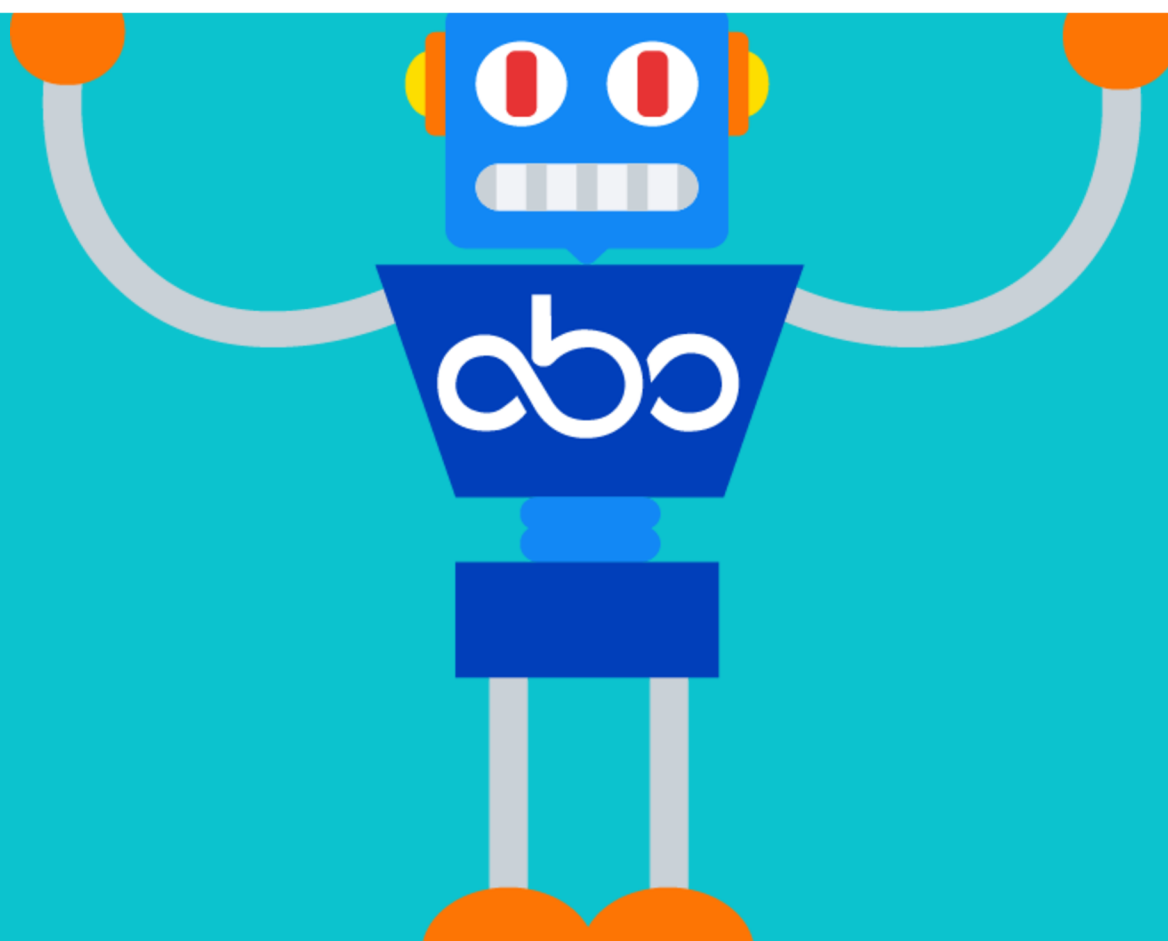




EU FOR ALL

Using Sustainable Entrepreneurship to Rebuild European Heritage for All





FROM PLASTIC TO FILAMENT

**TEACHER'S
MANUAL FOR
PET RECYCLING
IN THE
CLASSROOM**



The resources of the EU FOR ALL project, including the materials kit, 3D models, and educational proposals, are undergoing continuous improvement. We are constantly working to incorporate new ideas, adjustments, and contributions from the participating teams. Therefore, both the documents and files may be reviewed and updated over time.

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Project Overview



This document is designed to assist educators in the implementation of the EU FOR ALL project's PET Filament Pathway within the classroom. It functions as a pedagogical guide to contextualize, organize, and advance the project utilizing the student activity booklet "From Bottle to Filament." Emphasis is placed on the educator's role and the interconnection of various phases of learning.

Pedagogical strategies and methodologies

The itinerary is structured as a project-based learning experience, enabling students to acquire knowledge through experimentation, creativity, and reflection.

Experiential and practical learning

Directed inquiry

Maker culture

Digital and communicative proficiency

Collaborative effort

The educators serve as guides and facilitators, supporting the process by posing questions and assisting in the comprehension of the learning experience.

Educational environment

The students engage with an authentic PET filament recycler, converting plastic bottles into material suitable for 3D printing.

This practical context enables us to comprehend:

The tenets of the circular economy

- The lifecycle of materials
- The interplay between waste, technology, and innovation

The project integrates sustainability, design, technology, and communication, providing coherence to the entire process.



1 Project Overview



Learning Objectives

Throughout this itinerary, the students will:

It encompasses the procedure of recycling PET plastic and transforming it into filament for 3D printing.

Identify the components and functionality of the filament recycler.

Cultivate digital proficiency by utilizing Canva, Tinkercad, and artificial intelligence tools.

- Employ innovative thinking and design to address genuine needs.

Enhance your communication abilities by producing videos and presentations.

Contemplate sustainability and its environmental implications.



Curricular Connections

This itinerary can be interconnected transversally with:

- **Science and Technology.** (Operation and assembly of the recycling machine, 3D printing...)

Art Education. (Creation and design of filament spools, design utilizing Canva...)

Language and Communication. (Oral and written presentations, script development...)

Digital Competence (Computer usage, 3D design, keyboard shortcuts...)

- **Environmental Education.** (Environmental awareness, recycling, waste management)

- It facilitates adjustments based on the educational level and the context of the institution.



Scan the QR code to view the video tutorial on how to access the documentation.

Project Overview



Connection to the SDGs

The project directly contributes to the following Sustainable Development Goals:



SDG 4: Quality Education

The project cultivates STEAM (Science, Technology, Engineering, Arts, and Mathematics) competencies, advancing inclusive and high-quality education.

The utilization of digital tools like Tinkercad, alongside collaborative methods, fosters hands-on learning and promotes critical thinking.

- SDG 12: Responsible Consumption and Production

Recycling PET bottles conserves virgin resources and diminishes plastic waste.

Transforming plastic into filament fosters sustainable practices within educational and community contexts.

The emphasis on reuse enables students to comprehend the effects of their actions on the environment.

- SDG 13: Climate Action

By converting plastic waste into valuable resources, both pollution and the buildup of waste in landfills are diminished.

The production of sustainable products from recycled filament diminishes the carbon footprint linked to the creation of new materials.

SDG 17: Partnerships for the Goals

The initiative fosters collaboration among educational institutions, communities, and the technology sector.

Fostering collaboration between educators and students yields a beneficial effect on the local environment.

- The collaboration with initiatives like EU FOR ALL broadens educational access and promotes the sharing of best practices.





How can educators implement the Sustainable Development Goals (SDGs) in the classroom through project-based learning?

The integration of the Sustainable Development Goals (SDGs) should not be regarded as isolated theoretical concepts, but rather as a comprehensive approach that links the project to the students' reality.

Generate questions.

Before elucidating the SDGs, it is prudent to provoke contemplation through questions such as:

What occurs to plastic bottles when we dispose of them?

Can we transform waste into a valuable resource?

What effect does our consumption have on the environment?

Can we develop solutions from the classroom?

These inquiries enable the project to be situated within the framework of SDG 12 (Responsible Production and Consumption) and SDG 13 (Climate Action).

Align the project with the relevant Sustainable Development Goals (SDGs).

Instead of presenting all 17 SDGs, it is advisable to concentrate specifically on:

[SDG 4 – Quality Education](#)

What knowledge are we acquiring while constructing the recycling machine?

What STEAM competencies do we cultivate?

[SDG 12 – Responsible Consumption and Production](#)

What are we mitigating by reusing PET bottles?

What distinguishes recycling from reusing?

[SDG 13 – Climate Action](#)

In what ways does this project mitigate pollution?

What is its connection to minimizing the carbon footprint?

[SDG 17 – Partnerships for the Goals](#)

Who is participating in this project?

How can we disseminate it to other schools?

Concluding with a contemplation

Conclude with inquiries such as:

What modifications have we implemented in this project?

What areas could we enhance?

Could we implement this concept beyond the school environment?

In this manner, the SDGs transition from theoretical concepts to a transformative, practical learning experience that aligns with genuine sustainability.

Assembly

To transform bottles into filament utilizing a recycling machine, we require bottles composed of a specific material: PET. Suitable bottles can be identified by the presence of the Möbius triangle featuring a "1" inside. Recycling PET bottles not only enables the production of material for 3D printing but also enhances our understanding of the significance of environmental stewardship. It is important to note:

Minimizing the ecological footprint.

The repurposing of materials that would otherwise be discarded.

- The capacity to generate beneficial and value-enhanced products from waste.

🎯 Preparation

Our filament recycler arrives nearly ready for operation. The electronics are pre-assembled to ensure safety and facilitate ease of use. You will only need to assemble a few components, such as the motor and the coil, to finalize the setup and understand its functionality. The recycler includes all essential items: screws, washers, necessary components for optimal performance, and a power cable. Additionally, we provide a document and video on our website, www.euforall3D.com, showcasing the recycler's components.

👉 Assembly



Scan the QR code or click to discover the assembly instructions for the recycler.

For assembly, we will provide a video tutorial that thoroughly explains the components included in the package and their respective functions. The video will also guide you through the assembly process step-by-step, addressing any challenging areas. You will require Allen wrenches or screwdrivers with an assortment of spare bits.

🎯 Instructional videos

Scan the QR code or click to discover how the recycler operates.



The QR codes below grant access to videos pertaining to the assembly and commissioning of the recycling machine. These videos are also accessible on the website www.euforall3D.com, and all essential video tutorials are consolidated on our YouTube channel.

PET Filament Extrusion Machine Assembly

- The Operation of a PET Recycling Plant
- Preparing Bottles for the PET Extruder
- 3D Printing Utilizing Recycled PET Filament

Activities and Schedule

The project activities are implemented progressively, enabling students to transition from comprehending the recycling process to developing and presenting a final product.

The schedule is adaptable and can be tailored to the group's proficiency and the time allocated at the center.

The project can be executed in six sessions, each lasting between 60 and 90 minutes; however, it is also feasible to consolidate activities or extend them based on the context.








Utilized applications

Canva is an online design platform that enables users to effortlessly create visual materials without requiring advanced technical skills. For educators, it serves as a practical and intuitive tool that streamlines the development of presentations, worksheets, posters, videos, infographics, and collaborative student projects. The platform operates through pre-designed templates and a drag-and-drop interface for incorporating elements, images, icons, and text.

- Tinkercad is a complimentary online 3D design tool developed by Autodesk, specifically tailored for educational purposes and serving as an accessible introduction to digital modeling. It is advisable to create a class.
- Slicer: A slicer is a software application that prepares a 3D model for printing on a 3D printer. Its primary function is to convert the design created in Tinkercad or another program into a file that the printer can interpret.

Significance of activity icons

Throughout the student document, you will encounter the following icons:

ICON	MEANING
	Screen-free activities do not require the use of computers or tablets for engagement.
	A task that necessitates the utilization of a computer or tablet for completion.
	We will primarily utilize the mouse to drag and organize icons within the document.
	We will primarily utilize the keyboard in conjunction with other peripherals for drafting, planning, and related activities.
	If we possess the printed document, we can annotate it; this can also be accomplished using a computer.

Activities and Schedule



Session 1: Overview of the project and PET recycling facility



Approximate duration: two sessions of sixty minutes.

Applications and tools: Canva and resources for assembling the recycler.

Strategies for Collaborating with Students:

Present the overarching challenge of the project: converting waste into valuable resources.

- The PET filament recycling machine is designed to process and repurpose PET materials, facilitating sustainable practices in the manufacturing of filament. Its primary purpose is to convert waste PET into reusable filament, thereby promoting environmental responsibility and resource efficiency.
- View the videos regarding the overall functionality of the machine.
- Facilitate a brief guided discussion on the utilization of plastic and the importance of recycling.

Role of the instructional personnel:

Accompany the observation, pose open-ended questions, and relate the content to the students' everyday experiences.

Goals:

- Promoting awareness of recycling among students.
- Learn how to convert a bottle into filament.
- Familiarize yourself with the names and components of our recycling machine, as well as the assembly process.



Session 2: Materials, Safety, and Bottle Preparation



Estimated duration: 1 session of 60 minutes.

Applications and tools: Canva and digital calipers.

Strategies for Collaborating with Students:

Analyze images of objects and tools, distinguishing between those that are essential and those that are not.

Focus on fundamental safety principles.

- Elucidate and demonstrate the required materials.
- To promote decision-making and the rationale behind the choices made.

Role of the instructional personnel:

To direct reasoning, strengthen safety practices, and enhance comprehension of the pre-recycling process.

Goals:

To understand the essential elements required for the construction and operation of the machine.

- Learn to assess the thickness of the bottle to ensure a consistent diameter.
- Access videos pertinent to the topic to assist in resolving issues during project development.

Activities and Schedule



Session 3: Innovation and Initial Design



Approximate duration: three sessions of sixty minutes.

Applications and materials: Canvas, artistic supplies (brushes, tempera paints, etc.)

Strategies for Collaborating with Students:

Utilize Canva to design filament spools.

- Craft physical reels using recycled cardboard and embellish them.

Contemplate the role of the spool and the significance of its design.

Role of the instructional personnel:

To cultivate creativity, to integrate aesthetics with functionality, and to emphasize the importance of repurposing materials.

Goals:

Embellish a filament storage spool using Canva elements.

- Acquire recycled cardboard to construct a reel.
- Coat the spool made from recycled materials.



Session 4: Digital Design and Three-Dimensional Modeling



Approximate duration: one session lasting 90 minutes.

Applications: Canva, Tinkercad, and Slicer.

Strategies for Collaborating with Students:

Introducing Tinkercad and its fundamental tools.

- Refine current models associated with the recycling facility.
- Create a straightforward object (e.g., a ruler) suitable for 3D printing.

Role of the instructional personnel:

To facilitate the utilization of the digital tool, address technical inquiries, and assist in translating concepts into the three-dimensional environment.

Goals:

Acquire the ability to utilize Tinkercad autonomously.

- Create a three-dimensional ruler utilizing Tinkercad.
- Embellish the 3D recycling bin using Tinkercad components.
- Understand the fundamental parameters for printing with recycled PET filament.

Activities and Schedule



Session 5: Innovation and the Application of Artificial Intelligence



Estimated duration: 60 minutes.

Applications: Canva.

Strategies for Collaborating with Students:

Introducing artificial intelligence as a creative instrument.

- To demonstrate a genuine need that can be addressed with a 3D-designed object. Create a design utilizing AI and evaluate the outcome.

Role of the instructional personnel:

Elucidate the concept of a prompt, advocate for a critical and responsible approach to AI utilization, and stimulate contemplation regarding the efficacy of designs.

Goals:

To foster student autonomy in the creation or acquisition of designs.

- Enhance linguistic competence by delivering a concise presentation of the product.



Session 6: Communication and Formal Presentation



Approximate duration: two sessions of 60 to 90 minutes.

Applications and materials: Canvas, recording equipment, and chroma key.

Strategies for Collaborating with Students:

Draft a concise script to elucidate the project.

- Produce a chroma key video that highlights your product, its applications, and the manufacturing process.

Disseminate the results among the group.

Role of the instructional personnel:

To aid in the organization of the speech, facilitate the recording, and enhance both oral and audiovisual expression.

Goals:

Enhance linguistic competence and collaboration by producing a video to discuss the project, designed object, recycling machine, and more.



Adaptability and flexibility

Educators are able to:

Adjust the number of sessions accordingly.

- Engage in the activities either independently or collaboratively.

To explore the technical or creative dimensions based on the students' proficiency.

- The project is crafted to accommodate various educational contexts while consistently emphasizing sustainability, creativity, and digital competence.

The assessment emphasizes both the educational process and the final outcomes.



What is under evaluation?

Engagement and disposition
Comprehending the recycling process
Utilization of digital tools
Creativity and design.
Communication and Presentation

- Skills.
- EUFORALL3D Initiative.



Recommended instruments

Direct observation

- Analysis of the final products
- Student self-evaluation and introspection

The subsequent pages contain examples of rubrics for project evaluation. If the entire project is not completed, we can choose the rubrics or items that best align with the activities we engage in. On the subsequent page, we will encounter rubrics addressing the following competencies and a final project assessment:

Digital proficiency.

- 3D printing and sustainable production.
- Linguistic proficiency.
- Artistic and creative proficiency.
- Mathematical proficiency, scientific knowledge, and technological expertise.
- Collaborative effort.
- Integration of the Sustainable Development Goals.
- Project assessment.

1. DIGITAL COMPETENCE (CD) Utilization of tools: Canva, artificial intelligence, Tinkercad, Chroma, video production

Indicator	1 – Initial	2 – In Progress	3 – Adequate	4 – Excellent
Use of Canva and AI for design	Needs constant guidance and reproduces designs without clear criteria.	Uses Canva with partial support; simple designs.	Designs independently and applies basic design criteria.	Creates original, clear and well-organized designs.
Use of Tinkercad	Has difficulty using the interface.	Creates simple shapes with help.	Designs complete and correct objects.	Designs complex models with scale and precision.
Recording and green screen	Has difficulty following instructions.	Records with support; irregular green screen use.	Uses green screen correctly.	Records, adjusts and improves videos independently.
Video editing	Does not manage editing tools.	Produces basic editing.	Integrates images, voice and music correctly.	Creates complete, coherent and creative videos.

2. 3D PRINTING AND SUSTAINABLE MANUFACTURING

Indicator	1 – Initial	2 – In Progress	3 – Adequate	4 – Excellent
Understanding of the 3D printing process	Does not understand the steps.	Knows the parts but confuses the process.	Explains the printing stages correctly.	Understands and explains the complete process accurately.
3D Design (recycler decoration or sustainable object)	Incomplete or incorrect model.	Simple but functional model.	Functional model with appropriate scale.	Detailed and precise model with creative/technical intention.
Use of recycled filament	Does not understand its value.	Recognizes that it is sustainable.	Explains why it reduces waste.	Explains environmental impact and proposes

3. LINGUISTIC COMPETENCE

Indicator	1 – Initial	2 – In Progress	3 – Adequate	4 – Excellent
Video script writing	Confusing or poorly structured script.	Confusing or poorly structured script.	Clear, appropriate and well-sequenced script.	Creative, coherent, engaging and well-documented script.
Video presentation	Poorly structured or unclear video.	Functional video.	Clear and well-sequenced video.	Coherent, engaging and well-structured video.

4. ARTISTIC AND CREATIVE COMPETENCE

Indicator	1 – Initial	2 – In Progress	3 – Adequate	4 – Excellent
Digital spool design	Poorly designed or without aesthetic intention.	Simple design with some elements.	Correct, balanced and visually appealing design.	Creative, very detailed and personal design.
Physical spool design	Poorly designed or without aesthetic intention.	Simple design with some elements.	Correct, balanced and visually appealing design.	Creative, very detailed and personal design.

5. MATHEMATICAL, SCIENTIFIC AND TECHNOLOGICAL COMPETENCE

Indicator	1 – Initial	2 – In Progress	3 – Adequate	4 – Excellent
Use of measurements and units	Does not understand or correctly apply measurements.	Applies measurements with help or makes frequent mistakes.	Correctly uses measurements (mm, thickness, diameter) in the design.	Applies measurements accurately and adjusts parameters independently.
Understanding of 3D geometric shapes	Does not identify basic shapes in the design.	Recognizes some shapes but has difficulty combining them.	Correctly identifies and combines 3D geometric shapes.	Designs complex models combining shapes with spatial logic.
Application of mathematical thinking in Tinkercad	Does not apply mathematical concepts in the design process.	Applies some concepts with support (proportions, alignment).	Uses proportions, alignment and dimensions appropriately.	Optimizes dimensions, calculates adjustments and improves the design using mathematical
Understanding of the technological process	Does not understand the design and printing process.	Partially understands the phases of the process.	Understands the full process: design, slicing and printing.	Analyzes the process, adjusts parameters and proposes technical improvements.
Technical problem solving	Gets blocked when facing technical difficulties.	Needs constant help to solve problems.	Solves simple problems with some autonomy.	Identifies errors, tests solutions and improves the final result independently.

6. COOPERATIVE WORK

Indicator	1 – Initial	2 – In Progress	3 – Adequate	4 – Excellent
Group participation	Participates very little.	Participates only sometimes.	Collaborates actively.	Shows positive leadership, organizes and helps others.
Conflict resolution	Does not manage disagreements.	Needs teacher help to solve conflicts.	Reaches agreements with the group.	Mediates, proposes solutions and maintains a positive team environment.
Responsibility in tasks	Does not complete assigned tasks.	Completes some tasks.	Completes assigned tasks.	Takes initiative, proposes improvements and helps others.

7. SDG INTEGRATION

Indicator	1 – Initial	2 – In Progress	3 – Adequate	3 – Adequate
Understanding of SDGs (4, 12, 13, 17)	Does not identify the SDGs or their relation to the project.	Does not identify the SDGs or their relation to the project.	Identifies the main SDGs and relates them to the project.	Clearly explains how the project contributes to several SDGs.
Responsible consumption (SDG 12)	Does not understand the importance of reusing materials.	Participates in recycling tasks in a limited way.	Actively collaborates in material reuse.	Proposes concrete actions to reduce waste inside and outside the classroom.
Environmental awareness (SDG 13)	Does not relate the project to environmental care.	Shows basic understanding of environmental impact.	Understands how recycling reduces pollution.	Reflects critically and proposes sustainable improvements.
Collaborative work (SDG 17)	Does not cooperate in group work.	Participates irregularly.	Works adequately in a team.	Collaborates actively, respects ideas and contributes to the common goal.
Communication of impact (SDG 4)	Cannot explain the project or its impact.	Poorly structured explanation.	Presents the project in a clear way.	Clearly explains the social and environmental impact generated.

8. PROJECT EVALUATION (TEACHER SELF-ASSESSMENT)

Indicator	1 – Initial	2 – In Progress	3 – Adequate	4 – Excellent
Planning and organization	Final product and dissemination	Planning was partial and required constant adjustments.	Planning was adequate and allowed the project to be developed properly.	Planning was strategic, flexible and optimized time and resources.
Curricular integration	The project was not clearly connected to the curriculum.	Occasional connection with some subject areas.	Planning was adequate and allowed the project to be developed properly.	Clear transversal integration aligned with competences and assessment criteria.
Active methodology	Theoretical explanation predominated.	Some practical activities were implemented.	Active and project-based learning methodology was used.	Students were the protagonists, with a high level of autonomy and decision-making.
Student engagement	Low participation and motivation.	Irregular participation.	Good participation and general motivation.	High engagement, initiative and enthusiasm from students.
Final product and dissemination	Final product poorly defined or not shared.	Correct final product but with limited dissemination.	Final product well presented and shared.	High-quality product with dissemination in the educational community or networks.

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The educational materials developed within the framework of the EU FOR ALL project, led by the consortium of OBO - We Teach Robotics, have been designed to promote digital inclusion and technological literacy.



These materials aim to provide accessible and engaging learning experiences that foster key competencies in digital skills, problem-solving, and critical thinking. Through interactive and hands-on approaches, the project seeks to empower learners of all backgrounds by equipping them with the necessary tools to navigate an increasingly digital world.

Developed in collaboration with experts in education, technology, and inclusion, these resources reflect the commitment of the EU FOR ALL consortium to innovation in education and the reduction of the digital divide.

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