boys and girls can contribute to deconstructing gender stereotypes and biases in both groups.

[3] https://ec.europa.eu/social/main.jsp?langId=en&catId=89&newsId=10193&furtherNews=yes

2. Introduction to the Circular Learning Space (CLS)

The Circular Learning Space is an open-source online learning management system. It offers learners the opportunity to work individually and in groups during online and in-person sessions. Furthermore, the CLS encompasses interactive learning modules on the circular economy, including entrepreneurial roleplays and challenge-based exercises to develop digital and entrepreneurial skills. To that end, the CLS offers a mix of videos, podcasts, learning materials and group challenges. In addition, the CLS supports teachers in conducting interactive and motivating classes, allowing them to easily follow students' progress on developing entrepreneurial and digital competencies.

The following paragraphs describe how to use the CLS successfully.



2.1 How to Join the Circular Learning Space?

The Circular Learning Space is an open-source tool - anyone can create an account and start learning. However, if you would like to join the CLS as a teacher and work with your students, the following steps are required:

Write an email to **girlsgocircular@eitrawmaterials.eu** requesting access to the platform, and we will generate a unique URL for your school/institution.

Then, using this special link, you can create your account and inform us about that. We will manually give you special teacher's rights on the platform. Through your teacher profile, you will be able to monitor your students' progress.

Following this, you will have to share this URL with your students and ensure that they use only this link to register for the platform. By using specifically this link, they will be automatically assigned to your school, which will give you the ability to monitor their progress.

- N.B. If your school is part of the project's outreach campaign promoted in collaboration with **Junior Achievement**, the JA staff in your country will collect your teacher data and send it to the project team on behalf of your school. You do not need to contact the Girls Go Circular team separately.

- Once you join the platform, you can explore the different learning modules. If you would like to start exploring the platform independently, you can also create a learner profile **here**.

- Some of the training activities require the use of additional apps to complete individual or group tasks. These might be, for example, a **Padlet** board to brainstorm or a **Prezi** canvas to prepare a presentation. We recommend that teachers familiarise themselves with these tools before starting the work with the students. The list of all the apps needed for each learning module can be found in the Teacher Guidebook Part 2, Chapter **1. Introduction to the Learning Modules.**

2.2 A Walk Through the Circular Learning Space

We encourage teachers to familiarise themselves with the platform in advance of the classwork. You can find a detailed description of the learning modules in the Teacher Guidebook Part 2, Chapter 1. Introduction to the learning modules. When working with students, teachers should also log in and progress through the navigation with them.

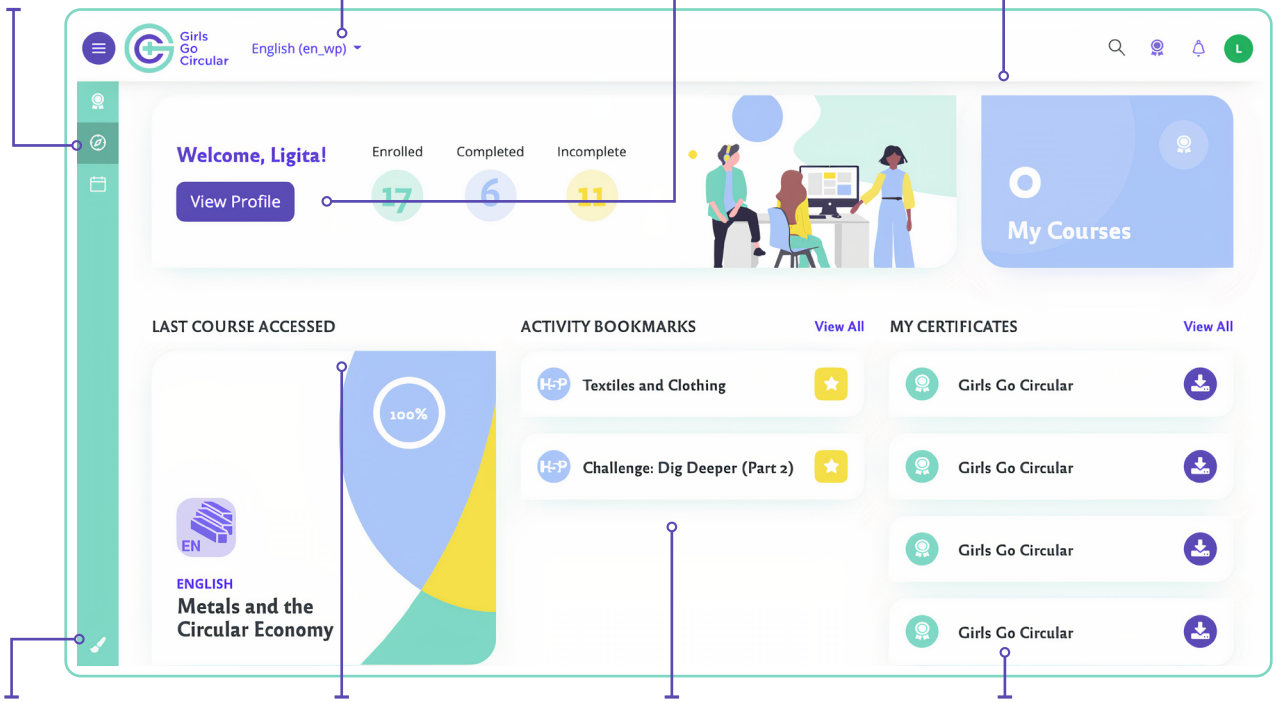
Here is an example of the dashboard view of the Circular Learning Space. This looks the same for every user.

Navigation bar
In this section you can find shortcuts to navigate the platform. This icon will always remain visible. You can come back to his page anytime by clicking on the compass icon

Language Menu
Here users must select their preferred language for the navigation

View Profile
Here users can see and edit their profile.
NOTE: users cannot interact with each other or view other people's profiles

My Courses
Here users can consult the list of learning modules



Pattern Picker
Here users can pick the preferred colour combination for the platform view

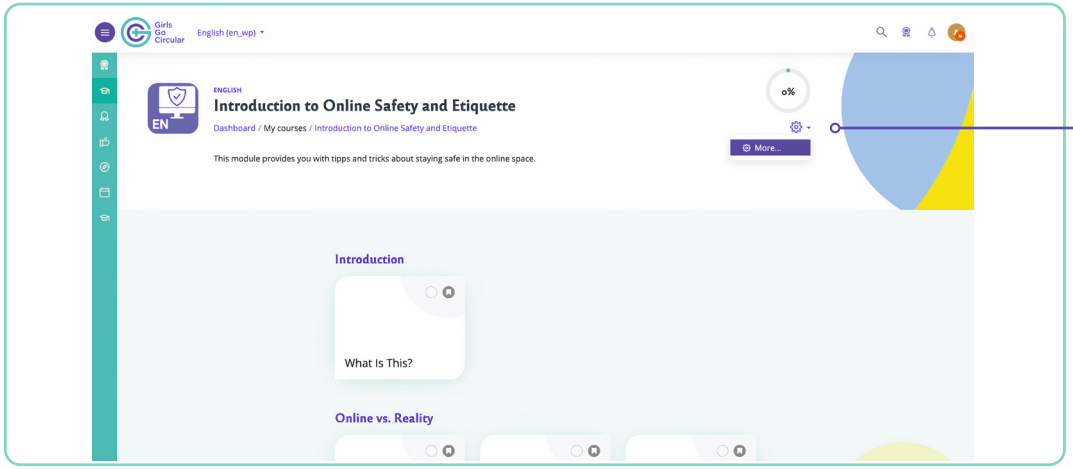
Last Course Accessed
From here users can return to the course they last accessed and continue their work

Activity Bookmark
Users can mark the tasks they would like to come back to, which will appear here

My Certificates
Once students complete a module successfully, they will obtain a certificate, which will appear here

Teachers **(if they follow the registration procedure above)** can monitor students' progress on the platform, as is shown below:

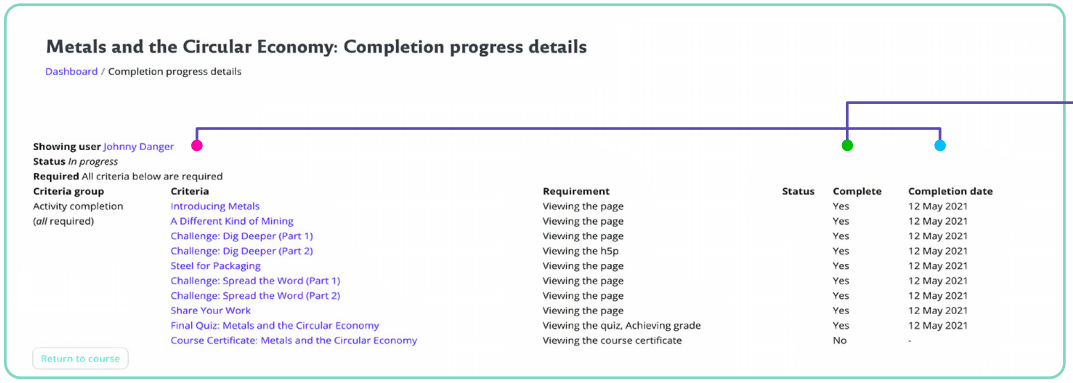
1



Enter a learning module. On the right top corner, you will find this gear icon. Click on it to open the drop-down list:

Course completion
Activity report
Course participation

2

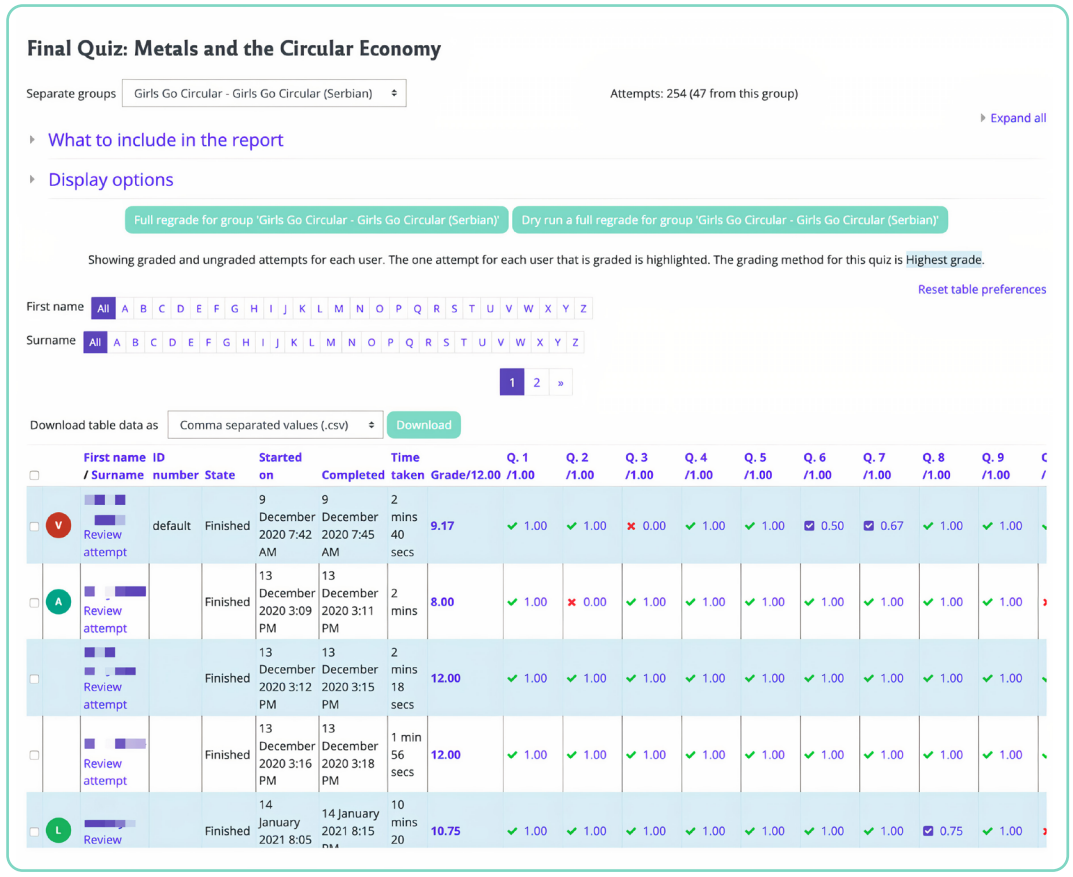


Click on Course Completion to find a list of your students, who have enrolled in the module. You can open each student's profile and check their progress.

Here you can see all the **lessons** of the module, if the students have **completed** them and what **date** they have done so.

You can review the quiz results in detail through the table below. You can monitor the performance of every student: how much time was spent on the quiz, which questions were answered correctly, etc.

3



Final Quiz: Metals and the Circular Economy

Separate groups: Girls Go Circular - Girls Go Circular (Serbian) — Attempts: 254 (47 from this group)

Expand all

- What to include in the report
- Display options

Full regrade for group 'Girls Go Circular - Girls Go Circular (Serbian)' | Dry run a full regrade for group 'Girls Go Circular - Girls Go Circular (Serbian)'

Showing graded and ungraded attempts for each user. The one attempt for each user that is graded is highlighted. The grading method for this quiz is Highest grade.

Reset table preferences

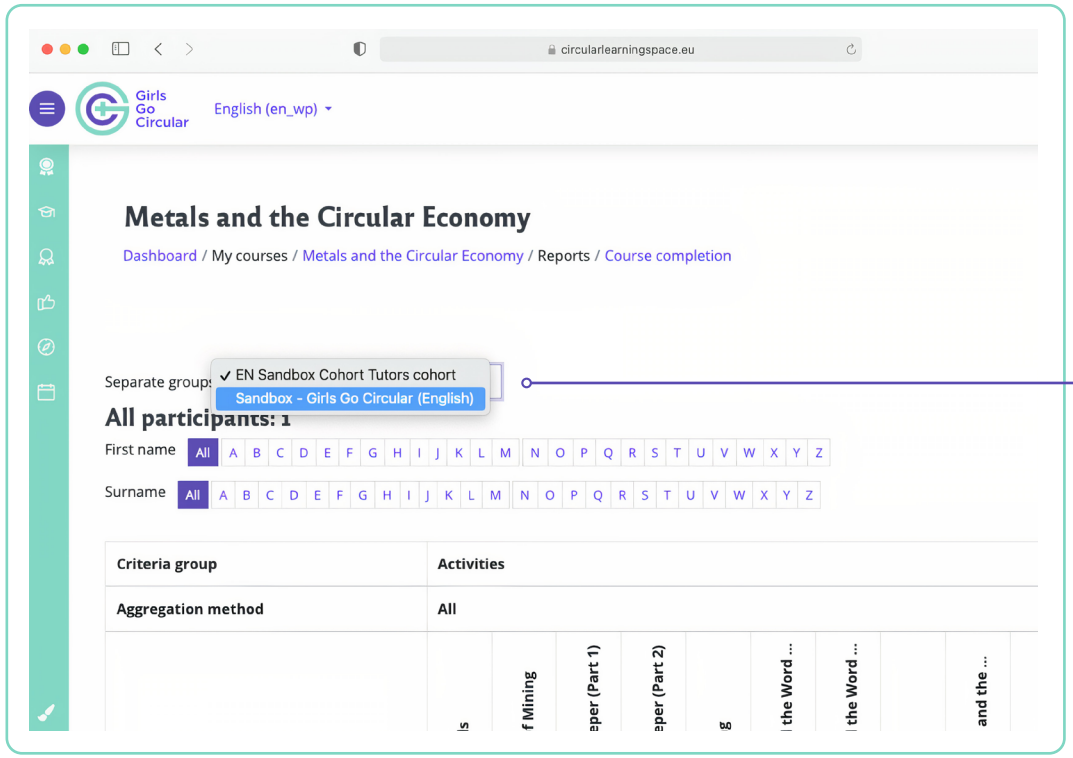
First name: All A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Surname: All A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

1 2 »

Download table data as: Comma separated values (.csv) Download

First name / Surname	ID number	State	Started on	Completed	Time taken	Grade/12.00	Q. 1 /1.00	Q. 2 /1.00	Q. 3 /1.00	Q. 4 /1.00	Q. 5 /1.00	Q. 6 /1.00	Q. 7 /1.00	Q. 8 /1.00	Q. 9 /1.00	Q. /1.00
Review attempt	default	Finished	9 December 2020 7:42 AM	9 December 2020 7:45 AM	2 mins 40 secs	9.17	1.00	1.00	0.00	1.00	1.00	0.50	0.67	1.00	1.00	
Review attempt		Finished	13 December 2020 3:09 PM	13 December 2020 3:11 PM	2 mins	8.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Review attempt		Finished	13 December 2020 3:12 PM	13 December 2020 3:15 PM	2 mins 18 secs	12.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Review attempt		Finished	13 December 2020 3:16 PM	13 December 2020 3:18 PM	1 min 56 secs	12.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Review		Finished	14 January 2021 8:05	14 January 2021 8:15	10 mins 20	10.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	1.00	



If you cannot see the list of your students in the system, please make sure you have chosen the correct group. The correct title of the group each teacher needs to select is: **SCHOOL NAME** – Girls Go Circular **(CHOSEN LANGUAGE)**

3. Facilitating the Work in the Classroom

3.1 What is the Role of Teachers?

As a teacher, you play a fundamental role in guiding students through the learning programme, supporting them in navigating the online learning platform and advancing their learning. But, more importantly, as a teacher, you will help your students take a leading role in tackling socio-economic challenges and gaining essential skills for their future.

The Circular Learning Space supports schools in Europe in the transition to digital education. The CLS will enrich the school curriculum by introducing new methodologies designed to deliver **knowledge on the circular economy, digital and entrepreneurial skills**. As an educator, you will also acquire digital competencies by mentoring your students in an online learning environment and supporting them in using digital tools.

- SELFIE (Self-reflection on Effective Learning by Fostering the use of Innovative Educational Technologies) is a free tool designed to help schools embed digital technologies into teaching, learning and assessment. SELFIE **anonymously gathers** the views of students, teachers and school leaders on how technology is used in their school. This is done using short statements and questions and a simple 1-5 answer scale. The questionnaire takes around 20 minutes to complete. The tool generates a report of a school's strengths and weaknesses in their use of technology. You can complete a self-reflection with your class (or school) to assess the strengths and weaknesses that require more attention before starting with the Girls Go Circular learning programme. The tool is available in 30 languages. For more information and to take the test, click **here**.

3.2 General Introduction to the Learning Modules

The CLS encompasses two groups of learning modules:

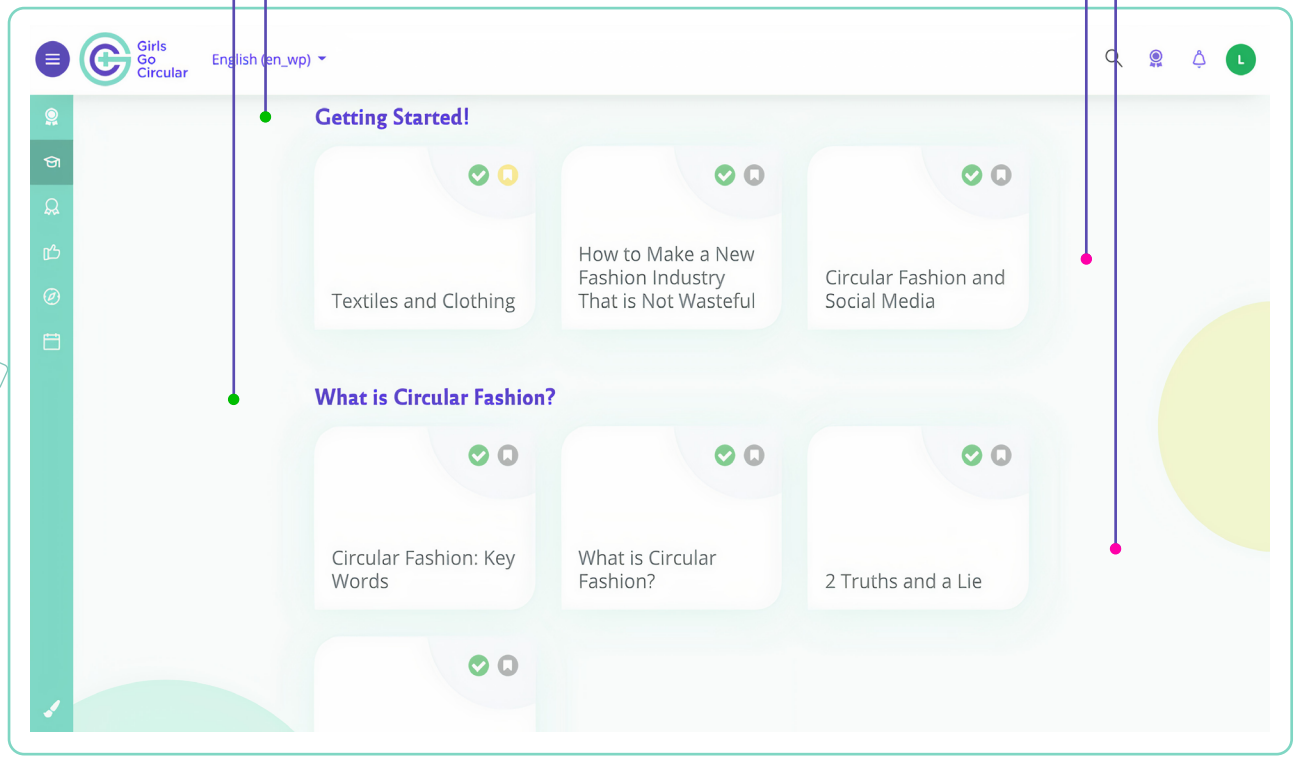
- Introductory modules give students basic information to commence their learning. We strongly recommend starting with these modules before moving on to the thematic modules:
  - Introduction to Online Safety and Etiquette
  - Introduction to the Circular Economy
- Elective modules focus on specific aspects of the circular economy and guide students through the activities and challenges to train their digital skills:
  - Metals and the Circular Economy
  - Fashion and the Circular Economy
  - Rethinking Plastics
  - A Circular Economy for Smartphones and Electronic Devices
  - Robotics and the Circular Economy
  - E-Waste and the Circular Economy
  - Circular Economy of Food in Cities
  - Tackling Climate Change Through Circular Consumption
  - Artificial Intelligence and the Circular Economy
  - Circular and Climate Resilient Transformation of Cities
  - Climate-neutral Hospitals of the Future - Saving Lives the Circular Way
  - Sustainable Mobility for Circular and Inclusive Cities
  - Schools as Living Labs for Systemic Food Circularity
  - Smart and Healthy Cities
  - Semiconductors: Powering Digital and Green Transformation
  - Deep Tech Innovation from Farm to Fork

Detailed descriptions of the learning modules and guidance on facilitating work in the classroom can be found in the second part of this guidebook - Teacher Guidebook: Introduction to the Learning Modules .

3.3 Summary of the Teaching Plan

As explained below, every module is divided into several units and lessons, guiding students through an incremental learning process.

When entering your selected module, you will see that it is divided into separate **Units**. Each Unit consists of several **Lessons**. Within each lesson, you will find the suggested time needed to complete the proposed activities.



The table below summarises the different activities needed to reach the minimum learning requirement according to the Girls Go Circular project methodology.

ELEMENT	DESCRIPTION	ROLE OF THE TEACHER/ FACILITATOR
Pre-reading (Can be done individually at home)	Introduction to Online Safety	Ask students to sign up to the platform the day before class activities and complete this module.
Introduction	Introduction to the Circular Economy, with reflections by students and a research challenge.	Guide students through the main concepts and reflect on the transition to a circular economy.
Dive into the topic	Based on the chosen module, students learn about different aspects of the circular economy. Simultaneously, they carry out engaging challenges (in a group or singularly) to acquire digital skills.	Ensure that students understand the topic and the challenges proposed.
Putting the Skills into Practice	Students use digital tools to consolidate knowledge on the selected topic. Finally, they go through a multiple-choice quiz to assess the knowledge and competencies acquired.	Support the students in using the digital tools recommended and completing the tasks successfully and within a set time frame.
Feedback	Teachers and students are invited to give feedback on the learning programme.	Ensure that students compile the feedback forms.

- The time indication is just a suggestion. Teachers can decide how to plan the learning and how much time to spend on each unit or lesson.

- In order to allow enough time to complete the learning programme, we recommend reserving at least 4-5 hours. Alternatively, teachers can also plan for implementing the programme over a longer period.

3.4 Preparations

Before starting the activities in the classroom, we recommend that teachers go through the following steps:

1. Go to **www.circularlearningspace.eu** and familiarise yourself with the platform.

2. Depending on the selected thematic module, review the Teacher Guidebook Part 2, Chapter **1. Introduction to the learning modules.**

3. Download and test the apps that students will be required to use during the learning activities.

4. Make a plan based on the tasks from the chosen module. Consider the indicative timings set for each task.

5. Ensure that students have all they need to start - access to a computer/smartphone and the necessary apps.

6. Review the online safety introduction and ask your students to read it in preparation for the workshop.

All the learning modules include short videos. Depending on your classroom setting, it is recommended to project these videos on a big screen so that students can watch them as a group. If the chosen learning module foresees activities that require working in groups, we invite you to think about the group allocation in advance.

- Please remember that the Girls Go Circular project aims to reduce the digital gender gap; therefore, if your class is mixed, you should address the importance of this issue with your students and point out the significance that boys also support this endeavour. Therefore, it is crucial to explain the necessity of the programmes deliberately addressing gender equality, ultimately leading to a better Europe for everyone.

3.5 Working in Groups

During group work, teachers should monitor and assist students. Observe the different groups and ensure that students make progress and collaborate.

In the time dedicated to reflections, encourage students to think back on what they have learned and how it impacts their lives.

Once they complete the final assignment, it is essential to acknowledge students' engagement and their achievements.

- After completing the learning programme, students should fill out the feedback form they will find on the CLS. Please make sure that they take the survey after completing the learning programme.

3.6 Certificates for Students, Teachers and Schools

The successful completion of the learning programme will grant students certificates that recognise the skills and competencies they have acquired. The CLS will automatically generate these certificates and send it to the email addresses students used to create their accounts.

Teachers that participate in the project will also be granted a certificate recognising their contribution to reaching gender equality in STEM.

Finally, schools will be given visibility on the project's website as the pioneers in Europe supporting the European Commission's Digital Education Action Plan[4]. If desired, a digital certificate can also be issued in the name of the school.

- Please keep in mind that students shall complete **both Introductory Modules and at least one Thematic Module** to receive a certificate.

- If you would like to receive support or training on the project and the learning modules, please contact **girlsgocircular@eitrawmaterials.eu**

[4] https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en

Girls Go Circular

Teacher Guidebook Part 2:
Introduction to the Learning Modules

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1. Introduction to the Learning Modules

Welcome to the **Teacher Guidebook Part 2: Introduction to the Learning Modules**. This is the second part of the Teacher Guidebook and gives teachers concrete tips and tricks to support their students in working with the Circular Learning Space.

The CLS is an online learning platform designed to improve secondary school students' digital skills while exploring the critical topic of the circular economy. This particular part of the Teacher Guidebook will introduce and analyse the different learning modules encompassed in the CLS.

- We advise you to read the first part of the **Teacher Guidebook Part 1: Introduction to the Project and the Circular Learning Space** before moving to this part.

The CLS encompasses two groups of learning modules:

Introductory Modules	Thematic Modules
The Introductory Modules on **Online Safety and Etiquette** and the **Circular Economy** give students basic information to begin the learning and set the tone for its progression. We suggest starting with these before accessing the elective modules. They are mandatory for the students to complete the learning programme and receive a certificate.	The CLS offers different elective Thematic Modules. They can be considered the backbone of the learning process. Each of them addresses a particular aspect related to the circular economy and encompasses activities to advance students' digital skills. The modules are designed to be carried out collaboratively in a virtual or in-person classroom environment.

It is important to remember that students must complete:

Introduction to Online Safety and Etiquette

+

Introduction to the Circular Economy

+

At least one thematic module.
Note, that the thematic module is considered completed when all the lessons are done and the final quiz score is 75% or more.

A set of these three modules is mandatory for the students to complete the learning programme and receive the certificates.

If students did not pass the quiz of the thematic module on the first try, they can repeat it as many times as they need to. Consequently, you, as a teacher, can monitor students' quiz attempts and see which questions were most tricky for your class.

- A Chapter **2.2 A Walk Through the Circular Learning Space** in the first part of the Teacher Guidebook, has an example of the teachers' view and navigation how teachers can monitor students' progress.

2. Learning Modules

2.1 Introductory Modules

The introductory modules lay the foundation of the learning programme. They give students an understanding of how to use the Internet safely and teach them basic circular economy concepts, which will be fundamental to continue working on the thematic modules.

- We strongly advise students to complete the Introductory Modules before progressing to the Thematic ones.

Introduction to Online Safety and Etiquette

Description	This module introduces students to the Internet's dangers and pitfalls and explains how to behave correctly and avoid risks. It is mainly composed of interactive readings and videos presenting how to protect personal data, creating strong passwords, and detecting fake news.
Module Duration	30 minutes
Required digital tools	-
Required preparation	Internet access and ICT device. This module can be completed at home, individually, before the classwork.

Introduction to the Circular Economy

Description	This module presents the basic concepts of the circular economy to students. It shows the main problems related to the current linear economic approach and offers ideas to transition to a circular economy.
Module Duration	45 – 60 minutes
Required digital tools	▪ Mural ▪ Dropbox or Google Drive ▪ Google Slides, Microsoft PowerPoint, Slideshare, Prezi
Required preparation	▪ Internet access and one ICT device per student. ▪ Before starting, teachers should familiarise themselves with the module and select a shared online storage space (Google Drive, Dropbox, etc.) where students can upload their presentations.

2.2 Thematic Modules

Metals and the Circular Economy

Description	A new approach is needed for the mining and metals industry. The high value of many metals and the environmental cost of their extraction makes it imperative to recycle, recover and reuse them. This module illustrates how metals can be extracted and used more sustainably.
Module Duration	3 hours
Required digital tools	▪ Mural ▪ Dropbox or Google Drive Google Slides, Microsoft PowerPoint, Slideshare, Prezi, Storyboarder Social Media platform: TikTok, Instagram, Facebook, YouTube, Twitter
Required preparation	▪ Internet access and one ICT device per student. ▪ Before starting, teachers should familiarise themselves with the module and select a shared online storage space (Google Drive, Dropbox, etc.) where students can upload their presentations.

Below you can find some valuable suggestions, divided per lesson, on preparing and facilitating the work in the classroom.

Lesson 1:

Why are Metals Important?

This introduction to metals invites students to start a discussion and think about their smartphones. Teachers can ask them to think of different ways to keep the metal components in use and prevent them from ending up in a landfill. Students can list their ideas on Mural, sticky notes or just share them orally.

Here are some ideas in case students need help:

- Pass on/sell/share the phone with others.
- Repair the phone.
- Take the old phone to a dedicated collection point

so that the metals are recycled.

- Manufacturers should design phones so that they can be easily and quickly taken apart and their components replaced.
- Put incentives in place to ensure smartphones are returned to manufacturers.
- Make manufacturers responsible for any waste their products create.

Challenge: Dig Deeper (Part 1)

In this challenge, students conduct research and create a digital slideshow using one of the following tools: Google Slides, Microsoft PowerPoint, Slideshare or Prezi. Teachers can select one software for all or let students choose.

- Our advice would be to let students explore on their own and pick their favourite digital tool. They should choose one in advance to the day of the challenge, create an account or install the software if needed.

Challenge: Dig Deeper (Part 2)

Once ready, ask students to upload their presentations on the shared folder, allowing groups to view each other's work. Then, display each group's work on a central smartboard/screen for teams to present one by one.

Challenge: Spread the Word (Part 1)

Remind students that they will be creating their slideshows on a chosen software. Monitor the groups to ensure they are on track and that all the students in a group are actively involved.

Challenge: Spread the Word (Part 2)

For this challenge, students must have access to social media apps. The main aim of this activity is to stimulate their creativity in using digital tools to communicate effectively.

Teachers should keep in mind that students must:

- Select the appropriate platform for a given target audience
- Think of ways to create engaging posts (design, feel, tone, language, text-based, image-based, or video-based)
- Decide on the content (what to say and how to say it)
- Is there a call to action? (Guiding questions could be: Are you asking people to do something? Or are you just hoping to inform them?)

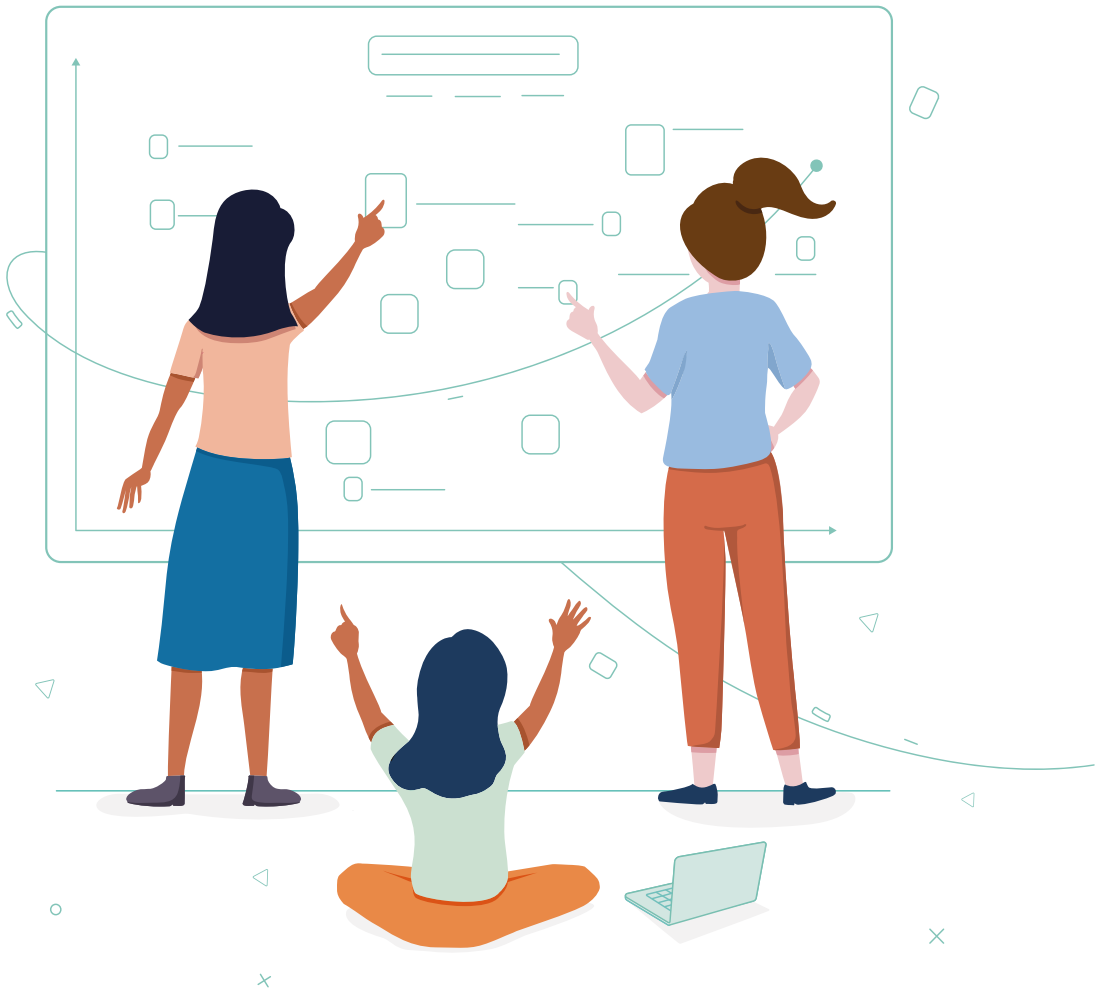
Set the scene for the task. To make it more interesting, organise a competition. For example, you can pretend to be the CEO of Making Metals Circular and create a roleplay in which the marketing team presents their social media pitch. You can also opt for a class vote of their favourite campaign.

Do not forget to ask students to share their social media campaign plan in the shared storage system you set up before the class.

- **IMPORTANT:** Students should create ad-hoc social media profiles where they do not share their data. They should not use their personal social media account!

Fashion and the Circular Economy

Description	Clothes and textiles should have a higher utilisation rate and re-enter the economy after use instead of ending up in a landfill. Learn about the concept of circular fashion and its impact on the economy and the environment, and create your own business model.
Module Duration	2 hours and 15 minutes
Required digital tools	▪ Mural ▪ Miro ▪ Dropbox or Google Drive ▪ Google Slides, Microsoft PowerPoint, Slideshare, Prezi, Storyboarder ▪ Social Media platform: TikTok, Instagram, Facebook, YouTube, Twitter
Required preparation	▪ Internet access and one ICT device per student. ▪ Before starting, teachers should familiarise themselves with the module and select a shared online storage space (Google Drive, Dropbox, etc.) where students can upload their presentations. ▪ This module encompasses several interview videos, which, if possible, we advise to watch together as a group on a big screen.



Lesson 3:

Circular Fashion and Social Media

This activity is excellent for group work and entrepreneurial skills training. Teachers can suggest that each student looks up a different influencer or organisation to cover plenty of ground collectively. Each group should work on one Mural or Miro board to create a mind map gathering all their ideas.

Lesson 5:

What is Circular Fashion?

Teachers can use this video to encourage a discussion. For example, students could be asked to debate the question: **What is one thing you will commit to doing?**

Challenge: Your Turn!

Students shall plan and create a social media profile. Then, they should launch an online campaign that informs and inspires young people about a particular topic of their choosing. Finally, the class is supposed to follow the tips and questions mentioned in the video.

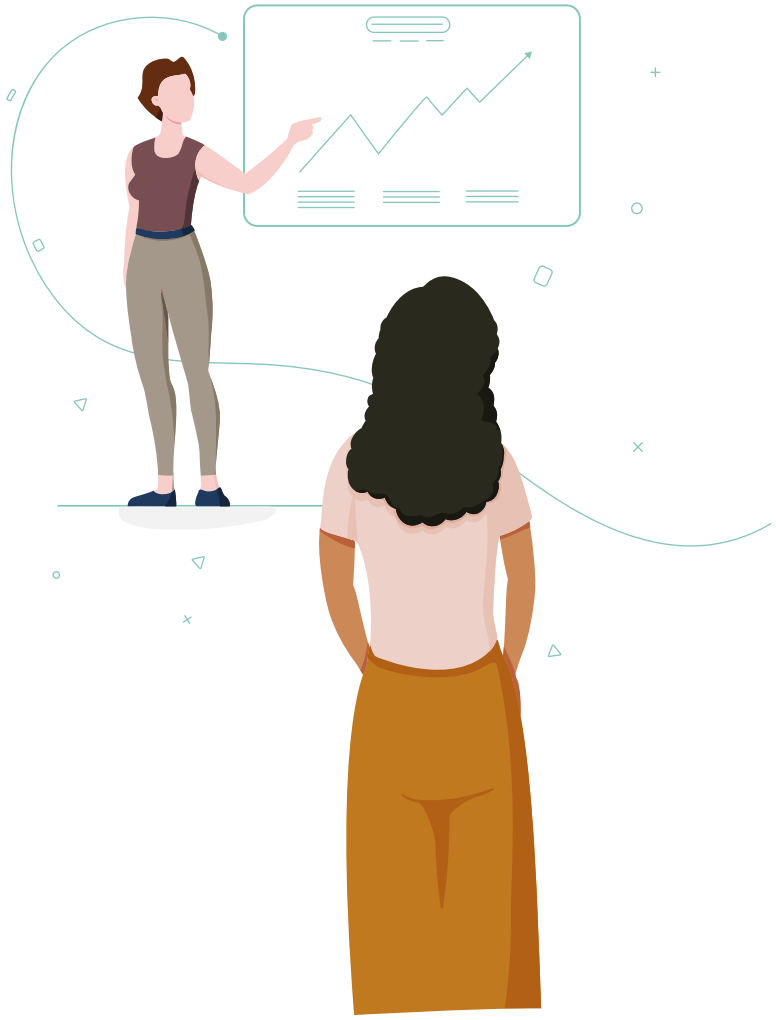
Challenge: Let's do this!

This challenge aims to develop a new business model that tackles the issue of disposable masks.

As the facilitator of the challenge, monitor the groups to keep track of time. Teachers should remember that the main aim of these activities is for students to use digital tools actively and communicate effectively.

Remind students to share their social media campaign plan in the shared storage system. Set the scene for their presentations and encourage them to impress the audience!

- **IMPORTANT:** Students should create ad-hoc social media profiles where they do not share their data. They should not use their personal social media account!



Rethinking Plastics

Description	Building a circular economy for plastics requires a complete rethinking of how **plastic items** are designed and used. Research the benefits and problems of using plastics, discover solutions to tackle the global plastic waste crisis and propose alternatives for producing goods without plastic packaging.
Module Duration	2 hours and 45 minutes
Required digital tools	▪ Mural ▪ Dropbox or Google Drive ▪ Google Slides, Microsoft PowerPoint, Slideshare, Prezi, Storyboarder ▪ Social Media platform: TikTok, Instagram, Facebook, YouTube, Twitter
Required preparation	▪ Internet access and one ICT device per student. ▪ Before starting, teachers should familiarise themselves with the module and select a shared online storage space (Google Drive, Dropbox, etc.) where students can upload their presentations.

Lesson 1:

A Closer Look at Plastics

This lesson introduces group work. Before starting this lesson, teachers could ask students to share their brief opinion about plastics – **should they be banned?** Many students may think that this is the best solution to the plastics' problem, but they will understand later that it is not that simple.

Following that, teachers should continue with the task on this first lesson and ask students to research the benefits and problems of plastics. Once the task is complete, start a broader discussion on the same reflection question: Should we ban all plastics completely? Is this the way forward?

Invite students to think carefully about the potential consequences and analyse how their opinions have changed.

Challenge: Researching Solutions (Part 1)

This challenge trains students' online research and presentation skills. The primary source of information for this challenge is **The Ocean Plastic Innovation Challenge.**

"The Ocean Plastic Innovation Challenge, a key component of National Geographic and Sky Ocean Ventures' partnership to reduce plastic waste, asks problem-solvers from around the globe to develop novel solutions to tackle the world's plastic waste crisis."

For the best entrepreneurship experience, students should work in groups. Also, teachers can suggest that each group member can look up different finalists to cover plenty of ground collectively.

Teachers should monitor the groups to ensure students stay on track during their research and actively contribute.

Challenge: Researching Solutions (Part 2)

Once the presentations are ready, ask students to upload them to a shared folder. Then, display each group's work on a central smartboard/screen so that everyone can see it while they present.

- Our advice would be to let the students explore on their own and pick the digital tool they would like to use. They should choose one in advance of the day of the challenge, create an account or install the app as needed.

Challenge: Chocolate Bar Redesign (Part 1)

For this challenge, students should have access to various materials such as pens, paper, cardboard, even LEGO building blocks might be helpful. As the challenge facilitator, inspire them to use digital tools and suggest using different materials to build prototypes and create scenarios. Students should use the materials available to bring their ideas to life. Encourage groups to assign roles and share workload effectively to maximise the use of the time. (The videos can be taken on phones or tablets.)

Challenge: Chocolate Bar Redesign (Part 2)

If students have already watched the video in the previous lesson, or if it is possible to dedicate more time to this module, use this opportunity to complete the bonus activity outlined in this lesson.

- "<...> use this time to identify a person or an organisation that you would ask to share your video on social media. Include your choice in your final pitch, explaining why you have chosen this person or organisation."

Lesson 8:

Share Your Work

This lesson completes the Chocolate Bar Redesign Challenge. It also includes few valuable tips on how to deliver the presentation.

Before asking students to share their presentations, teachers can use this lesson to check if they have fulfilled all the requirements.

- **SUGGESTION:** To model a dynamic working environment, teachers could initiate a brief Q&A after each presentation. Try to give everyone a chance to speak, especially those who haven't been the group spokespeople.

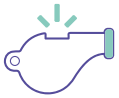
A Circular Economy for Smartphones and Electronic Devices

Description	Mobile phones contain a lot of precious metals and minerals. Therefore, we must keep them working as long as possible and ensure that the raw materials that constitute them are recycled, reused or disposed of properly. This module explores the impact of smartphones and other electronic devices on the environment and presents ideas to create a circular economy for ICT appliances.
Module Duration	4 hours
Required digital tools	▪ Mural or Miro ▪ Dropbox or Google Drive ▪ Google Slides, Microsoft PowerPoint, Slideshare, Prezi, Storyboarder ▪ Social Media platform: TikTok, Instagram, Facebook, YouTube, Twitter
Required preparation	▪ Internet access and one ICT device per student. ▪ Before starting, teachers should familiarise themselves with the module and select a shared online storage space (Google Drive, Dropbox, etc.) where students can upload their presentations. ▪ This module encompasses several interview videos, which, if possible, we advise you to watch as a group on a big screen.

Challenge: How Circular is your Smartphone?

Students are required to design a circular ranking system for their smartphones. They shall also create social media profiles to show and compare their rankings.

Make sure that students understood the video's key concepts. For example, NPS (Net Promoter Score) is mentioned in the video. NPS is a concept that many companies use and may be unknown to some students.



- **IMPORTANT:** Students should create ad-hoc social media profiles where they do not share their data. They should not use their personal social media account!

- Net Promoter Score is a widely used market research metric that typically takes the form of a single survey question asking respondents to rate the likelihood that they would recommend a company, product, or service to a friend or colleague.

Read more about **NPS here** (in English).

Lesson 8:

New Business Models

After watching the video, it may be helpful to invite students to share their thoughts about their business model with the entire class. Then, reinforce the learning by asking: **what were the key points?**

Lesson 9:

Circular Economy Approaches for Smartphones

This activity is made up of a series of videos presenting examples of companies with innovative business models in the following areas:

- Sourcing of materials and manufacturing.
- Life extension, focusing on a modular design.
- End of life management and recycling.

Depending on time availability, you can watch these videos together as a group, ask students to go through all of them individually or invite each group to focus on a specific company and later explain what that company is doing to the rest of the class. If you choose the latter, encourage students to use Mural or Miro to map their ideas.

The goal is to show students different creative, practical examples, and new business models.

- You may ask students to carry out the challenges in smaller groups by dividing the blog writing and business development elements and then bring them back together. If the activities are too challenging, you can restrict the scope, asking students to focus only on some items, or assigning specific questions to specific groups.

Challenge: A blog is worth a thousand phones

This challenge focuses on raising awareness of circular economy strategies in the smartphone industry by creating a blog post.

- Teachers should monitor the groups and make sure they stay on track during their research and teamwork.
  Remind students to upload their plan to the shared storage system. Set the scene for their presentations and encourage them to impress the audience!

Challenge: Let's make a change

This challenge focuses more on business development. Students are required to develop a business idea for reusing old, semi-obsolete phones, tablets, or any other electronic devices to create interactive murals (video walls or screen walls) in hospitals, schools, shopping centres and other public places.

The questions are inspired by Alexander Osterwalder's Business Model Canvas:

<table>
<tr><td rowspan="2">Key Partners</td><td>Key Activities</td><td rowspan="2">Value Propotition</td><td>Customer Relationships</td><td rowspan="2">Customer Segments</td></tr>
<tr><td>Key Resources</td><td>Chanels</td></tr>
<tr><td colspan="2">Cost Structure</td><td colspan="3">Revenue Streams</td></tr>
</table>

- The main goal is that students get familiar with business plan development and train their entrepreneurial skills.

Students can recreate and fill in their business model canvas using Mural.

2.3 Advanced Learning Modules

Based on a "learning-by-doing" model, the advanced modules listed below will support the participating students in developing advanced digital skills aligned to the competence areas of the DigComp 2.1[5].

Robotics and the Circular Economy

Description	We are currently living in the new era of Manufacturing, a so-called **Industry 4.0,** in which innovative technologies such as Robotics and Artificial Intelligence play an essential part. Industry 4.0 bears enormous opportunities to enable a circular economy where end-of-life products are reused, remanufactured, and recycled. Throughout this module, students will learn and understand how these technologies change the industry to make it more sustainable..
Module Duration	3 hours (Completing one challenge) 4 hours and 30 minutes (Completing both challenges)
Required digital tools	▪ **Vectr** ▪ **BotSociety** ▪ **Dropbox** or **Google Drive**
Required preparation	▪ Internet access and one ICT device per student. ▪ Before starting, teachers should familiarise themselves with the module and the challenges and select a shared online storage space (Google Drive, Dropbox, etc.) where students can upload their presentations.

Choose Your Challenge	Students can choose between two challenges. It is highly recommended that they read through both challenges since two final assessment questions are related to these challenges. It is advised to discuss both challenges in the class to understand the requirements and ideas behind them.
Challenge A: May I Help You?	In this challenge, students have to develop a Chatbot related to Manufacturing by using MIro. Teachers are advised to analyze the scenario of the challenge thoroughly together with the students. Invite students to put themselves in the client's shoes to create the most helpful and accurate Chatbot.
Challenge B: Design Thinking Your Robot	In this challenge, students will learn how robots support the circular economy in Manufacturing by sorting out recyclable materials. The challenge requires students to design a robot that sorts items for recycling using the Design Thinking Methodology: a thought process created to solve a specific problem by brainstorming possible products.

[5] https://publications.jrc.ec.europa.eu/repository/handle/JRC106281

Lesson 1:

Robotics, Manufacturing & AI

Use this introduction to Robotics, Manufacturing and AI to discuss with students and invite them to brainstorm about the tasks robots can complete and how they can be introduced in Manufacturing. You could ask them to share their ideas orally.

Here are some examples of questions for the students:

- What is a robot?
- What kind of robots do you know?
- What kind of tasks can robots complete?
- What do you know about AI?
- What is Manufacturing?
- How can robots be incorporated into Manufacturing?

Lesson 5:

Looking for Keywords

Students should form small groups or pairs. They shall click on the image's hotspots to discover the keyword, research its meaning, and present these definitions to the class.

If they have trouble finding the meaning of the terms, here are some websites containing the definition of the field's (Robotics, Manufacturing, and AI) essential terms (content is provided in English):

- Robotics Terms
- Manufacturing Terms
- AI Terms

Lesson 9:

Inspiring Women in Robotics

This lesson introduces three empowering women and their impact on the Robotics field. Teachers are invited to use this opportunity to start a discussion about entrepreneurship, interest in technological careers and gender stereotypes in this field.

There are some ideas for the discussion:

- Did you know these women? What surprises you most about them?
- How do you think their work will impact the world? And the future?
- How can the role of women benefit the Robotics industry?

Information about some organizations in the field can be found at the links below.
(EU Robotics, International Federation of Robotics (IFR), OECD, Partnership on AI, DeepMind Ethics & Society, Carbon Robotics, Robotics Business Review, Forbes 30 under 30)

Choose Your Challenge

Teachers should announce that students have to choose between two challenges. They shall at least read both (even if they decide to do only one of them) because there are two questions related to both Challenges in the Final Assessment.

Challenge A: May I Help You?

This challenge invites students to develop a Chatbot related to Manufacturing by using BotSociety.

As a teacher, you should explain the context to ensure that students understand the challenge and what is required to complete it successfully. Emphasize that students should analyze the client's needs accurately in order to create the most helpful and accurate Chatbot.

They need to understand what and why is being returned, evaluate if reverse logistics can be used according to the info provided by the client (e.g., delivery date, weight, guarantee, dimensions, value) and suggests possible outcomes and actions.

- **Do not forget** to ask students to share their results in the shared storage system you set up before the class.

Challenge B: Design Thinking Your Robot

This challenge reveals how robots can help the Manufacturing field by sorting out recyclable material and improving the circular economy.

Before starting, the class could briefly discuss how students at home sort recyclable materials. If they do not do that – invite students to share their thoughts on why not.

In this challenge, students have to design a robot that does precisely that - sort items to be recycled at home. They will plan their ideas using Miro and develop the robot prototype in Vectr.

As a teacher, you should encourage students to think about the recycling dynamics - what goes into which container, how items can be sorted according to the materials or colour, etc.

Students should design the robot using the Design Thinking Methodology: a thought process created to solve a specific problem (sorting items for recycling) by brainstorming possible products (different robot designs).

Although the steps of this thought process are defined in the module, it would be beneficial if you, as a mentor, would go through it together with the students.

- Remember, these are only general guidelines. Therefore, although it is enough to complete one challenge for the students to receive the certificate, you, as a teacher, can freely decide to add both challenges to your teaching plan.

E-waste and the Circular Economy

Description	This module looks at the growing problem of E-waste. It explores the importance of improving the collection, sorting and recycling of E-waste as well as the role a circular economy can play in eliminating waste in the first place.
Module Duration	2 hours and 30 minutes (Completing one challenge) 4 hours (Completing both challenges)
Required digital tools	▪ BotSociety ▪ Wix ▪ Inkscape
Required preparation	▪ Internet access and one ICT device per student. ▪ Before starting, teachers should familiarise themselves with the module and the challenges and select a shared online storage space (Google Drive, Dropbox, etc.) where students can upload their presentations.
Challenge 1: Build Your Own E-waste Solutions Website Page	In this challenge, students should work in teams of 3-4 and build a website to inform people of the potential solutions to the growing E-waste problem.
Challenge 2 (Optional): Design Your Own Circular Product 90 mins	In this challenge, students shall design a circular electric or electronic product. Once this is done, they will build a brand around it by creating a website homepage representing their innovative circular product.

Lesson 1:

What is E-waste?

After watching an introduction video, teachers could make the learning more accurate for the students by quickly scanning the classroom or environment they are in. How many different items can they see around them that would be considered E-waste if they were thrown away? This can include things they might have on them such as phones, tablets etc.

Lesson 3:

E-waste Problems and Solutions

Teachers shall ask students to answer the question prompt collectively on Miro. For this exercise, students can be divided into smaller groups.

- **Question prompt:** We can't just stop using electric and electronic equipment; they are an essential part of modern life. So what can we do?

  Afterwards, teachers could use these two discussion points to encourage a dialogue among the students:

  - Which of the possible solutions you have heard about so far are the most likely to succeed, in your opinion?
  - Are there any other possible solutions?

Lesson 4:

Recycling E-waste

The last exercise of this lesson is an E-waste calculator. Teachers are welcome to use it as a homework activity for students.

Later you could ask them to bring in their E-waste calculator figures and compare them. Alternatively, you could also turn this exercise into a school-based activity, making sure to factor the extra time into your lesson.

Lesson 7:

What Have We Learned?

Either as a whole class or in groups, pick 2-3 discussion points from the list. Encourage students to capture notes of the key points raised on their Miro board. You may find that students have a strong opinion on some of these.

A homework task could be to create a 1 minute video presentation in which students express their thoughts on one of these topics.

Challenge 1: Build Your Own E-Waste Solutions Website

It is recommended to place students in teams of 3-4. Then ask the teams to build a website that aims to inform people of the potential solutions to the growing E-waste problem.

Things that students need to include in the website:

- A brief introduction to E-waste and the problems associated with it
- Why do we need to find solutions to the problem of E-waste?
- The range of possible solutions that exist (going beyond recycling to include other circular strategies)
- How we might design products differently so that materials stay in use and out of the landfill (i.e. design for a circular economy)

In the lesson, you will find the WIX website builder tutorial that has been created to support this challenge. Before diving into the challenge, students should watch this tutorial.

It may be that students have gained sufficient knowledge for this task from the module itself; however, you, as a teacher, should encourage further research outside of the module. **WEEE4Future** is a good resource, as is the **Global E-waste Monitor** report and **YouTube** for video content.

After the groups have built their websites, ask them to present it to the rest of the class. Encourage the other groups to provide feedback so that changes can be implemented.

Challenge 2 (Optional): Design Your Own Circular Product

This is a more advanced challenge for those with strong digital skills and who want to be more creative.

Students form groups of 3-4. Students will use a digital design/visualization tool to design a circular electric or electronic product for this challenge. Note: it is helpful for the students to sketch the designs first before making them digital.

This new product aims to ensure that its materials stay in use for as long as possible. Students have to take into consideration the points below:

- Durability
- Easy to repair
- Easy to upgrade
- Easy to take apart
- Functionality and appearance

As the facilitator of the challenge, explain to the students that once they have their newly designed circular product, now they will build a brand around it. That includes:

- Brand name
- Brand values
- Mission statement
- Logo

Moving forward, students should combine these two elements - circular product and the brand - by creating a website homepage that represents their brand while showcasing the innovative circular product.

Once they have completed the challenge, students are welcome to share their work with the rest of the class. We recommend having a Q&A session after the presentations so that the class members can give their feedback and offer advice.

- Teachers should point students to the Inkscape and WIX tutorials before taking on this challenge.

Circular Economy of Food in Cities

Description	Cities – that's where 80% of food will be consumed by 2050, and most of the population will live. Today's linear cities experience an increasing demand for resources and diminishing supplies. Cities can be key drivers for circular change. By using circular economy principles, cities and the businesses and people in them have the power to transform the food system. Transitioning to a circular economy is not only about saving and reusing resources: it is about identifying and implementing innovative ways to make, share, maintain, reuse, remanufacture, and recycle products, materials, and energy.
Module Duration	2 hours and 50 minutes (Completing one challenge) 4 hours and 5 minutes (Completing both challenges)
Required digital tools	▪ Miro ▪ Dropbox or Google Drive ▪ Invision App ▪ Canva ▪ Social media platforms: TikTok, Instagram, Facebook, YouTube, Twitter
Required preparation	▪ Teachers and students should have internet access and their devices ready. ▪ Before starting, teachers should go through the module and familiarise themselves with it. ▪ Before starting the work with the students, teachers should choose one shared storage system (Google Drive, Dropbox, etc.) and create a folder where students can perhaps share their work.
Challenge A – Let's Design Together - Your Innovative Digital Solution to Help Your City Become More Circular	Students team up to prototype a digital product (mobile app) that improves the circularity of the food system in their city. A role-play simulates the entire production chain and guides the app's ideation and design process.
Challenge B – Social Media Campaign: Your Circular Economy of Food (Optional)	Building up on the mandatory challenge, students design a social media campaign to promote their innovative business idea and raise awareness on the circular economy of food in cities.

Lesson 3:

How Entrepreneurs are Fostering Circular Food Innovation in Cities

Students learn how circular entrepreneurs put their ideas to work in their communities around different countries and make the circular economy of food in cities a reality.

Dedicated inspirational videos and interviews are proposed related to different aspects of the circularity of food in cities. Students should take notes of what they find exciting and get ready to share their learnings.

- Please make sure that students watch the videos, as the final quiz will include questions about them.

Challenge A: Let's Design Together – Your Innovative Digital Solution to Help Your City Become More Circular

Students are asked to develop an innovative digital idea (a mobile app) related to food circularity in their city.

They may decide to help the city in:

1. Fighting food waste
2. Promoting alternatives to single-use packaging
3. Supporting correct waste segregation

They can find source inspiration from existing applications and solutions such as **Junker app, TGTG, Reloop Platform** and other case studies they have explored during the module (and the challenges and ideas that emerged from the brainstorming and reflection activities). They can find out more about possible opportunities and imagine what innovations could be helpful in their context.

Below is a suggested action plan that teachers can propose to students (perhaps some steps in class and others at home):

1. Form teams.
2. Let students choose an expert among the ones proposed.
3. Suggest students go back to the brainstorming they did earlier to understand what already exists in their city regarding food waste, single-use packaging or waste segregation. If needed, do a little more research on the topic.
4. Suggest students get inspired by the suggested case studies and search for more examples online.
5. TIP for students: choose only one topic for the challenge from the three proposed: food waste OR single-use packaging OR waste segregation.
6. Let students define the goals and objectives of the digital solution.
7. Let students define the target persona. TIP: watch the **video** to learn more!
8. Deliverable: prepare a mock-up (digital prototype) of the idea/app (through **Invision app**).
9. Final step: get ready to pitch the idea.

Teachers may suggest students continue working on the idea and develop the solution (e.g. code the app) in the following weeks as optional homework.
Tip: Students conduct research and develop their ideas based on the information they have acquired and their creativity. It is up to teachers to either pick one software for all students (the one suggested) or let them choose an alternative one.

- Once the presentations are ready, ask students to upload them on a shared folder, allowing groups to see each other's work. Display each group's work on a central smartboard/screen so that everyone can see while they present.
- Monitor the groups to ensure they keep on track during the task and that everyone in the group engages in the work.
- Set the scene for the task: to make it more interesting, organise it a competition between the groups. You could opt for a class vote on their favourite innovative idea (suggesting that they cannot vote for their presentation).

Our advice would be to let the students explore independently and pick the digital tool they want to learn and master. It is best to do that in advance and in preparation for the classroom activities (create an account and install the software if needed).

Challenge B: Social Media Campaign: Your Circular Economy of Food (Optional)

Students are asked to design a social media campaign and share a post to promote their innovative business idea, while also informing and raising awareness on the circular economy of food in cities.

Suggested action plan that teachers can propose to students:

1. Decide the focus and objective of the social media campaign.
2. Define the target audience.
3. Define the appropriate and preferred social media channel (Instagram, TikTok, YouTube, Facebook, etc.).
4. Define the expected impact and outreach (KPIs, numbers, etc.).
5. Design your first post (e.g. on Canva).
6. Upload your first post.
7. Get ready to show your work to your classmates.

Extra steps (optional):

A few weeks/months later, teachers may suggest students to go back to their post and check the impact:

1. Check feedback and impressions (numbers, etc.).
2. Reflect on the results and learnings. Can the campaign be considered successful? What could they have done better? Are they satisfied with their work? What have they learned?
3. Share the results of their work with classmates.

- **A few tips:** Remember, the main aim of this activity is to get creative in using digital tools to communicate effectively. Try to keep their focus on that.

Remember that students must come up with the best ideas for:

- Which social media platform is most popular among the people listed as the target audience?
- How to create engaging posts (design, feel, tone, language, text-based, image-based, or video-based)?
- What is the content? What do you want to say and how do you want to say it?
- Is there a call to action? Are they asking people to do something? Or are they just hoping to inform them?

Monitor the groups to ensure they keep on track during the task and that everyone in the group engages in the work.

Set the scene for the task. To make it more interesting, organise a competition between the groups. You could opt for a class vote of their favourite campaign (suggesting that they cannot vote for their presentation).

Tackling Climate Change Through Circular Consumption

Description	This module emphasises the role of the circular economy in tackling climate change. It gives an overview of the environmental issues relating to consumer goods and indicates how adopting circular consumption practices can help us reduce humanity's climate impact.
Module Duration	2.5 h
Required digital tools	▪ Miro ▪ Canva ▪ Dropbox or Google Drive
Required preparation	▪ Teachers and students should have internet access and their devices ready. ▪ Before starting, teachers should go through the module and familiarise themselves with it. ▪ Before starting with the students, teachers should choose one shared storage system (Google Drive, Dropbox, etc.) and create a folder where students can share their work.
Challenge	The students are asked to develop a consumer product by applying the circular criteria that they have learned. The choice of the consumer product is entirely up to the students. Even though the development of a circular product is the core of the challenge, there are two requirements: ▪ The first is to validate the product's reduced climate impact. ▪ The second requirement is to show an entrepreneurial mindset and demonstrate the competitiveness of the product.

Lesson 09:

Circular Consumption Practices? You Name It!

This lesson asks students to remember all the keywords they learnt during this module. If the students struggle with concluding the important terms, you can guide them towards the following keywords:

modular design, lifetime extension, naked packaging, bio-based materials, eco-friendly packaging, product-as-a-service, consumer culture, lifestyle emissions, consumption practices,

dematerialization, performance-based economy, sharing schemes, carbon footprint, climate/environmental impact, material use.

Challenge: Create Your Own Circular Consumer Product

This challenge asks students to think about creating a consumable product (e.g., clothes, cosmetics, devices, household tools) by applying circular criteria and indicating how the circular features reduce the product's climate impact.

Students should keep in mind that the aim is not to simply add another product to the market (even if it comes with reduced environmental impact) but to really substitute already existing and harmful consumption practices. In the challenge description, students can find several tips helping them to stay focused and on track.

For this part, students can work in groups and use Canva to brainstorm ideas.

Once the idea is finalised, students are requested to create a presentation on Canva for their final pitch. It's up to the students to decide what template they would like to use and how they want their idea to be presented.

Teachers should request students to upload their pitch presentations on the shared folder, allowing groups to see each other's work. Display each group's work on a central smartboard/screen so that everyone can see while they present.

- Remember that students have to demonstrate the following features:
  - Enhancing a product's (or its packaging's) circularity;
  - Understanding how the increased circular performance influences the product's climate impact;
  - Indicating the market validity of the product

Set the scene for the task: to make it more interesting, make it a friendly competition between the groups. For example, have the class vote for their favourite innovative idea, but students cannot vote for themselves.

Don't forget to ask the students to share the developed materials in the shared storage system you set up before the class.

2.4 Expert Modules

Artificial Intelligence and the Circular Economy

Description	We are currently living in the new era of technology and innovation, the so-called Fourth Industrial Revolution in which Artificial Intelligence (AI) is playing an essential part. AI bears enormous opportunities to enable circular economy in which end of life products are reused, remanufactured, and recycled. Throughout this module, students will learn and understand how this technology is accelerating the transition to a Circular Economy.
Module Duration	5.5 hours
Required digital tools	▪ Miro ▪ Teachable Machine
Required preparation	▪ Teachers and students should have Internet access and their devices (computers, laptops, tablets) ready. ▪ Before starting, teachers should read through the module and familiarise themselves with the tasks and challenges ahead.
Challenge: AI for waste management	Waste is a recurrent issue today that is worsening over time. To help alleviate the consequences of global warming caused by the mismanagement of waste, it is essential to act and come up with creative solutions. Therefore, students are presented with a scenario in which they lead a tech company that sorts out waste. They are challenged to think about an innovative AI system as the main product of their company.

Lesson 1:

Going Circular

This lesson consists of a brief explanation about the Circular Economy which aims to familiarise students with the concept, since it will be the centre of the module.

Lesson 2:

What is Artificial Intelligence?

This lesson consists of both a text and a video that dig deeper into AI and Machine Learning (ML). The text is intended to be an introduction to the video, to grasp the meaning of AI and ML better. Please notice that there are technical terms which are accompanied with an explanation to understand the concepts.

Lesson 3:

Looking for Keywords

Organise the students into small groups or pairs. They shall click on the image's hotspots shown in the module to discover the keyword. Then, they will research online the meaning of the keywords and share the definitions and descriptions they have found with the rest of the class.

Lesson 4:

What goes into Artificial Intelligence?

This lesson consists of a detailed video that explains the lifecycle of AI. Additionally, it explains how a Machine Learning model is created. It is crucial that students understand and pay special attention to this lesson as the Challenge involves creating a Machine Learning Model. Moreover, many Final Assessment questions relate to these concepts.

Lesson 5:

2 Truths and a Lie

Organise the students into small groups or pairs to discuss the three statements about Artificial Intelligence, Machine Learning and algorithms and decide which one is the lie. In this case, there is no need to further research the statements online because they are tightly related to the concepts they learned in Lessons 1 and 2. Moreover, an additional explanation is provided under the "Check" button.

Lesson 6:

How AI Contributes to the Circular Economy

Students shall watch a video that dives into the relation between Circular Economy principles and Artificial Intelligence. Afterwards, they will read the text below that summarises the applications of AI in the Circular Economy, mentioned in the video. It also includes real-life examples of companies who use Artificial Intelligence to accelerate the transition to a circular model. Students should take notes or remember the content while they

watch since some of the questions in the Final Assessment are related to this topic.

Lesson 7:

Did You Know?

In small groups, students read and comment on the possible answers to the flip cards. They shall research online to answer the questions. Afterwards, they will flip the cards and check their answers. It would be convenient if all groups could share their results and findings to compare them and get a better overview of the impact of Artificial Intelligence on society. Note that some organisations and reports are cited with links that redirect to their home pages (e.g., **PWC, WEF Report 2020**).

Lesson 8:

The Future of Artificial Intelligence

This lesson consists of a detailed video that explains how AI will affect our future, emphasising on key areas: transportation, manufacturing, healthcare, education, media, and customer service.

Lesson 9:

Inspiring Women in Robotics

This activity consists of a fun flashcard game that briefly describe four women's impact on the AI/ML field. Students shall copy and paste the information appearing in the flashcards onto a search engine (e.g., Google) and find the women's name. The aim is to spur students to develop entrepreneurship and interest in technological career paths. Note that some organisations are cited with links that redirect to their home pages (e.g., Google's ML Fairness and Responsible AI, **The ExCo Group**, **Accenture**).

Teachers can encourage students to immerse themselves in these stories by asking questions such as:

- Did you know these women before? What surprises you most about them?
- How do you think their work impacts the world and our future?
- How can the role of women in the tech industry benefit it?

Challenge: AI for waste management

In groups, students will have to come up with a name and slogan/ad for their company that answer the questions mentioned in the challenge (Who, What, Why, Where?). It is recommended that students organise their ideas using Miro as shown in the tutorial, and then decide on the name and slogan.

Students will have to look for public domain or free content images of different types of waste and organise them into two folders – Training and Test. Most of the pictures will go to the former and just a few to the latter. Using Teachable Machine, they will import the pictures and test the model. When they are finished, they shall export the model as shown in the tutorial. Finally, students will present their businesses including the Machine Learning model they trained.

Final Assessment

The final assessment aims to test students' knowledge on the Circular Economy, Artificial Intelligence, and tools that can be applied in these areas (Machine Learning Models). The Assessment will be done individually. It consists of 15 questions that include exercises in the following formats:

- **Drag and Drop:** selecting words and placing them in the correct space.
- **Multiple Choice:** four options from which only one is correct.
- **True or False:** a statement is given, and students decide if it is true or not.

Final Reflection

After completing the module, you may ask the students to reflect on the learning and activities:

- What impact does Artificial Intelligence (AI) have in Design and Business? How can it change these industries for the better?
- How can we use these new technologies to make the economy more circular?
- How can algorithms and humans work together? What can each one add to the world and the industry?
- How does AI make our lives easier?

Circular and Climate Resilient Transformation of Cities

Description	This module emphasizes the role of the circular economy in urban transformation towards a net zero society. It gives an overview on the circular aspects and opportunities of the urban environment and also on how one can be the driving force of systemic change.
Module Duration	5 hours
Required digital tools	▪ Miro or Jamboard ▪ Canva ▪ Dropbox or Google Drive ▪ Microsoft PowerPoint or Google Slides ▪ Wix (Optional)
Required preparation	▪ Teachers and students should have internet access and their devices ready. ▪ Before starting, teachers should go through the module and familiarise themselves with it. ▪ Before starting the work with the students, teachers should choose one shared storage system (Google Drive, Dropbox, etc.) and create a folder where students can share their work.
Challenge: Rethinking urban areas along circularity and climate resilience	In groups of five, students are asked to redesign an urban area into a circular city district. First, they need to think about what stakeholders they could involve and engage in the design process and what circular and sustainable elements they could incorporate in their design. The ones choosing **Option 1** can compare the circular and sustainable ideas in the design, then watch a video about the **La Cité Fertile** in Paris, which is a real-life example for the challenge: a former brownfield turned into a "fertile city", with lots of circular and sustainable elements incorporated into its design. The groups working on **Option 2** will watch this **video** presenting a lot of examples for the circular transformation of a neighbourhood.

Challenge: Rethinking urban areas along circularity and climate resilience

After choosing an option and watching the related video, students discuss what elements could be installed in their own neighbourhood or city. Once the design process is finished, they need to create a map of the new area and a piece of communication material describing and advertising this new "circular urban oasis". They can use Canva or can even build a Wix website for advertisement. At the end, students are asked to present their results to the rest of the class.

Outcomes: students create a digital slideshow, map, and communication pieces about their circular urban design using various softwares (Google Slides, Jamboard, Miro, Canva, etc.). Once the presentations are ready, request students to upload them on a shared folder, allowing the groups to see each other's work. Display each group's work on a central smartboard/screen so that everyone can see while they present.

Remember that students must demonstrate the following features:

- Redesigning an urban area with circularity in mind.
- Looking at the challenge with a systems perspective, mapping relevant stakeholders that could be involved in the redesign process.
- Create marketing tools or visual illustration for their designed area.

Guiding questions for students to ask at the initial brainstorm:

- In your opinion, what kind of stakeholders could be brought in the design process?
- How would you bring these stakeholders on board and how would you engage them?
- What kind of circular elements could you incorporate in the buildings in the area?
- What values do you want to create for the citizens of the city?
- What regulations are relevant to your project?
- What economic, social, and environmental trends influence your project?

Guiding question for students to consider when preparing the communication material:

- How would you advertise your circular urban oasis to city-dwellers?

Climate-neutral Hospitals of the Future - Saving Lives the Circular Way

Description	This module focuses on the dichotomy that exists between health and the circular economy. On the one hand, climate change presents the biggest threat of global health in the 21st century. On the other hand, the health care sector itself is responsible for approximately 5% of global net emissions, which is more than global air traffic. In this module students will learn how the health care sector can take responsibility, search for ways to reduce their carbon emissions and find innovative solutions to implement principles of circular economy.
Module Duration	5.5 – 6.0 hours
Required digital tools	▪ YouTube ▪ Miro Padlet or Mural ▪ PowerPoint
Required preparation	▪ Teachers and students should have internet access and their devices ready. ▪ Before starting, teachers should go through the module and familiarise themselves with it. ▪ Before starting the work with the students, teachers should choose one shared storage system (Google Drive, Dropbox, etc.) and create a folder where students can share their work.
Challenge: Mission Net Zero Emissions	In the Challenge, students act as green consulting teams to create a road map for the hospital to reach net zero emissions by 2040. They present their road map of maximum seven minutes to the CEO of the hospital.

Challenge: Mission Net Zero Emissions

Time to team up!

Students form "green consulting teams" of 4 students to create a road map for the hospital to reach net zero emissions by 2040 and present it to the CEO.

Road map structure

- Students prepare a short introduction to the topic and at least two arguments as to why it is important that the hospital becomes climate neutral by 2040.
- Students choose at least four different areas of action (e.g., waste, general energy consumption, heating, AC, lighting, transportation, food, anaesthetic gases, others). For each area of action, they come up with at least two possible solutions that could be implemented and explain how the outcome.
- Finally, students propose one solution that should

be implemented as the first step, taking into consideration the impact, ease of implementation, cost, etc.

Site visit

To decide on the areas of action and solutions, the green consulting teams participate in a virtual hospital visit to gain insights. They visit the following areas:

- Pre-operative consultations
- Radiology CT Scan
- Operation room
- Post-operative stay, intensive care unit and normal ward
- Discharge and rehabilitation

Time to present!

Each student team presents their road map of maximum seven minutes. Other teams provide feedback; ask them which idea they think was the best and why?

The final roadmap should include these elements:

- A short introduction with at least two arguments that justify the importance of a climate neutral hospital.
- At least four areas of action that each have two solutions. For example, waste, general energy consumption, heating, AC, lighting, transportation, food, anesthetic gases, or others:
    - Area: Waste
    - Solution: Switching from single-use to reusable medical devices

Of all the solutions, students should prioritise one to be implemented first.

Sustainable Mobility for Circular and Inclusive Cities

Description	This module emphasizes the importance of adopting circular and more equitable planning approaches for improving the mobility systems of our cities. It gives an overview of the environmental and societal challenges produced by urban mobility, and how the concept of sustainable mobility is addressing them by bringing together technology solutions with a healthier and greener lifestyle.
Module Duration	6 hours and 30 minutes
Required digital tools	▪ Mentimeter ▪ **Social media platforms, YouTube** ▪ **Google Slides, Microsoft PowerPoint, etc**
Required preparation	▪ Teachers and students should have internet access and their devices ready. ▪ Before starting, teachers should go through the module and familiarise themselves with it. ▪ Before starting the work with the students, teachers should choose one shared storage system (Google Drive, Dropbox, etc.) and create a folder where students can share their work.
Challenge: Gamify Sustainability	The challenge focuses on creating a gamification app to engage students into sustainable mobility habits. The idea is that students assimilate the learning outcomes shown along the module. Basically, in teams, they must develop an app that awards the most sustainable transportation options to go to the school. For that purpose, team members need to choose different roles and work alongside their teammates as depicted in the Challenge.

Lesson 1:

Transforming cities through sustainable mobility

This introduction is meant to start a discussion about mobility's importance when planning a city's transformation. Make sure students get the message Jane Jacobs wanted to transmit and the role of this woman in the development of sustainable urban mobility.

Lesson 3:

What are the main current Urban mobility challenges?

This first lesson serves as an introduction to the challenges that urban mobility faces. It is important they get the main issues and understand the definitions. Let them know!

Lesson 4:

A sustainable and circular approach to mobility

Once students have understood the sustainable approach to mobility (also the video is quite explanatory), guide them through the reflective questions about the transport of their cities so they can have a brief but enriching discussion. Remember that it is key for them to understand the concepts of Reduce – Shift – Improve.

Lesson 5:

The future of mobility

In this last lesson, you should help students with their collaborative work, since it is meant to be a preparation for the Challenge. Guide them through the questions related with connectivity and shared mobility solutions.

Lesson 8:

Remarkable women in transport

In this section, there is an interactive map with remarkable women working on the sustainable urban mobility field. All the role models have been selected from the following sources:

Remarkable Women in Transport 2019 – WomenMobilizeWomen

Remarkable Women in Transport 2020 – WomenMobilizeWomen

Remarkable Women in Transport 2021 – WomenMobilizeWomen

Remarkable Women in Transport 2022 – WomenMobilizeWomen

However, it is also possible to choose different role models from the ones shown if your intention is to present individuals from your country.

Challenge: Gamify Sustainability

1. Ideation. When it comes to the game/app ideation, you can give students hints and show them key questions to ease their work.

a. Design the "gamification element". These are possible questions for the students. Especially, they are relevant for the role of "Sustainable Mobility Expert":

- Do you remember the "sustainable mobility pyramid"?
- How many points will the app give to each mode and why?
- Will the app give points per trip, per kilometre travelled?
- Are you thinking on giving extra points? How?
- Is there any specific problem you would like to address for your school? Check your ideas from Lesson 4: A sustainable and circular approach to mobility.

b. Design app functionalities. Relevant for the role of "Developer":

- Make them remember their Lesson 2 ideas on Mentimeter.
- Keep it simple! Avoid overwhelming users with too many options. Also, think that you have a limited time to generate a prototype of the app.
- Think on apps you use every day, what do you like the most from them? Are these functionalities useful for the app you are designing?
- Your app might also include adding friends, chat, share results on other social media, etc.
- Although it is not necessary for this challenge, keep in mind that apps usually have sections such as configuration, troubleshooting, tutorials, account options, etc.

c. Define type of users (predefined users – students/parents/teachers).

- Will functionalities variate depending on the type of users?
- If so, how the app will control who can sign up as student or as teacher?
- How will users register?
- Will the app be open to everyone or limited to school members? How will the app control this?

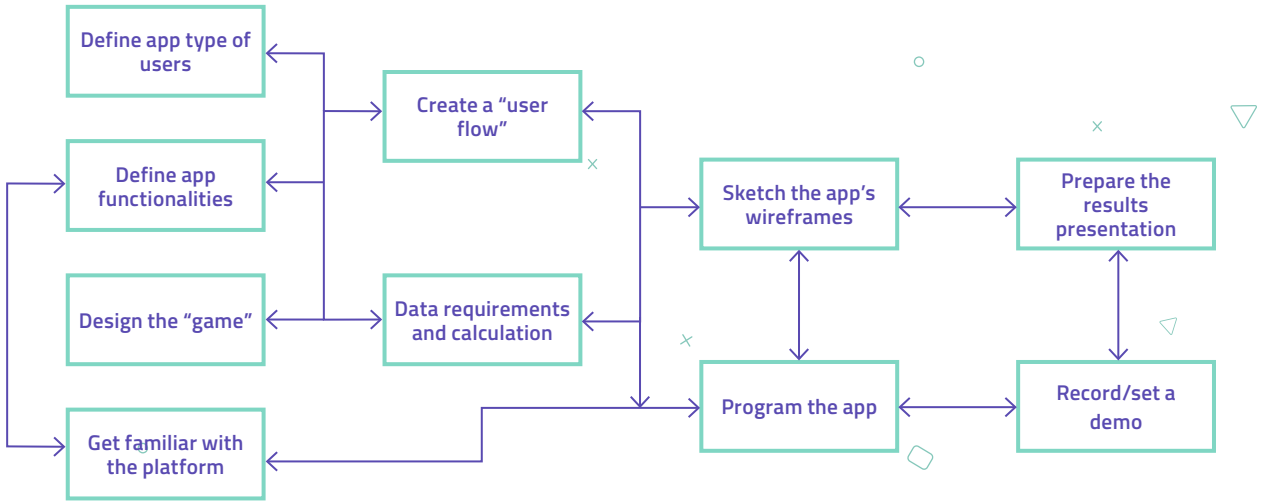
d. Create a user flow (predefined users – students/parents/teachers). Relevant for the role of "Designer":

- At this point, maybe your app is more complex

than you expected. Focus this part on the main user flow the app will be based on: recording a trip and gaining points for it.

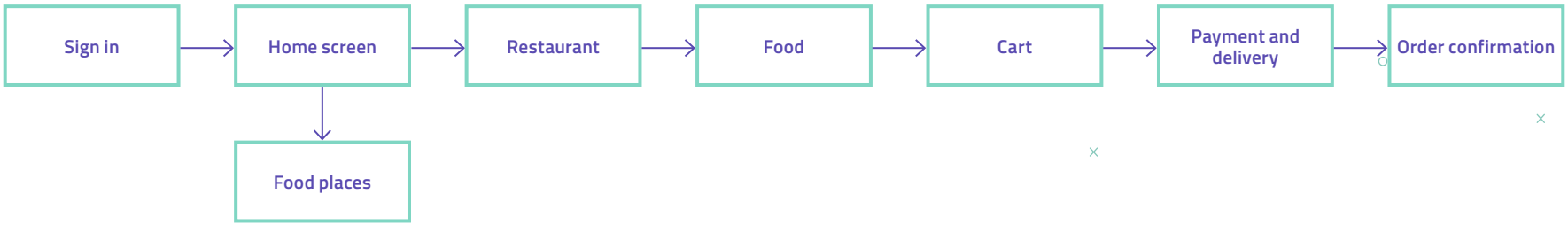
- We recommend sketching the user flow on paper.
- From this point on, the recommendation is to focus the design and prototype just to the screens included in this user flow.
- This user flow might be the based for your demo and results presentation.

At this point, it will be great if you show the students the following help. Next is a suggestion of how to approach the challenge. Notice that arrows are bi-directional, meaning that feedback and iteration between tasks might occur. For example, designers define a functionality that is impossible to code, so developers advise them to avoid or re-design it.



"User flow" examples:

User flow"of a food ordering process



Task: Purchase a hoodie (Buy Now Checkout)

Assumptions: User searches for product and lands on product page.

e. Data requirements and calculations. Relevant for the role of "Sustainable Mobility Expert":

- Remember the challenges learned during the module. Do you think user's will be interested in learning the impact of their trip, in terms of pollution, for example?
- An easy approach might be converting the distance travelled into CO2 emissions or public space usage. Check the figure included in Lesson 3.

f. Sketch the app's wireframe. Relevant for the role of "Designer":

- The wireframes are the screens of your app. Sketch those included in the main user flow.
- Remember you have a word cloud of terms related to sustainable mobility. Use them for your design.
- Involve developers in this activity, as they can advise how some screens might be implemented.

* Finally, you can suggest to your students that for their final presentation, it is a good idea to record a 1-2-minute video "navigating" through the app. They can record it directly from their computer screen.

Schools as Living Labs for Systemic Food Circularity

Description	The objective of this module is to educate the learners on the concept of "Systems Thinking" as a tool to analyse and understand the environment where students live and identify the opportunities and spaces to design food circularity through living labs. Particularly, this module focuses on the relevance of living labs in cities and peri-urban areas as systemic tools to foster a circular economy of food. Moreover, it presents the opportunities provided by school gardens as living labs for experimenting, innovating, co-creating, and educating about the circular economy in food systems.
Module Duration	5 – 5.5 hours
Required digital tools	▪ Miro ▪ Glide ▪ Google Sheets ▪ Dropbox or Google Drive
Required preparation	▪ Teachers and students should have internet access and their devices ready. ▪ Before starting, teachers should go through the module and familiarise themselves with it. ▪ Before starting the work with the students, teachers should choose one shared storage system (Google Drive, Dropbox, etc.) and create a folder where students can perhaps share their work.
Challenge: Digital tools to grow food in school living gardens	For the challenge, students will be working in groups to develop a mobile application that can be useful for students and teachers who decide to grow food in their school living gardens and make their contribution in actively promoting food circularity.

Lesson 1 and 2:

Introduction

The introduction aims to set the stage for the module. It is important that students get the key messages of the module (Systems Thinking for Food Circularity, Living Labs, School Living Labs). This process is ensured by explaining the topics that will be presented and mostly by the interactive activity related to the keywords.

Lesson 3:

Systems, Systems, Systems!

This first lesson serves as an introduction to the concept of Systems and Systems Thinking. It is key that the students learn how to describe a System and its three parts (Elements, Interconnections, and Purpose) and get the basis of Systems Mapping.

Lesson 4:

The Food System

Once students have understood what a System is, they will get introduced to Food Systems. It is important that they understand what the Elements, Interconnections, and Purpose(s) of a Food System are. The video provided is very useful for understanding how the current food system affects our health and environment and what benefits the transition to a circular food system could bring. We suggest stopping the video after 2'00 min.

Lesson 5:

Living... what? Living Labs!

Once students have familiarised themselves with the concepts of Systems Thinking and the benefits of transitioning to a circular Food System, it is important that they understand that one possible way to practically leverage systems thinking and foster a circular economy of food can be achieved through the design, co-creation, and implementation of Living Labs. The key learning elements here are the Where, the Who, and the What of Living Labs. In this lesson, students will get to know a Canadian student in sustainability, Emily, through a video, and they will meet her again later.

Lesson 6:

Schools as Living Labs

In this lesson, the students will continue their journey with Emily and discover how schools can be turned into Living Labs. It is key that they understand that this can be achieved by: (1) defining real issues to be addressed, like fostering food circularity in the urban and peri-urban areas; (2) involving all the relevant stakeholders, like students, teachers, citizens, food suppliers, local farmers, and cooks; (3) promoting co-creation. Also, it is important that students get the idea of the fact that an easy way to turn schools into Living Labs can be done through the co-creation of schools (living) gardens.

Lesson 7:

Inspiring case studies from around the world

In the last lesson, students will learn about inspiring case studies from around the world of how schools have been turned into Living Labs with a focus on the Food System. It is important that they familiarize themselves with what happens in other contexts, also outside of

Europe. Of course, there are many more case studies to learn from, so feel free to propose others that may come to your mind.

Lesson 9:

Inspiring Systemic Thinkers

In this section, there is an interactive map with remarkable women who made a difference in the key topics presented in the module (Systems Thinking, Food System, Schools Gardens). However, it is also possible to choose different role models from the ones shown, for example, you could find other women from Europe or your own country. Or you may ask the students to come up with names of inspiring women they know.

Challenge: Digital tools to grow food in school living gardens

Teachers could propose to the students the following action plan (perhaps some steps in the class and others at home):

1) Form teams of four or five students, with at least half girls!

2) Use systems thinking lens to ideate and plan a project for the app.

3) Build a functioning prototype.

4) Present the prototype to the rest of the class.

An important initial step in the ideation and planning is the reflection on the following aspects, that teachers should remind students:

- Who will be the users of the app?
- What is the goal?
- What are the users currently missing to reach their goal?
- What problems could they face while working to reach their goal?
- What can be done to provide them with what is missing?
- What different solutions to these needs and problems can be implemented?

The target users are teachers and students from different schools who are not experts in gardening and horticulture, motivated to contribute to the circular

economy of food by transforming their school gardens into living gardens to grow food and vegetables for local consumption.

To develop the app, students will use a digital tool called "Glide". It is a powerful tool that helps create a functioning app starting from Spreadsheet files. Hence, the next steps to be followed by the students are:

5) Preparing the spreadsheet file – which entries for the columns and which entries for the row: names, images, description, the quantity of water indoor, the quantity of water outdoor, etc.

6) Looking for the data to insert into the spreadsheet: looking online for a list of commonly grown vegetables, their images, their descriptions, and the amount of water they usually need.

7) Filling out the spreadsheet with the data collected.

8) Opening Glide and Signing up by entering an e-mail address.

9) Uploading the spreadsheet file on the Glide platform.

10) Setting the functionalities of the app (e.g., the relations between data) and its appearance (e.g., its colours and layout).

11) Publishing the app and sharing it with classmates and friends!

Teachers may suggest students to continue working on the idea further in the following weeks as extra and optional homework.

Additional tips:

Students research and develop their ideas based on the information they have received and their creativity.

- We advise letting the students choose independently the digital tools. It is best to do that in advance and in preparation for the classroom activities (create an account and install the software if needed). Once the presentations are ready, request students to upload them to a shared folder, allowing the groups to see each other's work. Display each group's work on a central smartboard/screen so that everyone can see it while they present.

Monitor the groups to ensure they stay on track during their research and that all the students in a group are involved in the work. Set the scene for the task; to make it more interesting, make it a serious but friendly competition among the groups. For instance, you could opt for a class vote of the best presentation.

Here are some ideas for you to have up your sleeve if students need some guidance for brainstorming sessions:

- What were the crucial aspects?
- What was surprising?
- What was inspiring?
- How does it relate to their everyday life?
- What could be done in their context?
- Do you know other similar solutions?
- How does this newly acquired knowledge make them want to act?

Smart and Healthy Cities

Description	Air pollution, noise, heat, and the lack of green space and physical activity, are all environmental factors that can have a negative impact on our health. Students will learn how to contribute to healthier urban environments by adopting the right urban design and mobility solutions. The module will also present some examples of technological advances in the service of people's health and well-being. The aim of this module is to let students: ▪ Identify the main environmental stressors and understand their impact on your health. ▪ Discover how technology can help us monitor what we are exposed to in our environment, and choose the best solution. ▪ Understand that changes in where we live and how we move are part of the solution too. ▪ Get familiar with R coding language and data analysis. ▪ Develop your problem-solving and presentation skills.
Module Duration	7 hours (420 minutes): ▪ Lessons: 118 minutes ▪ Preparation for the Challenge: 23 minutes ▪ Challenge: 269 minutes ▪ Final Quiz: 10 minutes
Required digital tools	▪ YouTube ▪ Google Maps ▪ Free option plan of Posit Cloud **(including RStudio and Shiny App)** ▪ **PowerPoint presentation (template provided)**

Required preparation	▪ Internet connection is needed for this module. ▪ For the challenge (the second part of the module), students will need to use a computer; it cannot be completed with other devices such as smartphones or tablets. ▪ The challenge is designed to be used through Posit Cloud's free option plan. However, it can also be developed by downloading and installing RStudio on school computers for free.
Challenge	*Healthy school environments: analysing reality and coming up with urban design and mobility solutions.* Students are appointed by the mayor of Barcelona to analyse and come up with solutions to make school environments healthier. In groups of 3-4 students and with the help of Shiny App and machine learning, students will perform an analysis of the environmental stressors around schools in 3 different districts of Barcelona and give recommendations for some solutions in urban design and mobility. Results are presented to the class for collective discussion.

Introduction:

Lesson 2:

What is a Smart City?

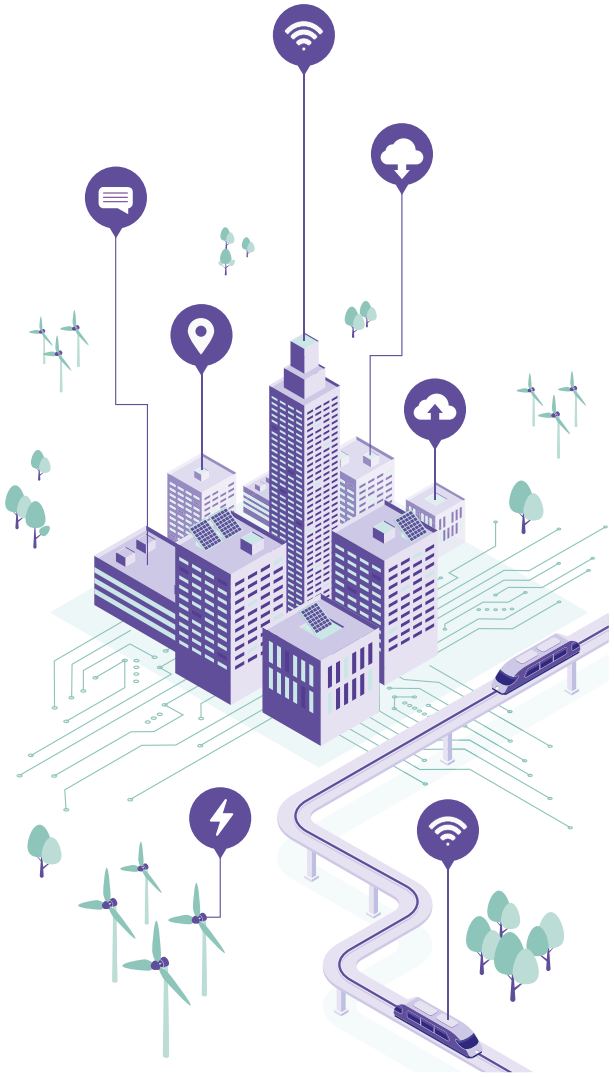
Through definitions, illustrations and real-life examples, students will understand that healthy and smart can materialise in many different elements in an urban environment.

After some examples of *"smart solutions"* for cities, students are asked the following question: *"Can you think of any other examples of smart city solutions? How do you think your city could become "smarter"? Discuss in class with the teacher for 5 minutes."*

The purpose of this open question is for the class to collectively reflect on those "smart solutions" and come up with new ideas that could be best adapted to their local city, considering its scale, resources, capacities, and other relevant characteristics.

Here are some examples of potential solutions for discussion:

- Something as simple as provision of free WiFi services could be considered a "smart solution". Offering free WiFi to citizens and tourists helps to connect society better and to keep customers in a shop productive, which will help to **make them stay on the premises for longer.**
- **Carpooling and bike-sharing** can help citizens and tourists get around town more efficiently.
- **Intelligent streetlights** adapt to movements of citizens.
- Smart bus stations provide live travel information.
- Smart waste management systems can optimise the routes of trash collectors.
- Smart benches can enable charging devices by running on green energy (like **this one** invented in Croatia).
- A switch to a digital healthcare system that uses wearable devices and video consultations to care for patients remotely (as implemented in Singapore).
- San Diego (United States of America) has installed 3,200 smart sensors to optimise traffic flow and parking as well as enhancing public safety and environmental awareness. Electric vehicles are supported by solar-to-electric charging stations and connected cameras monitor for traffic problems and crime.



Five Key Environmental Stressors

The students will go through **5 key environmental stressors: air pollution, noise, natural spaces, physical activity, and heat.** The material presented for all stressors follows a similar structure (although with some variations in the type and format of the content):

- A short video on the topic
- Informative text and interesting facts
- An example of a "deep tech" development in the field
- A multiple choice quiz about the main sources/ causes in cities

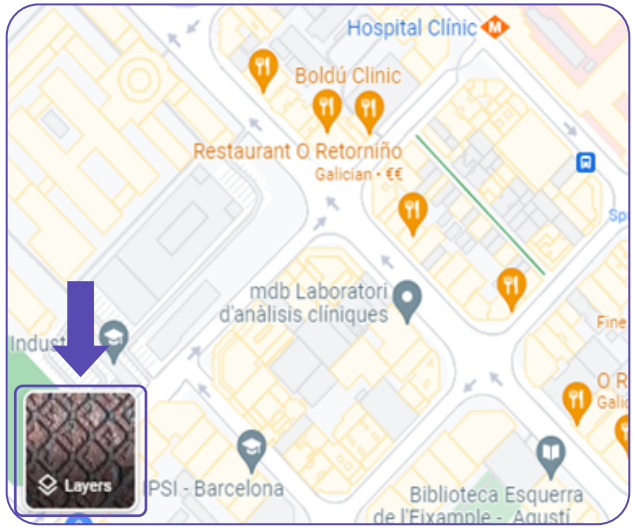
Students might need the teacher's guidance or assistance in the following tasks:

Lesson 7:

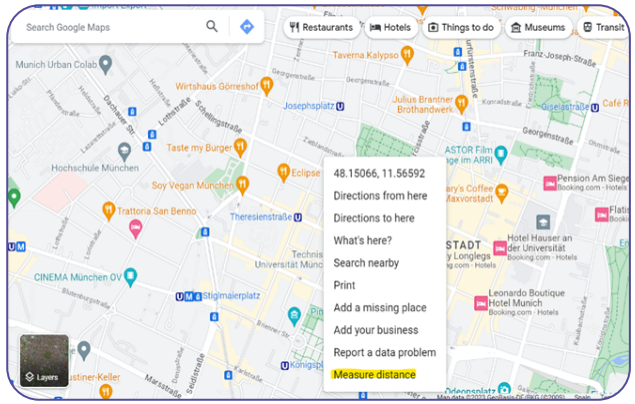
Natural Spaces

- **QUESTION:** *Does your home meet the 3-30-300 rule? Check on Google Maps using satellite view and measure the walking distance from your home to the nearest park.*

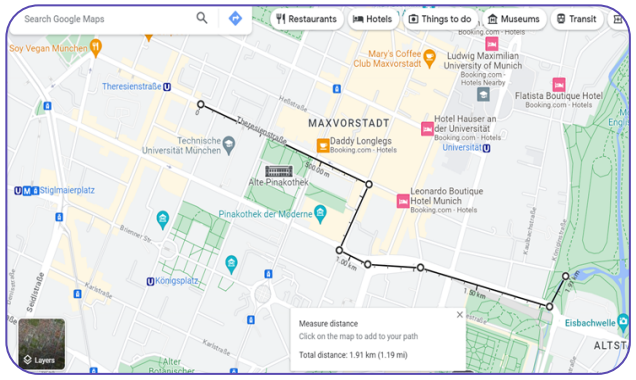
To check the number of trees that are visible from their home, students can use the Google Maps' Satellite layer (to be selected on the bottom left corner of the screen), where trees are visible when zooming in.



To measure the distance between their home and the park, students can **right click** on the home location on the map and **select "measure distance".**



Then, **draw a path** as the distance is measured. The total distance will appear in the pop-up box, like in the example below.



Lesson 8:

Physical Activity

- **QUESTION:** Do you meet these guidelines? Discuss in groups of 3-to-4 classmates for 5 minutes.

You should make sure that students discuss among themselves about whether they meet the WHO physical activity guidelines. Be careful to include all students in the conversation, whether they are more interested in sports or not. Students should go beyond stating "yes" or "no" to meeting the guidelines, providing some **examples of the type of physical activity they usually choose or prefer, or the barriers they have or perceive in order to be more active in their everyday life.**

- **ACTIVITY** on the report by Sport England, girls aged 3-11 experience less enjoyment from being physically active and are less confident about their sporting ability than boys.

- **QUESTION:** *What do you think could be done to revert this trend? Discuss in class with the teacher for 10 minutes.*

Here, you can lead the discussion and bring some examples to the class, such as:

- Search for more investment in girls' sport, e.g., involving private entities as sponsors.
- Challenge current stereotypes by making inspiring female athletes visible, e.g., through social media, ads, or as a part of school curriculum.
- Insist on the importance of sharing household chores and responsibilities in childcare, e.g., reflecting on their own situations at home, role playing some typical situations.

Lesson 9:

Heat

- **ACTIVITY:** *Use the* ISGlobal Heat Index Calculator *to compare the level of danger and associated protective measures for the summer conditions in these four cities.*

Solution:

CITY (COUNTRY)	MONTH, HOUR	TEMPERATURE (°C)	RELATIVE HUMIDITY (%)	HEAT INDEX	WARNING
Vilnius (Lithuania)	July (14:00)	22	41	21 °C	Safe
Lisbon (Portugal)	July (14:00)	27	50	27 °C	Caution
Bucharest (Romania)	July (14:00)	34	35	35 °C	Extreme Caution
Reykjavik (Iceland)	July (14:00)	13	62	12 °C	Safe

Lesson 12:

7 Ways That Bicycles Can Make Cities (and Citizens) Healthier

This lesson emphasises the links between mobility and health, through the example of bicycle use (compared to driving cars). After viewing 7 infographics on the topic, students will read about the idea behind **Biklio App**, which is still in a pilot phase. Once they've done this, the following question is raised:

- **QUESTION:** *Would this kind of incentive make you use your bike more often? Discuss in pairs for 5 minutes.*

Classmates should talk about the purpose of this type of apps, sharing their impressions and own experience regarding cycling. They might also think of what could be a motivation to use their bike more, beyond what Biklio App proposes.

Preparing For the Challenge

Lesson 16:

School Environments: Why Protect Them?

Through informative text and a brief video, students will be given some context on the importance of protecting school environments and on how the use of "smart" technology can aid in the creation of healthier school environments.

Lesson 17:

Getting Started with Programming and Visualisation Tools

The students get to try out RStudio programming through two very brief and simple exercises. They will use the online version through **Posit Cloud** for this. Video tutorials are available for the students to help them in this task.

In the instructions for these exercises, students are told to write on lines 2 or 3 so that all the exercises look similar to what appears on the tutorial videos. However, the exercises will still work if students use different lines of code (as long as they follow the correct order, in the case of Exercise 2).

The code provided in the instructions has blank spaces between the letters, the symbols, and the numbers. The exercise would work without these blank spaces, but programmers use them so that it's easier to read the code.

The Challenge: Building Healthy School Environments

Lesson 21:

Step 1: Visualise the Map Using the Shiny App

- **Goal:** To visualise the map that they will need to carry out an analysis of the environmental stressors in real-life school surroundings.
- **Tools:** Posit Cloud (including RStudio and Shiny App)

1.1 Students have to gather in groups of 3-4 students to work together on this challenge. You should try to keep the size of the groups within the class homogeneously distributed.

1.2 Students have to choose a district of the city to work with, from the 3 options provided.

You should make sure that all case study districts are covered in the class.

1.3 Students have to start RStudio and work on the Shiny App through Posit Cloud online site, following the step-by-step instructions provided. Students have to download a folder with data here.

Students will use Posit Cloud's free plan to avoid installation and configuration on school computers. This free plan allows each personal account to work on a maximum number of projects, hours, and GB of data use. **The work carried out by the students for this challenge is unlikely to exceed these limits.** However, if such was the case, one possible solution would be to run the code and open the Shiny App using a different account. As the challenge is developed in groups of 3-4 students and they work on the tasks together, probably just one or two accounts will be actively using the Shiny App. Therefore, if they were to reach a limit for free use

with one account, a different member of the group can follow the instructions to run the code and open the Shiny App using a different account; hence having more time to complete the challenge.

There is **another option** to carry out the challenge that is not dependent on Posit Cloud. This option involves **downloading RStudio software** and installing it in the computers that the students are going to use prior to carrying out the challenge. RStudio is a free and open source software, so it is considered a safe download. Check the steps to do this **here** and a **video tutorial.**

The students are then reminded about the ethical use of open data, and shown that the references to the datasets they will be using are on the "References" button on the Shiny App window. You can take this opportunity to remind students about the importance of acknowledging authorship and that the data they will be working with is real-life and recent data gathered in the city of Barcelona. This is the data that many researchers and entrepreneurs are using today to carry out studies or come up with innovative products.

Lesson 22:

Step 2: Analyse the Map Using the Shiny App

- **Goal:** To carry out an analysis of the environmental stressors in real-life school surroundings.
- **Tools:** Posit Cloud (including RStudio and Shiny App), PowerPoint presentation

Students will use the map on the Shiny App to visualise the different layers of information in order to conduct the analysis.

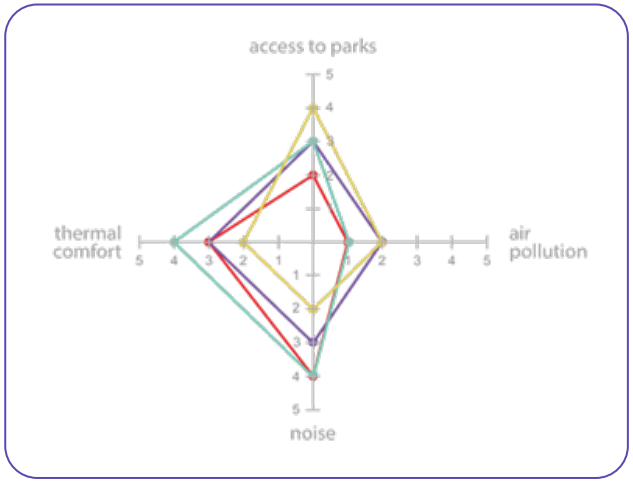
Students will answer some questions and record their findings on the presentation template file that has been prepared for their district of study, which they can download from the **link** provided.

You should remind all groups of students that they should choose the right presentation layout according to their district choice (District A, District B, or District C).

If you prefer, you can print a copy of the slides for each group of students, so they can work on the paper.

Students are asked to transfer their answers to

questions 4-7 on a spider web diagram on their presentation. Instructions on how this diagram works are provided, however you might offer assistance in this step if students find some difficulties interpreting and completing the spider web diagram.



On the 1-5 scale for each axis, **1 represents the worst situation and 5 represents the best situation.**

The answers to each school environment in the district of study can be drawn in a different colour so they are easier to distinguish.

This overlapping can help students evaluate the overall situation of school environments in their district of study. For instance, in the example included in this guide, air pollution levels are generally worse, while the rest of indicators (access to parks, noise, and thermal comfort) are intermediate. This means that air pollution is the most worrisome environmental stressor that should be tackled in this district.

Lesson 23:

Step 3: How Can Machine Learning Aid Us in Our Analysis?

- **Goal:** To learn about the application of Machine Learning in data generation and visualisation through an example of NO2 levels in the area of study.
- **Tools:** Posit Cloud (including RStudio and Shiny App), PowerPoint presentation.

In this step, you can help the students identify the differences between the NO2 CALIOPE layer and the NO2 Machine Learning layer for their district of study.

You can also suggest some reasons behind the disparities between the two maps, such as traffic intensity or housing density.

Traffic intensity:

In general, we know that the main source of NO2 in cities is motorised traffic. This means that those areas with more traffic intensity will probably show higher levels of NO2 concentration. The 800 sensors deployed for the Machine Learning model are able to register peak levels of pollution in areas such as busy intersections, traffic lights, tunnel exits... where cars have to stop and re-start their engines, brake and/or accelerate quickly.

Housing density:

The map generated through Machine Learning also allows us to see differences between areas that are more built-up (ie. have higher building density) and areas that are more dispersed (e. have lower building density). In general, less built-up areas allow the contaminants to disperse more, so sensors register lower concentrations. In highly built-up areas, where streets are narrow and buildings are high-rise, contaminants tend to get "trapped" and are not easily dissipated by wind flows.

Lesson 24:

Step 4: From Analysis to Action

- **Goal:** To transition from analysis to solutions, by focusing on the case of one school and one green space, and working on their connection (healthy routes/itineraries).

- **Tools:** Posit Cloud (including RStudio and Shiny App), PowerPoint presentation

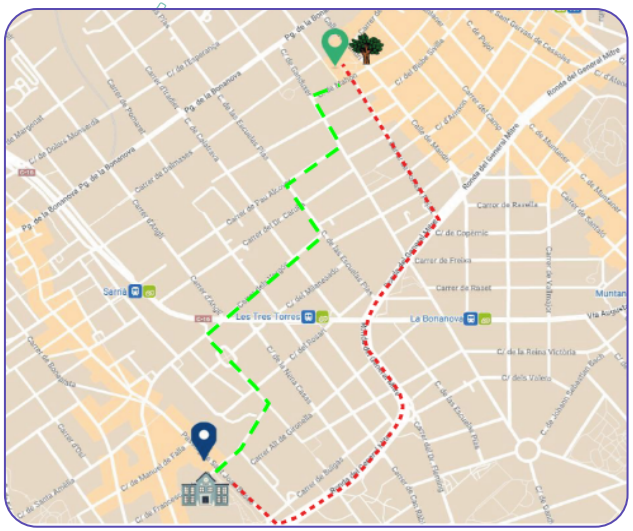
In the presentation layout provided, the groups will find a map with a red dotted line representing the fastest route to walk or bike from a school to a park. Students should locate the school and park on the Shiny App map and start analysing the route in terms of the available environmental indicators. You can help students identify these elements on the map by reminding them that the school of study will be marked with a white icon and that the park is marked with a green icon. You can also suggest considering the presence of nearby gas stations (marked with an orange icon), since it is known that these are areas where cars pass by a lot and could lead to higher risk of accidents.

The groups should then, after considering these multiple environmental factors, come up with an alternative route to walk or bike from the school to the park.

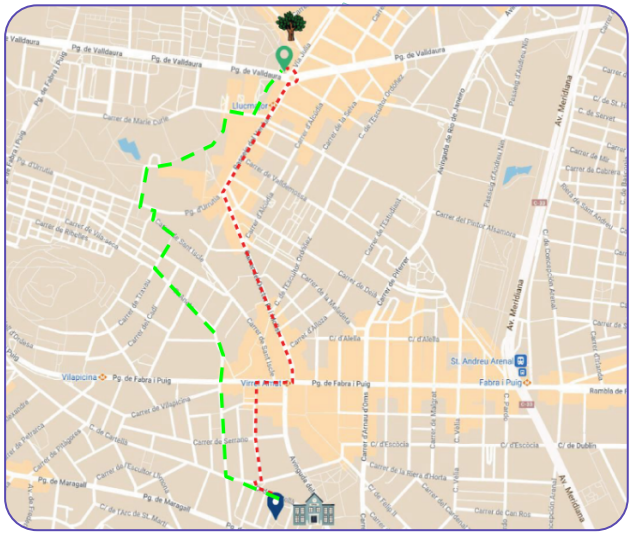
There is no single right answer to this activity, since groups might weigh certain factors differently when making decisions. However, both in the PowerPoint presentation and during their presentation in front of the class, students should be able to justify their proposal for an alternative route in terms of air pollution, noise, green space, and/or thermal comfort. Traffic safety might also be considered a relevant factor here.

The following are examples of **possible alternative routes (in green)** versus the "fastest route" (in red).

District A:



District C:



District B:

To boost their creativity and problem-solving skills during this challenge, students are asked to come up with **5 key context-based actions** that should be brought to the local government's attention in order to make the fastest route (in red on the map) also be the healthiest route.

You must remind the students that, among the list of 5 actions proposed, at least two actions should involve urban design measures, and at least two actions should involve changes in mobility.

You can help the students by providing some examples of actions, such as:

- **Urban design measure:** Redesigning streets so that the motorised traffic lanes are less and in the middle, while pedestrians, bicycles, and vegetation occupy most of the width of the road. Putting cars in the middle of wide roads also reduces the noise levels that reach the buildings (**link**).
- **Urban design measure:** Improving street crossings and making streets greener in general (**link**).
- **Urban design measure:** you might also suggest how AI could help in street redesign (**link**).
- **Change in mobility:** An app to promote walking to school together (**link**).
- **Change in mobility:** Reducing speed limits to 30 km/h to reduce the noise of motorised traffic and also reduce the risk and severity of accidents. The health of pedestrians and cyclists is more protected if cars slow down (**link**).
- **Change in mobility:** Bicibus Kid Wheel Power (**link**).

Lesson 25:

Step 5: Zoom Out and Present the Results

- **Goal:** To make some final reflections at a city scale and introduce the socioeconomic variable as an object of collective discussion on equity issues comparing the 3 different districts of study.
- **Tools:** Posit Cloud (including RStudio and Shiny App), PowerPoint presentation.

After all this analysis, the students will zoom out to understand the situation of their district in relation to the other districts of study and to the city of Barcelona in general. **Each group will present their results**, which will have been compiled in a single presentation document. The students should present

their findings using the presentation slides.

In addition to the results of the analysis itself, you should encourage the students to explain other aspects of the challenge experience, such as:

- their decision-making process;
- their impressions regarding RStudio, the use of the code, and the Shiny App visualisation tool;
- who carried out the different tasks within the group;
- what they find most interesting or challenging.

All group members should present the findings of the group and speak for a similar amount of time.

Once the presentations by the students have finished, you will lead the conversation by introducing the topic of inequity. You can start by raising the following questions to the class, for groups to compare their districts of study:

- **Q14:** *Are there differences in the amount of green spaces?*
- **Q15:** *Are there differences in the environmental quality of school environments?*
- **Q16:** *Could socioeconomic variables be behind these findings?*

Collective discussion can be aided by input such as the following:

- The latest research has shown that disadvantaged neighbourhoods usually have lower environmental quality (ie. more air pollution, noise, and heat) and less access to green space or public facilities (such as good public schools). This means that those living in poorer neighbourhoods are bound to have less opportunities and poorer health throughout their lives (**link**).
- It is often said that our zip code is a better predictor of our health than our genetic code (**link**). This means that the environment we live in is key.

Collective discussion can also revolve around which urban design and mobility strategies have been proposed the most by the different groups, and/or which stand out as especially interesting or innovative.

Semiconductors: Powering Digital and Green Transformation

Description	It is impossible to imagine our world without semiconductors. We find them in almost all devices in our daily lives and the demand continues at a steep level. Not only the demand for semiconductors is high, but also the need for employees in this technical fiewd. The semiconductor industry is increasingly becoming the focus of new processes or measures to reduce environmental pollution. In this module, theoretical background knowledge is addressed, but also the need to find new innovative approaches in order to produce semiconductors in an environmentally friendly way.
Module Duration	7h 45min
Required digital tools	▪ **Device to access the internet.** ▪ Figma ▪ GoDaddy ▪ Microsoft Bing ▪ Looka ▪ Canva
Required preparation	▪ Teachers and students should have internet access and their devices ready. ▪ Before starting, teachers should go through the module and familiarise themselves with it. ▪ Before starting the work with the students, teachers should choose one shared storage system (Google Drive, Dropbox, etc.) and create a folder where students can share their work.
Challenge	In the challenge, students put themselves in the role of a project team in a semiconductor manufacturer in Europe. The management team has given the project team the task of restructuring the entire company and preparing it for a green future. Therefore, students must first examine the existing manufacturing process and then implement eco-friendly and circular economy strategies. Additional they have to create a complete rebranding of the company and design a new marketing statement that differentiates the company brand from the competitors.

Lesson 1:

Our World Runs on Semiconductors

The introduction briefly points out the importance of semiconductors in our daily lives, but also their responsibility in terms of environmentally friendly production and the use of raw materials. In the hotspot exercise, students are asked to identify different devices that contain semiconductors in a private household.

Lesson 2:

Semiconductors and Their Role in Facing the Climate Change

In this lesson, students get a first impression of how semiconductors are key players in advancing green technologies, like solar panels and wind turbines. They convert sunlight and wind into clean electricity through photovoltaic cells and power electronics. Semiconductors also optimise energy distribution in smart grids, boost electric vehicle performance, and cut emissions. By empowering green solutions, the

semiconductor industry is driving a global shift toward sustainability and a greener future, reducing fossil fuel reliance. In the following chapters, however, students also take a critical look at how they are produced and what resources are required in their manufacturing process.

Lesson 3:

The European Union and Its Role in the Semiconductor Industry

Over the last 70 years, semiconductors have become a crucial element in the manufacturing of electronics. Since the Transistor's invention, electronics have rapidly advanced, powering various sectors like manufacturing, communication, arts, and medicine. Semiconductors control electric currents in devices, forming electronics' core. The EU aims to strengthen semiconductor production due to chip shortages, striving for 20% of the production by 2030. This involves attracting talent, creating infrastructure, and investing in research and development. While East Asia and North America dominate the field, the EU seeks greater independence in semiconductor manufacturing.

This lesson provides an overview of the essential purposes to achieve these goals and the efforts of the European Union (EU) to avoid chip shortages on the market.

In the exercise, students have to drag the words to the right place to complete the 6 challenges of the EU's semiconductor industry.

Lesson 4:

Words and Their Meanings

Since we have learned about the important role of semiconductors in our daily life, this lesson focuses on different keywords that students should come in touch with to fully understand the next lessons and its content. Students have to discover the image where they can find diffe rent hotspots with detailed explanations.

Lesson 5:

The Difference Between a Conductor and an Insulator

Before students can understand what a semiconductor is, they have to understand what a conductor and an insulator are. A short video explains the differences.

In an exercise, students have to think about it, research on the internet, and choose the right definition.

Lesson 6:

It All Depends on the Materials

Different materials can conduct electricity differently. In this lesson, students have to decide between pictures if the material is a conductor or an insulator.

Lesson 7:

Why Everything Comes to 1s and 0s

The lesson demonstrates how semiconductors can be used to act as electronic building blocks. Due to the physical possibility to conduct electricity or not, semiconductors are able to transmit signals to computer-driven devices, e.g., to activate or deactivate them (let electricity flow or not). Students come in touch with a simple switch with a bulb. In the exercise they can click on different materials to see if the electricity flows.

Lesson 8:

Welcome to the Silicon Age

This lesson explains that silicon is currently the most important semiconductor and how this raw material can be extracted to produce semiconductors. Students can discover the different steps to gain silicon from sand. By clicking on the flip cards, they get detailed information.

Lesson 9:

From Sand to Chip

This chapter introduces the essential semiconductor manufacturing process. Silicon is the main material used for semiconductors, extracted from sand through steps like melting, crystallisation, and slicing into wafers. Although, students also get to know the dark side of the process, namely resource-hungry production. This energy-intensive process depends heavily on fossil fuels, with chip manufacturing contributing to significant carbon emissions. Ultrapure water is crucial for cleaning silicon wafers, using a substantial amount of municipal water. At the end of the lesson, a video shows interesting insights on how microchips are made.

Lesson 10:

Every Step Counts

The production of semiconductors consists of many individual steps. Students learned the different steps in Lesson 8. In a short exercise, they now have to bring the manufacturing process in the right order.

Lesson 11:

Innovations in the Semiconductor Field

To address the climate crisis and the scarcity of raw materials (especially in Europe), the semiconductor industry needs critical changes from architectural design to sustainable materials and end-to-end fabrication. To achieve this, the industry is adopting the production process by implementing the latest technologies that increase efficiency and meet environmental requirements.

In a drag and drop exercise, students find the right trends and innovations. They can use the web to search for further information.

Lesson 12:

Get in Touch With Companies!

In this lesson, students form small groups to search on the internet for start-ups or companies in the semiconductor field. It should be a company, ideally in their country, that is focusing on one specific problem of the semiconductor industry.

Three websites can help for research:

University incubators (e.g., https://siliconcatalyst.com), **Crunchbase** (https://www.crunchbase.com/) or **TechCrunch** (https://techcrunch.com/).

If they don't find anything here or the search takes too long, this article can also help:

https://www.semi.org/en/blogs/technology-and-trends/startups-for-sustainable-semiconductors-2023-finalists-announced.

Students have maximum 3 minutes/group to present information about the company in front of the class:

- Name
- Description of the service or the product they offer.
- Why is the service/product useful for the semiconductor industry?

Ask students to discuss the results with the other groups.

Lesson 13:

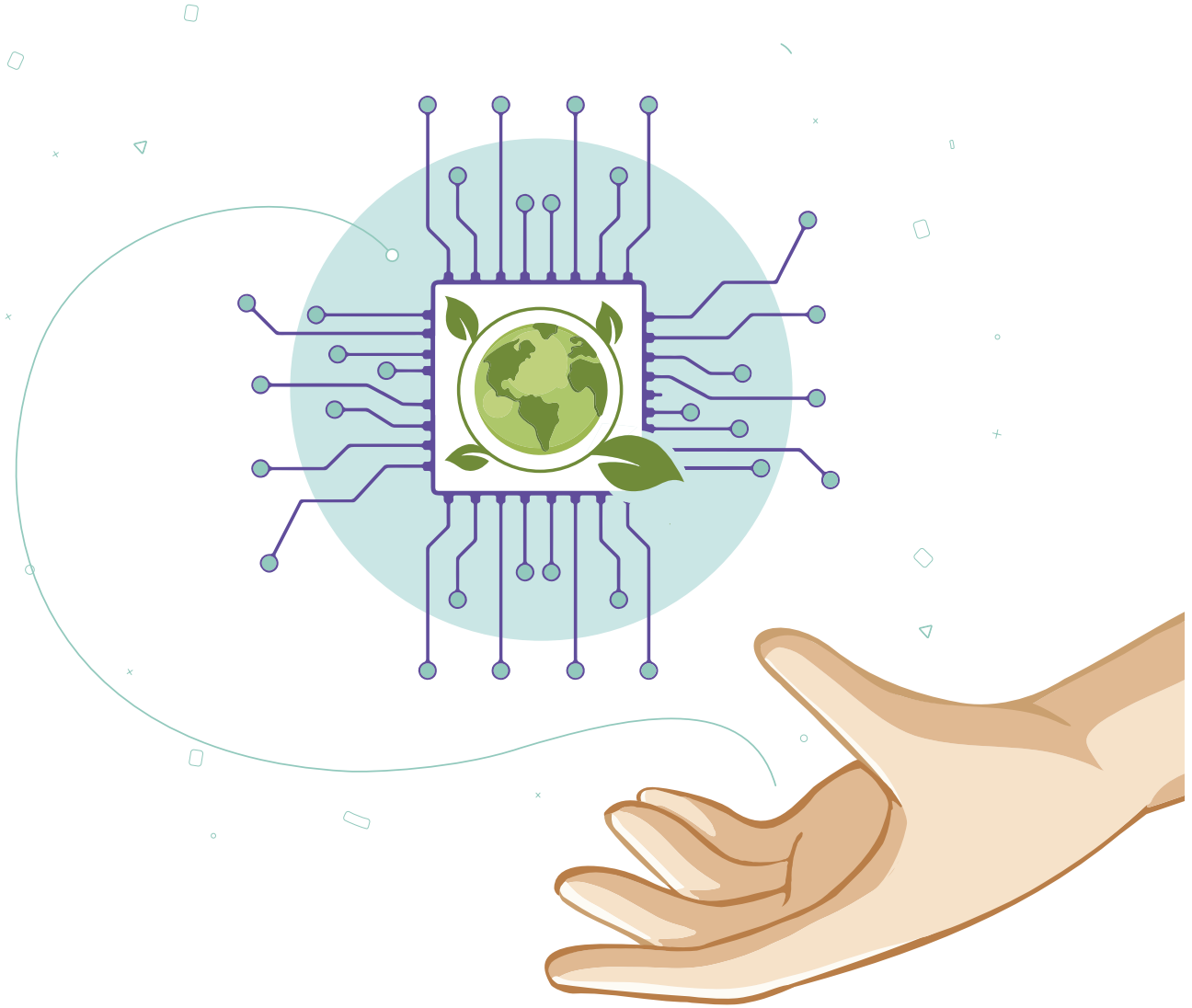
Did You Know?

In this lesson, exciting questions with detailed feedback are waiting for students to consolidate what they have learned in the previous lessons.

Lesson 14:

How Can the Semiconductor Industry Implement the Circular Economy?

Semiconductors drive green technologies like solar cells, but their production consumes energy and water. Manufacturers need eco-friendly approaches, like reusing heat and water, for more efficient production. Sustainability and circular economy principles are crucial for an eco-friendly semiconductor industry. Embracing sustainable practices involves redesigning products, extending lifecycles, and promoting recycling. The rise of "Internet of Things" devices adds to e-waste concerns, emphasising the need for responsible practices in the semiconductor sector.



Lesson 15:

How to Turn Electronic Waste into Raw Materials

In two insightful videos students get in touch with real examples of recycling materials and finding circular economy strategies.

Lesson 16:

Known Strategies to Become More Eco-friendly

On one hand, companies look for innovations to redesign the manufacturing process of semiconductors. On the other hand, there is a high demand on the market for those products. There are four major strategies, and students have to solve the exercise by choosing the right one.

Here are short descriptions of the strategies:

Data Mastery: Data mastery is not only key to a sustainable future, but also the new currency for competitive advantage. Semiconductor manufacturing analytics embraces data strategy goals, data engineering requirements, and yield improvement use cases to drive strategic growth insights.

Green Tech: Incorporating green tech involves optimising energy use through data centre strategies such as transitioning to hyperscale centres and leveraging local renewables, which, as exemplified by semiconductor companies, can lead to substantial emissions reductions and enhance sustainability efforts.

Supply Chain Management: Effective supply chain management entails standardising reporting processes, fostering collaboration, and embracing responsible sourcing practices to enhance sustainability throughout the electronics industry supply chain.

Circular Design: Circular design is essential as it not only addresses the mounting issue of electronic waste but also offers substantial economic benefits, including increased operating profit and cost savings. Embracing sustainability from the design stage can contribute significantly to reducing material losses, CO_2 emissions, and achieving ESG (Environmental, Social, and Governance) goals within the electronics industry.

Lesson 17:

The Future Cannot Be Written Without Women

The final lesson highlights the gender gap. Two interviews of women in the tech-industry explain the challenges.

Challenge:

Lesson 18:

Reimagine a Company Into a Green Future

Students form teams and put themselves in the shoes of employees who already work at a semiconductor manufacturer and have been tasked by management with making the entire development process sustainable.

To achieve this, the entire production process needs to be reengineered. Eco-friendly and circular economy strategies have to be implemented. This requires additionally a complete rebranding of the company, including a new marketing statement which differentiates the brand from other competitors (Unique Selling Proposition) as well as a new name and corporate design.

Before diving into the challenge, students watch a video to refresh their understanding of the semiconductor manufacturing process.

Lesson 19:

Challenge Overview

The steps of the challenge will be shortly listed and the goal – a presentation for the management team – is explained. Make sure students save the documents in a central location.

Lesson 20:

Analysing the Existing Manufacturing Process

First, students look at this process in detail and analyse the individual steps with the help of a special business

model canvas that focuses on the environmental lifecycle. In the picture, students can see the current manufacturing process. They explore the different segments and identify factors that have negative impacts on the environment and sustainability. By clicking on the hotspots, they get a short definition of the element, as well as an example of the status quo.

Lesson 21:

Add Eco-friendly and Circular Economy Strategies

Now, students have to improve the manufacturing process. To start, they have to build up their own business model canvas by using Figma: https://figma.com. Students should use existing templates to save time by setting up the canvas. The next step is entering the current state of each element as a starting point which represents the status quo.

When that's done, they analyse the individual sections and integrate eco-friendly and circular economy strategies. It is important to describe the strategies and their effects on the existing process as well as the positive impact on the environment. Students have to be aware that all elements are interconnected and a change in one element can affect the other ones.

Support students to describe the strategies. For this, we recommend reading the following hints in advance. These 20 hints can help semiconductor manufacturers embrace eco-friendly practices and contribute to a more circular economy:

1. **Design for Longevity:** Develop products with extended lifecycles, reducing the need for frequent replacements.
2. **Modular Design:** Create modular components that can be easily upgraded or replaced, reducing electronic waste.
3. **Remanufacturing:** Establish processes to refurbish and remanufacture components, extending their usefulness.
4. **Recycling Programmes:** Implement effective recycling programs for used components and materials.
5. **Reuse of Components:** Incorporate reclaimed and refurbished components into new products.
6. **Material Efficiency:** Optimise material usage to minimise waste during manufacturing.
7. **Clean Energy Usage:** Transition to renewable

energy sources in manufacturing processes to reduce carbon footprint.

8. **Smart Energy Management:** Implement energy-efficient practices and technologies to minimise energy consumption.
9. **Waste Reduction:** Minimise waste generation through efficient processes and material optimisation.
10. **Water Management:** Utilise water-efficient practices in manufacturing and cooling processes.
11. **Circular Supply Chain:** Collaborate with suppliers and partners to ensure a circular approach to sourcing and materials.
12. **End-of-Life Solutions:** Develop take-back programmes for products at the end of their lifecycle, encouraging responsible disposal.
13. **Product-as-a-Service:** Shift to service-based models where customers lease products, encouraging reuse and remanufacturing.
14. **Eco-Friendly Packaging:** Use sustainable packaging materials and designs to reduce waste.
15. **Reduced Hazardous Substances:** Minimise the use of hazardous materials in production processes.
16. **Energy-Efficient Cooling:** Implement advanced cooling technologies to reduce energy usage in data centres.
17. **IoT Monitoring:** Utilise IoT sensors for real-time monitoring and optimisation of manufacturing processes.
18. **Collaborative Innovation:** Collaborate with industry peers and research institutions to develop innovative sustainable solutions.
19. **Ethical Sourcing:** Ensure ethical practices in sourcing minerals and raw materials, addressing social and environmental concerns.
20. **Transparency and Reporting:** Implement transparent reporting of sustainability practices and progress to build trust with stakeholders.

Also, this blog post and the website can help to get input for different strategies:

- https://www.semi.org/en/blogs/technology-and-trends/startups-for-sustainable-semiconductors-2023-finalists-announced
- https://www.semi.org/en/industry-groups/startups

Lesson 22:

Create Your Unique Selling Proposition (USP)

Now that they have established the eco-friendly strategies, it's time to communicate those benefits in a clear key message to the customers. For this reason, students learn what a Unique Selling Proposition (USP) is and how they create one.

Lesson 23:

Give Your Company a New Name

In this lesson, students have to find a new, suitable name for the company. Therefore, they use an AI chatbot (Bing). Students have to find the right prompts to get reasonable suggestions. Once they have decided on a name, they still need to check if the domain is free. A domain refers to the unique and human-readable address that is used to access a company website. They can use a domain provider (GoDaddy) to check the availability.

Lesson 24:

Create the Public Appearance of Your Company

Now, students have to create a corporate identity again with the help of an AI tool. With Looka, they can easily create entire designs and logos in a short time. Of course, the new design should highlight the new direction of the company.

Lesson 25:

Bring It All Together

In a final step, students have to pitch all the information in a short teaser created with Canva. The teaser must consist of two parts:

1. **Business perspective:** In the first part, students present the business model canvas and explain in detail the strategies they have chosen. How does the manufacturing process change and what is the impact on the environment? This part can be up to two minutes long and is more from the business perspective where they focus on facts and strategies. Ideally, students can also film themselves and include these statements.

2. **Marketing perspective:** In the second part, students have no limits to creativity. They reveal the new corporate identity with the key message and the new company name. This conclusion (up to 60 seconds) should once again attract the full attention of the management team.

After the presentations, the videos of the two groups will be discussed.

Lesson 26:

Congratulations!

After completing the challenge, students are asked to present their video in front of the class and discuss the results with the other groups.

Lesson 27:

Let's Wrap it Up!

After the challenge, it's time for students to reflect on their learnings and new developed skills.

- What impact do semiconductors have on their daily lives?
- What changes can semiconductor manufacturers make to become more eco-friendly?
- How can a circular economy help to reduce waste?

Lesson 28:

Final Quiz

At the end, students complete a 15-question quiz that reviews all the content.

To complete the quiz and earn a programme completion certificate, students must score 70% or more of the quizz correctly.

Deep Tech Innovation from Farm to Fork

Description	Changes in how we produce our agrifood system are necessary to satisfy the increasing food demand and address its environmental impact. To support the transition to an agrifood system that is able to meet the challenges of our era, innovative technologies play a crucial role. Deep Technologies (Deep Tech in short) will spark solutions to a better use of our natural resources, food transformation and traceability, healthy ways to nutrition and prompt circularity for the agrifood system. Throughout this module, students will understand how Deep Tech can support the food systems by innovating and making this industry more sustainable. In this module, students will go through several lessons containing videos, text, and interactive activities detailed below. Teachers must inform students that they have to complete two challenges in this module; the final quiz is related to the two challenges.
Module Duration	It will take approximately **6 hours** to complete this module.
Required digital tools	▪ Miro ▪ Teachable Machine The module includes tutorials for these tools.
Required preparation	▪ Teachers and students should have internet access and their devices ready. ▪ Before starting, teachers should go through the module and familiarise themselves with it. ▪ It would be advisable for teachers to go through the explanation of Deep Tech and its areas in the following link: https://www.eitdeeptechtalent.eu/the-initiative/what-is-deep-tech/

Challenge A: Food Waste Reducer	Students first **train** the **Machine Learning (ML) model and sort different stages of food ripeness** into fit or unfit for consumption. Teachers should explain the **scenario** (relevance of avoiding food waste and possibility to do so with AI) thoroughly to immerse the students in the challenge. It is best if the teacher asks students what they consider "fit for consumption" to reduce food loss as much as possible. Teachers can make use of or share the provided example with the students. The teachers need to emphasise how the students should **train the model:** understand what stages are fit (preferably unripe, ripe and overripe), **select** clear images of products (same fruit/vegetable, clarity and quality, distinguishable stages of ripeness) and **test** the model with a different image of the same product at any stage. Students will make use of **Teachable Machine**, an online tool used to seamlessly train ML models.
Challenge B: Design Thinking Your Robot	In the second challenge, students learn how robots help to apply the circular economy model in manufacturing by sorting out recyclable material. Teachers should **discuss** how **households** sort **recyclable** materials. The challenge is to **design** a robot that does precisely that (sort items to be recycled at home). Teachers can **discuss** with the students the **recycling dynamics** (what goes into each container and why, how items can be sorted according to material or colour, etc). Students are expected to design the robot using the **Design Thinking Methodology:** a thought process created to solve a specific problem (sorting items to be recycled) by brainstorming different product functionalities according to user demand or experience (different robot designs for home sorting). Although the steps of this process are defined in the module, it would be desirable if teachers went through it with the students.

Introduction to the topic

This introduction tackles the ''Farm to Fork'' framework, a comprehensive look at the stages our food undergoes from production to consumption. Students need to understand how the system works to grasp how Deep Tech can be introduced in the different nodes of the food systems for sustainability.

Teachers are encouraged to ask students the following questions to set the tone:

1. What are the steps and processes for food to reach the consumer table?

2. What is the 'farm to fork' journey, and how can it change your view on what you eat?

3. What role does technology and innovation play in the modern agrifood systems?

Reflection on these questions should stimulate the students to learn about the agrifood system's current state and its **effect** on climate and the planet. The teachers should take time to discuss **why** raising awareness and promoting changes in the system is essential. Teachers can also link the discussion to the topic of health and migration, as presented in the module.

Lesson 7:

Looking for Keywords

The teacher organises the students in **groups**. The students are encouraged and trained to **click** on the image's **hotspots** shown in the module to discover the keyword. Then, the students will **research** online the meaning of the keywords and **share** it with the rest of the class.

Lesson 8:

How is our Food Impacting the Planet?

This lesson starts with a **video** that digs deeper into the environmental impact of agrifood systems and gives tools to evaluate the impact. After watching it, teachers could encourage the students to **compare the initial ideas** sparked from the three questions from the introduction that were previously shared with the ones introduced in the video.

The teacher then organises the students in groups to **discuss** the four **statements** about the current state of the agrifood systems and decide what fragments complete the statements. In this case, they will **not** need to research the statements because they are tightly related to the concepts, which they learnt in Lesson 1. They can answer the questions without looking for the answers online.

Lesson 10:

How is Deep Tech involved in the Agrifood System

Students watch a **video** on the relation between **Deep Tech** solutions and how they are applied in different stages of food production. They should take **notes** while they watch since some of the questions in the **Final Assessment** are related to this topic.

Lesson 12 contains a text describing food loss and waste, which will be deepened in Challenge A.

Lesson 11:

Did You Know?

In groups, students read and comment on the possible answers to the **flip cards**. They conduct online **research** to answer the questions. Later, they will flip the cards and **check** their answers. The teacher should encourage the groups to **share** their results and findings to get a better **overview** of Deep Tech's solutions for a sustainable agrifood system.

Lesson 13:

What is Circular Economy in the Agrifood System?

Students watch a **video** on combining Circular Economy Principles and tools like Deep Tech and Lifecycle Assessment to create a sustainable system. They should take **notes** while they watch since some of the questions in the **Final Assessment** are related to this topic.

Lesson 15 contains a text tackling the packaging issue, which will be deepened in Challenge B.

Lesson 16:

Inspiring Women in Deep Tech

This lesson consists of a three slides presentation, briefly describing three women's impact on the Agrifood sector. It aims to spur students to develop entrepreneurship mindsets and influence the students to undertake technological career paths. Teachers can encourage students to immerse themselves in these stories by asking questions such as:

- Did you **know** these **women**? What **surprised** you most about them?
- How do you think their work will **impact** the **world**? And the **future**?
- How can the **involvement of women** in the Agrifood industry **benefit** it?

Challenge A: Food Waste Reducer

Students **train a Machine Learning model** that sorts products into fit or unfit for consumption based on ripeness.

Teachers should explain the relevance of food loss

and waste in the agrifood sector and its impact on the environment, considering that 1/3 of the food produced is wasted globally. Link food waste to technology, explaining that Deep Tech can help automize the product sorting, reducing food waste and maximizing profit, as shown in the module. The teachers should emphasise the value of limiting food waste and encourage the students to see that food loss and waste is an opportunity for creating entrepreneurial ideas that valorise food waste via circular models.

The teacher invites the students to watch the tutorial for the T**eachable Machine** – the tool they will use. Instructions for the activity are explained in the module. The teacher should remind the students to select 7-10 pictures from the Internet of different products to train the model and 1-3 pictures to test it. The students shall look for pictures online and upload them to Teachable Machine as shown in the tutorial.

Challenge B: Sustainable Packaging Solutions

The students learn how traditional packaging is impacting the environment. Then, they will be introduced to real-life solutions proposed by companies to mitigate or eliminate the use of this type of packaging. The challenge is to **ideate** a tech-driven innovation

that proposes solutions for packaging, ranging from recycling to reusing. They will tackle the challenge using the **Design Thinking Methodology:** a thought process created to solve a specific problem (environmental impact of packaging) by brainstorming possible solutions (Sustainable Packaging/ Recycle and - or Reuse/ Business Idea/Product/Services). Although the steps of this thought process are defined in the module, it is important that the teachers go through it with the students. Students will plan their ideas using **Miro** and present it to the rest of the class.

Final Reflection

This part aims to conclude the module by summarizing the content and reflecting on key takeaways. Watch the video by TED-Ed as it's an excellent summary of the module's content. Then, spur discussion on the implications of Deep Tech and the future of the agrifood systems.

Final Quiz

At the end, students complete a 15-question quiz that reviews all the content. To complete the quiz and earn a programme completion certificate, students must score 70% or more of the quiz correctly.

3. Project Consortium

The Girls Go Circular project is led by EIT RawMaterials, an Innovation Community within the **European Institute of Innovation and Technology (EIT)**, which drives innovation across Europe to find solutions to pressing global challenges.

This project is designed and implemented together with other Knowledge and Innovation Communities (KICs), namely EIT Manufacturing, EIT Food and Climate-KIC, which are part of a larger network supported by the EIT to foster innovation and entrepreneurship in Europe.

Managed by:

EIT RawMaterials – Connecting matters
EIT Manufacturing
EIT Climate-KIC
EIT Health
EIT Urban Mobility
EIT Digital
EIT Food

Project Partners:

Sostenibilidad Ética
brainshuttle
Universita degli Studi di Torino
learn
PPIS Pannon Pro Innovations
JA Europe 100 Years of Achievement – A Member of JA Worldwide
EUIPO European Union Intellectual Property Office
synergy learning
Ellen MacArthur Foundation

4. Glossary

Circular Economy: a closed-loop economic system aimed at eliminating waste, pollution and carbon emissions. In a circular economy, material cycles are closed following the example of an ecosystem and the residual streams are used to design new products. In addition, circular systems employ processes such as reuse, repair, refurbishment, or recycling to minimise the use of raw materials.

Gender gap: it refers to the disadvantages of women compared to men reflected in social, political, intellectual, cultural, or economic attainments and attitudes. It is measured through various indicators such as access to education, salaries, or the percentage of female leaders in different sectors.

Green Transition: substituting the linear economy with a circular model. It involves a systemic shift to pursue sustainable economic growth that presents reduced environmental damages.

Linear Economy: the traditional economic model based on a take-make-dispose approach to using resources. According to this model, raw materials are collected and transformed into products that end up in a landfill at the end of their life cycle.

Learning module: a learning unit encompassing multiple lessons on a given topic. Its content and activities are organised to create a clear learning path.

Learning platform: An online portal offering content, resources and tools that support educators in guiding students through the project's learning programme.

Moodle: a learning management system (LMS) used for both blended and e-learning in schools, universities, or companies. It allows educators to create personalised learning environments.

Mural: a digital workspace for visual collaboration. It provides virtual whiteboards where teams can visually explore complex challenges, map all kinds of content, and organise agile brainstorming processes.

Padlet: a free online notice board. Students and teachers can use Padlet to reflect and collaborate on specific topics by posting on a common page. The notes can contain links, videos, images, and document files.