A Problem-Based Learning (PBL) Case Study Design on Plastics Recycling

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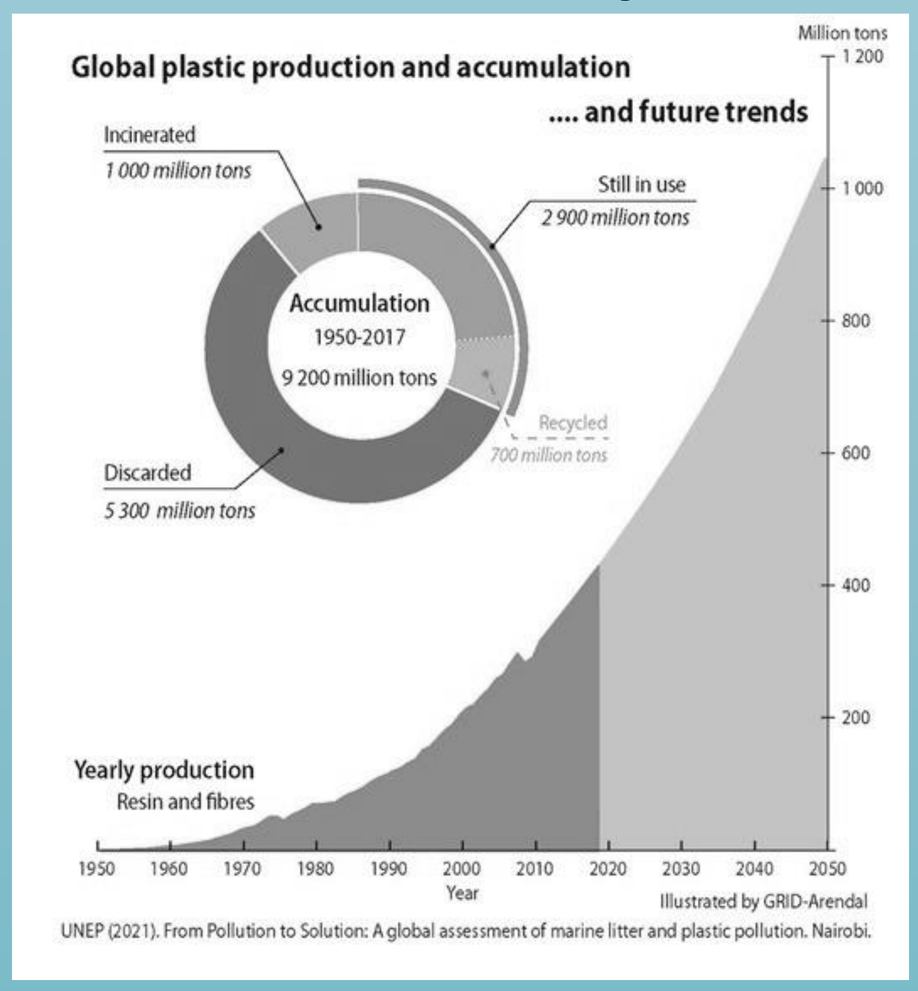
Why a PBL case study on plastic recycling?



What is Problem-Based Learning?

- Problem-based learning (PBL)[1] is a student-centred approach to learning in which **students work in groups to solve open-ended problems in real-life scenarios.**

A Relatable Challenge

- Today, we produce about 400 million tonnes of plastic waste every year.
- Global production of primary plastic is forecasted to reach 1,100 million tonnes by 2050.
- **Less than 10 per cent of the waste generated globally has been recycled.[2]**

What are the benefits?

- Literature precedents indicate that PBL enables students **to develop practical chemistry skills**, resulting in **increased participation and engagement.**[3]
- Additionally, empirical evidence supports the **acquisition of soft skills** through PBL.[4]
- **AND IT IS MORE FUN FOR LEARNERS AND EDUCATORS!**

How does it work?

A three weeks mini research project supported by recorded lectures and Tutors trained in PBL

Real-Life Scenario of the Case Study

"Students are part of a team of chemists and materials scientists working in a start-up company that develops processes for plastic recycling. The teams work on the optimisation of a method for the conversion of waste polystyrene into a sulfonated functionalised polymer".

Objectives

Students are provided with a sample of polystyrene (polystyrene cup) which they will use to:

- **Optimise the parameters** (time, temperature, particle size…) of the conversion of waste polystyrene into a functionalised polymer.
- **Characterise the new materials** (degree of sulfonation, wettability, ion-exchange capacity…)
- **Devise an application** that they will have to **pitch to a group of investors** (team of educators) in a Dragons' Den format.

WEEK 1

- **Kick-off lecture** (1 h)
  - Introduction of the problem of plastic waste, context and rules of the activity.
  - Teams' allocation (4-5 students)
  - Team Tutors allocation (usually a tutor per 2-3 teams)
- **Team meetings coordinated by tutors** (4h / group).
  - Preparation of an action plan and design of experiments.
- **Team submission of research plan**
  - Short experimental procedures and COSHH risk assessments

WEEK 2

- **Feedback on the Teams' research Plans** (beginning of the week)
- **Teams' Lab Sessions coordinated by tutors** (2x 4h)
  - Preparation of experiments and data collection.
  - Data analysis
- **Tutorial/Q&A Session** (End of the week, 20-30 minutes).
  - Small group tutorials. 2-3 teams + associated Tutor
  - Informal assessment
  - Damage control (e.g., equipment not working)

WEEK 3

- **Teams' Lab sessions coordinated by tutors** (2x 4h)
  - Completion of experiments, data collection and data analysis.
  - Completion of report and final presentation.
- **Final presentation**
  - 5 minutes presentation + 5 minutes Q&A session.
  - Panel of 3-4 members of the education team. Dragons' Den format.
- **Report Submission**
- **Peer Assessment**.

Assessment Profile

- **Group Mark**: Initial Research Plan 20%, Final Presentation 40%, Report. 40%. [c]
- **Final Students' Individual Mark**
  - Individual Mark = (Peer Assessment Scaling factor x Group Mark)

Challenges

- **Resources**. PBL is "expensive". Staff availability, Lab space, Equipment.
- **Consistent support by well-trained tutors** that act as facilitators and can motivate and guide students.[5]
- **Group work dynamics** and **Peer Assessment**.[5]

REFERENCES: **[1]** Henk G. Schmidt. A Brief History of Problem-based Learning. In One-Day, One-Problem. O'Grady G., Yew E., Goh K., Schmidt H. Eds. Springer, Singapore. 2012, 21-40. **[2]** Visual feature | Beat plastic pollution. (2022, March 1). UNEP - UN Environment Programme. https://www.unep.org/interactives/beat-plastic-pollution/ **[3]** Claire McDonnell , Christine O'Connor and Michael K. Seery. Developing practical chemistry skills by means of student-driven problem based learning mini-projects. Chem. Educ. Res. Pract., 2007, 8, 130-139. **[4]** Sadia Deep, Ali Ahmed, Nazia Suleman, Muhammad Zahid Abbas, Uzma Nazar. The Problem-Based Learning Approach towards Developing Soft Skills: A Systematic Review. The Qualitative Report; Fort Lauderdale. 2020, 25, 11, 4029-4054. **[5]** Diana H J M Dolmans Willem De Grave Ineke H A P Wolfhagen Cees P M Van Der Vleuten. Problem-based learning: future challenges for educational practice and research. Medical Education. 2005, 39, 7, 732-741.