MODULE II

Lesson Plan 2

Summary

Title	
From plastic waste to fabric	
Duration	135 minutes
The age range of students	10-14

Summary of the theme

This topic aims to teach students about the different types of plastics and their classification by PIC codes, their common properties and uses, and the problem of plastic in the environment. The importance of recycling, both mechanical and chemical, and its application in the textile industry, especially with recycled PET, will be addressed. Students will participate in a practical plastic separation and identification exercise and will conduct a home experiment to convert PET plastic bottles into textile fibers.

Learning outcomes

Aim/Learning Objectives

- Understand the different types of plastics and their classification.
- Know the common properties and uses of each type of plastic.
- Understand the environmental impact of plastics and the importance of recycling.
- Learn about mechanical and chemical recycling processes.
- Explore the use of recycled plastics in the textile industry.
- Conduct a practical experiment on PET recycling to obtain textile fibres.

Cross-cutting objectives

- Promote environmental awareness and ecological responsibility.
- Develop scientific research and experimentation skills.
- Promote teamwork and collaboration.
- Integrate knowledge of science, technology, and sustainability.

Connection with Sustainable Development Goals

This theme is aligned with SDG 12 "Ensure sustainable consumption and production patterns", especially target 12.5 "By 2030, significantly reduce waste generation through prevention, reduction, recycling, and reuse".

Implementation

Facilitation

- Ensure that all materials are ready before the class begins.
- Clearly explain each step of the experimental process.
- Supervise students' work, providing support and resolving doubts.
- Promote an atmosphere of collaboration and respect for the environment.

Resources / Materials needed

- Clean and empty PET plastic bottles
- Scissors and cutter
- Drill
- Threaded rod (recommended M6 or M8, length 200mm)
- 2 nuts (optional to fit two washers)
- Canned food can
- Punch or drill bit for drilling holes
- Cooker or heater
- Large cardboard box
- Tweezers and safety gloves
- Safety goggles
- Educational videos on PET recycling
- Tables and graphs on the classification of plastics and their properties.

Ideas to continue

- Conduct research projects on other applications of recycled plastics.
- Visit a local recycling plant or invite a recycling expert to give a talk.
- Develop recycling awareness campaigns at school.

Source / Classroom materials and preparation

- Video: "Barry the Bottle PET recycling journey". An animated video that follows Barry, a water bottle, on his journey from recycling to becoming a new food container. It is an entertaining and educational way to show the recycling process to students. Link: https://www.sciencelearn.org.nz/videos/1752-pet-plastic-recycling-process
- Video: "How Plastic PET Bottles Are Recycled Into Garments". This video illustrates how PET bottles are recycled and transformed into garments, demonstrating the complete recycling cycle and its application in the textile industry. Link: https://www.youtube.com/watch?v=ftKwPqO0CMg
- Video: "Step by Step: How to Recycle PET Bottles From A-Z". This video explains in detail each step of the PET bottle recycling process, from collection to

transformation into new products. Link: https://www.youtube.com/watch?v=HBCOyyY73e0

- Video: "PETCO's Story of how a PET bottle is recycled". Presents the story of how a PET bottle is recycled and turned into useful new products. It is an excellent resource to show students the positive impact of recycling. Link: https://www.youtube.com/watch?v=vBpNp0wYV8I
- Additional web resources:
- Science Learning Hub: Offers a variety of educational resources on plastics recycling, including videos and detailed articles. Link: https://www.sciencelearn.org.nz/topics

Topic outline

Time	Step-by-step instructions
10 min	Introduction to the topic and explanation of its objectives: Start the class with a general introduction to the problem of plastic in the environment. Explain how plastics, especially PET bottles, can be recycled and transformed into textile fibres. Introduce the objectives of the topic, emphasising the importance of recycling and its positive impact on the environment. Use a visual resource with images of plastic in the environment, graphs on plastic production, and data on plastic recycling. The following references can be used: https://ourworldindata.org/explorers/plastic-pollution; https://plasticoceans.org/infographics/; https://www.unep.org/interactives/beat-plastic-pollution/; and https://slidesgo.com/theme/plastic-waste-awareness-class.
20 min	Presentation on the different types of plastics and their PIC codes: Explain the different types of plastics and their identification codes (PIC). Focus on the seven main types: PET (1), LDPE (2), PVC (3), PP (4), HDPE (5), PS (6), and Others (7). Use a table or chart showing the PIC codes and examples of common products made from each type of plastic. You can use videos or animations that visually explain the different types of plastics. You can use these references: https://siteold.plasticsrecycling.org/images/pdf/Toolkits/Resin_Identification_Codes_Chart_Final.pdf; https://earth911.com/home-garden/infographic-plastic-recycling-codes/
15 min	Discussion of the common properties and uses of each type of plastic: It details the properties of each type of plastic and their most common uses in everyday life. For example, PET is used in beverage bottles, while LDPE is found in plastic bags. You can use this reference: https://www.plasticsforchange.org/blog/different-types-of-plastic Provide or search with students for physical samples of each type of plastic so that they can observe and touch them.
20min	Questions and answers on the classification of plastics: Conduct an interactive question-and-answer session to reinforce the information presented. Encourage students to ask questions and clarify doubts about the different types of plastics and their uses. You can use a whiteboard to record questions and answers. A card game with prepared questions on the classification of plastics is also proposed. Game Modes: ● Memory: Place the cards face down and allow students to turn over two cards in turn. They must find matching pairs (one question with its answer). ● Group Quiz: Divide the students into groups. One group chooses a card and answers the question. If they answer correctly, they earn one point.

	● Flashcards: Use the cards as flashcards. One student reads the question, and another student answers. See Figure 2.2.8 for various examples of cards.
15 min	Presentation and discussion on the environmental impact of plastic and the advantages of recycling. Explain the problem of plastic in the environment, including ocean pollution and its effect on wildlife. Discuss the advantages of recycling, such as reducing waste and conserving natural resources. Use an educational video on the environmental impact of plastic, such as National Geographic's video on plastic pollution: https://www.youtube.com/watch?v=HQTUWK7CM-Y
10min	Explanation of mechanical and chemical recycling processes. Briefly describe the two main recycling methods: mechanical and chemical: ● Mechanical recycling consists of collecting, sorting, washing, shredding, and re-melting plastics. This method is commonly used to recycle PET bottles. Show a schematic of the process. Example: Figure 2.2.9. ● Chemical recycling breaks down plastics into their basic chemical components through various processes. Show a schematic of the process. Example: Figure 2.2.10. Resources: https://uspackgroup.com/blog/the-life-cycle-of-a-pet-bottle-the-importance-and-process-of-recycling/; https://petcore-europe.org/images/news/pdf/14-chemical-recycling_wim-hoenderdaal.pdf; https://www.ygplasticmachinery.com/hdpe-pet-bottle-flakes-washing-line/
10 min	Examples of companies using recycled PET in the textile sector: Examples of companies using recycled PET to manufacture textile products are presented, highlighting their approaches to sustainability and the use of recycled materials. Exemplary companies: ● Ecoalf: Spanish company that specialises in the manufacture of clothing and accessories using recycled materials. Its mission is to create sustainable products with the same quality and design as the best non-recycled products. Products: Jackets, T-shirts, shoes, and backpacks made from recycled PET. Focus on Sustainability: Ecoalf recovers plastic bottles from the ocean and transforms them into textile fibres. It uses advanced technology to ensure that the final products are of high quality. It is recommended to show this promotional video of the company: https://www.youtube.com/watch?v=i7HNmVMhpdE ● Patagonia. Outdoor clothing brand that uses recycled polyester, including PET, in many of its products. Products: Jackets, T-shirts, and outdoor equipment. Focus on Sustainability: Patagonia is known for its commitment to sustainability and recycling, using recycled plastic bottles to create recycled polyester. Company website: https://eu.patagonia.com/es/en/home/ ● Adidas Parley: Adidas collaborates with Parley for the Oceans to create sports products using recycled ocean plastic. Products: Trainers and sportswear. Focus on Sustainability: The Parley Ocean Plastic initiative converts plastic waste collected from beaches and coastal communities into high-performance clothing and footwear. It is recommended to show this video: https://www.youtube.com/watch?v=oOdZCjr95GU ● G-Star RAW: Fashion brand that uses recycled materials, including PET, in its sustainable product line. Products: Jeans and denim garments. Focus on Sustainability: The RAW for the Oceans collection uses recycled ocean plastic to create fibres that become sustainable denim. Promotional video: https://www.youtube.com/watch?v=9kXqZ1Ptyvw
35 min	Homemade experiment: obtaining fibres from PET bottles by mechanical means. This homemade experiment will allow you to turn PET plastic bottles into fibres using homemade tools and materials. Based on the video: https://www.youtube.com/watch?v=TlTRTgQ1eT0&t=9s

Steps before practice (to be carried out by the teacher):

- Take a cylindrical tin can and make at least 10 holes (16 recommended) along the perimeter near the base (Figure 2.2.1):



Figure 2.2.1 Tin can with holes. Source: https://www.youtube.com/watch?v=TlTRTgQ1eT0&t=9s

- Drill a hole in the base of the can with a drill bit according to the metric of the threaded rod (of the same diameter) and insert the threaded rod (Figure 2.2.2). To fix the rod, place two nuts (inside and outside of the can).



Figure 2.2.2 Drill placement in the can. Source: https://www.youtube.com/watch?v=TlTRTgQ1eT0&t=9s

- Insert the rod, and it can be assembled into the hole of the drill (Figure 2.2.3).



Figure 2.2.3 Drill placement. Source: https://www.youtube.com/watch?v=TlTRTgQ1eT0&t=9s

Step-by-step practice to be carried out in the classroom:

- Preparation of the Bottles (Figure 2.2.4):
  Cleanliness: Make sure PET bottles are clean and free of labels and liquid residues.
  Cutting: With scissors or a cutter, cut the bottle into long, thin strips. The thinner the strips, the better the final result.



Figure 2.2.4 Bottle pieces. Source: https://www.youtube.com/watch?v=TlTRTgQ1eT0&t=9s

- Plastic Softening (Figure 2.2.5):
  Place the pre-cut strips in the tin, rod, and drill and place them over a heat source (a heating element is recommended). Keep them on the heat source until they melt slightly. This step is recommended to be done outdoors or in a large, ventilated area to avoid inhalation of fumes. Constantly monitor the process to prevent the plastic from melting completely. Students should be placed at a sufficient distance to see the process but avoid burns.





Figure 2.2.5 Heating the plastic. Source: https://www.youtube.com/watch?v=TlTRTgQ1eT0&t=9s

- Fibre formation (Figure 2.2.6): Put the assembly in a cardboard box and connect the drill to the power supply. At a medium-high speed, start moving the assembly. The fibres will start to form. Initially, deposits may occur. Keep the assembly rotating for about 2-3 minutes. After this time, stop the drill. The fibres will appear both inside the can and on the walls of the cardboard box.

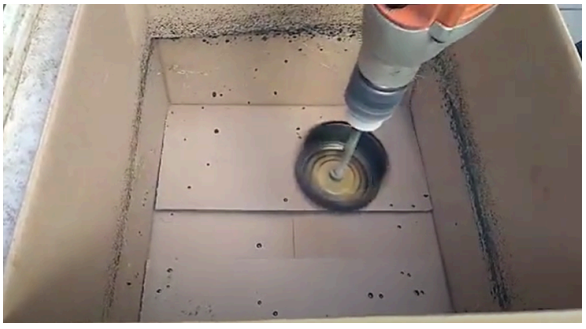




Figure 2.2.6 Generation of tissues. Source:
https://www.youtube.com/watch?v=TlTRTgQ1eT0&t=9s

- Collection, observation, and possible uses of the fibres (Figure 2.2.7): The pupils will collect the fibres deposited on the walls of the box. One possible use is to stuff pillows or create wigs for toys. The following image shows the final result:



Figure 2.2.7 Generated tissues. Source: https://www.youtube.com/watch?v=TlTRTgQ1eT0&t=9s

Formative evaluation

Two formative evaluation tools are proposed for this theme:

- Learning diary:
  Description: Ask students to keep a journal in which they write their reflections on what they have learned.
  Example: At the end of each session, ask students to write about the most important thing they learned that day and how they can apply that knowledge in their daily lives.
- Small group discussion:
  Description: Divide students into small groups to discuss specific topics and then share their findings with the class.
  Example: Ask each group to discuss the environmental impact of a specific type of plastic and then present their findings to the rest of the class.

Feedback

Net Promoter Score (NPS) is a widely used tool to measure the loyalty and satisfaction of customers or, in an educational context, students. It measures the likelihood that students will recommend the subject or course to others.
How to analyse and apply NPS is explained below:

Development of the NPS question:

- Main question: "On a scale of 0 to 10, how likely are you to recommend this topic to other students?
- Follow-up questions: "Why did you select this score?" and "How can we improve this issue?

Collection of responses:

- Digital surveys: Use online tools such as Google Forms, SurveyMonkey, or Typeform to collect student responses.
- Paper surveys: Paper questionnaires are handed out at the end of the lesson for students to complete. A template for collecting responses with paper surveys is shown in the Annex.
- Interactive applications: Interactive applications such as Quizziz, Mentimeter, or Kahoot! are used to collect answers in real-time.

Classification of responses:

- Promoters (Score 9-10): Students are very satisfied and likely to recommend the subject.
- Passive (score 7-8): Satisfied, but not enthusiastic students; they could easily change their minds.
- Detractors (Score 0-6): Dissatisfied students who are unlikely to recommend the subject; they could provide constructive criticism.

Calculation of NPS:

- Formula: NPS = % of promoters - % of detractors.
- Score interpretation: NPS ranges from -100 to +100. A positive score (above 0) is generally good, and a score above 50 is excellent.

Analysing and using comments:

- Review the comments to understand the reasons behind the scores.
- Identifies patterns and specific areas for improvement among detractors and passives.
- Use the promoters' positive comments to reinforce the positive aspects of the issue.

Annexes

Figure 2.2.8. Card models

Questions	Answers
Question: What does the PIC code 1 on a plastic bottle mean?	**Response:** PET (Polyethylene Terephthalate)
Question: What type of plastic is commonly used for grocery bags and has the PIC code 2?	**Response:** HDPE (High-Density Polyethylene)

Question:

Which type of plastic is difficult to recycle due to its rigidity and is used in water pipes, with PIC code 3?

Response:

PVC (Polyvinyl Chloride)

Question:

What is the degradation time of polystyrene (PS), used in disposable cups and fast food trays?

Response:

More than 500 years old

PS is difficult to recycle and degrades very slowly, releasing toxins into the environment as it decomposes.

Question:

How many years can it take for a plastic straw to degrade?

Response:

Approximately 200 years

Plastic straws are small but harmful, as they can be ingested by marine animals and take centuries to decompose.

Question:

How many years can it take for a PET plastic bottle to degrade in the environment?

Response:

Between 450 and 1000 years

PET plastic bottles can take several centuries to degrade completely in the environment.

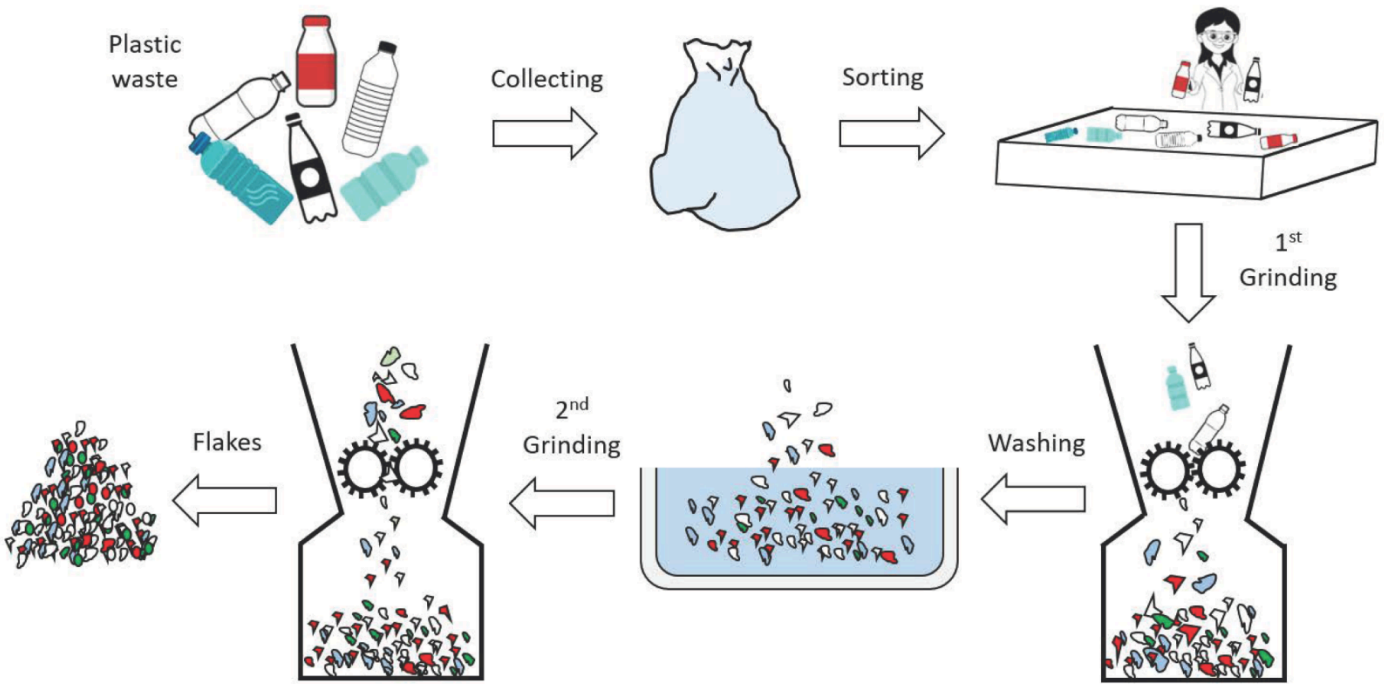


Figure 2.2.9. Main steps in mechanical recycling. Source: https://ubuntoo.com/blogs/mechanical-recycling-for-dummies

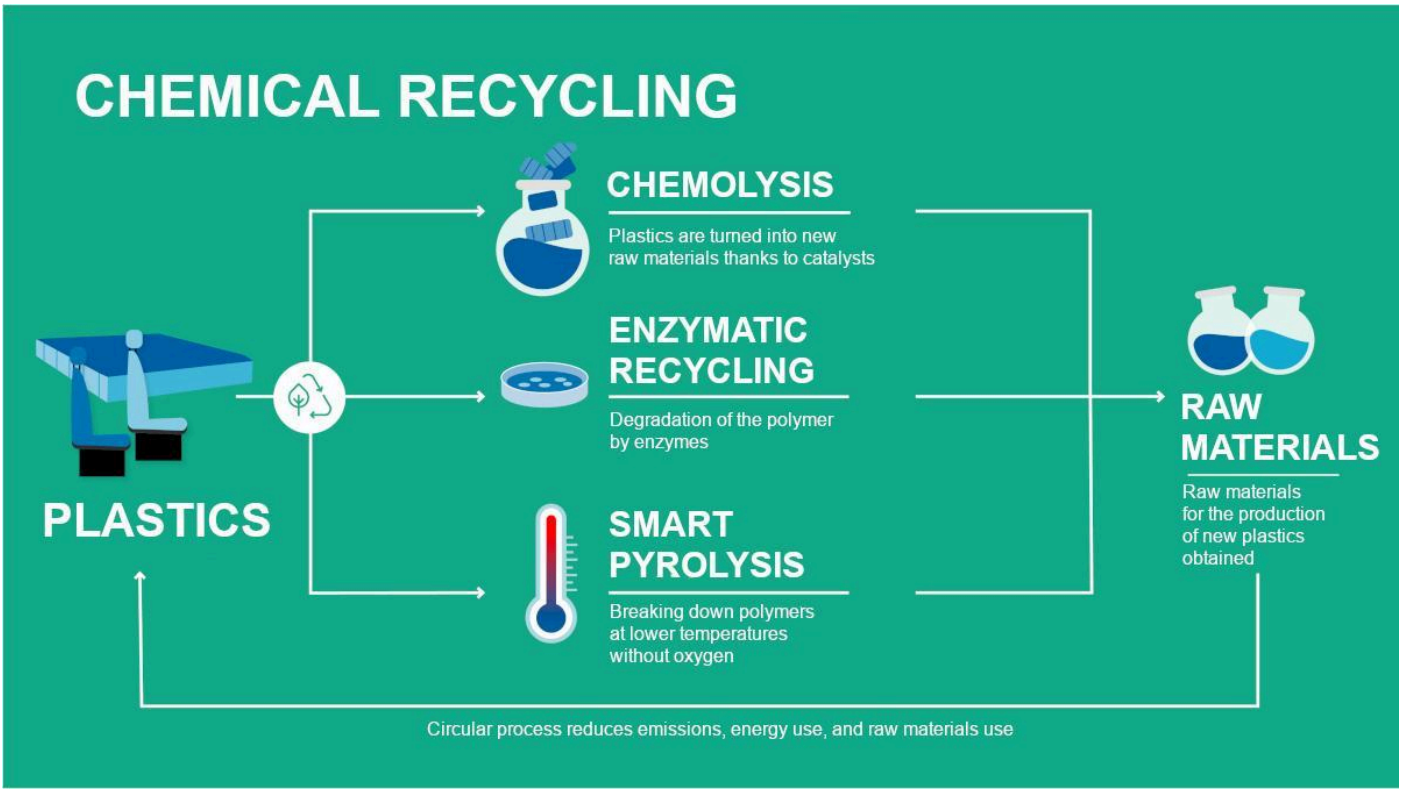


Figure 2.2.10. Chemical recycling methods. Source: https://www.chemistryviews.org/chemical-recycling-a-key-technology-for-the-circular-economy/

QUESTIONNAIRE TO COLLECT FEEDBACK ON THE TOPIC

On a scale of 0 to 10, how likely would you recommend this subject to other students?

0	1	2	3	4	5	6	7	8	9	10

Not likely at all — Extremely likely

Why did you choose that score?

How could this issue be improved?