From Biomass to Sustainability: A Journey Through Problem-Based Learning Workshops

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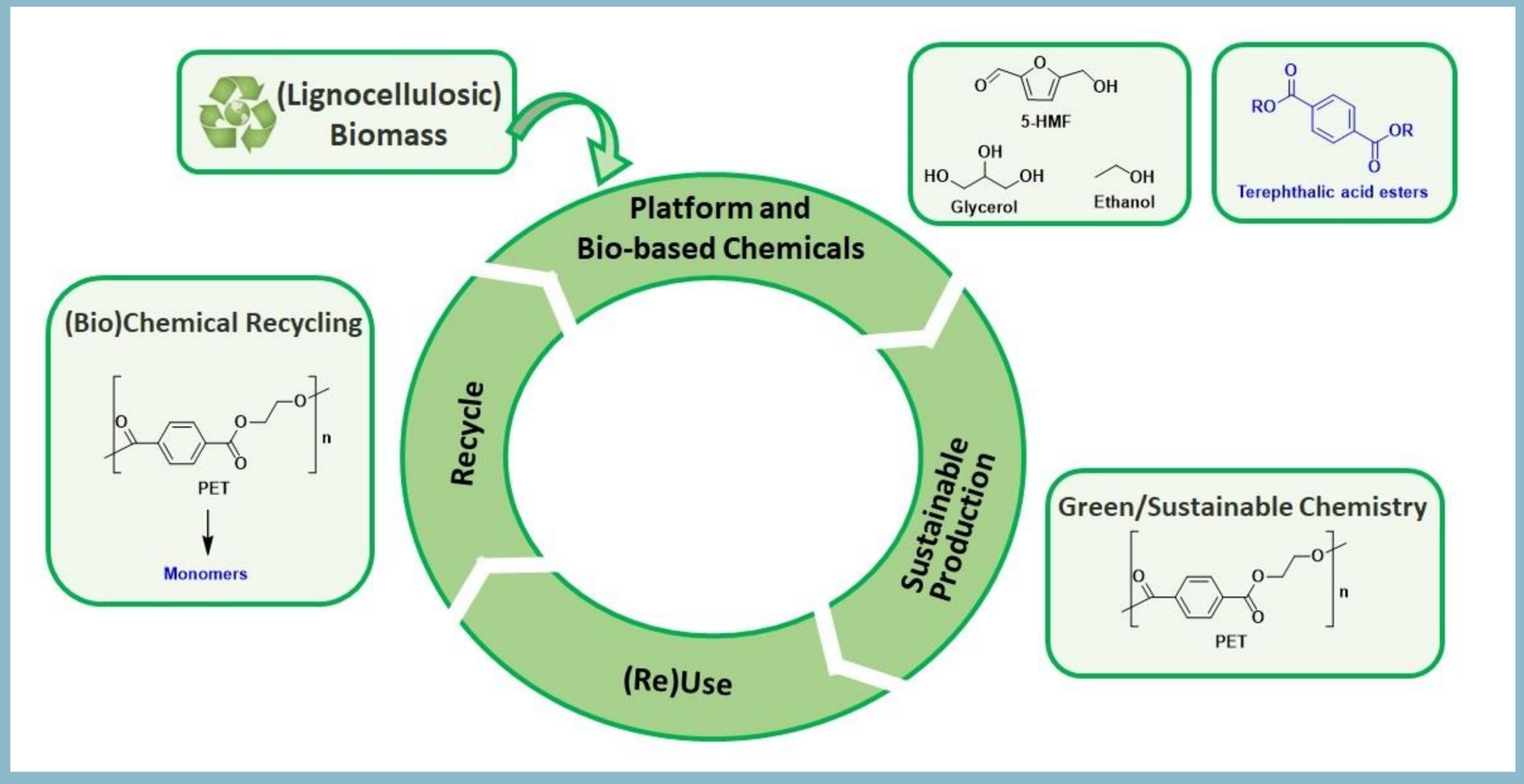
Introducing Sustainability in Chemistry with Problem-Based Learning

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**. This poster shows an introduction to sustainability using the example of sustainable production of PET in a framework of PBL workshops.



Sustainable production of PET. 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 found that PBL was effective **in improving critical thinking and problem-solving skills** in Chemistry students.[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?

Three workshops over three weeks supported by on-line lectures to design a Sustainable Production of PET from Biomass. At the end of every workshop students produce 1/3 of the report they need to submit for assessment.

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 sustainable processes. The teams work on the sustainable production and recycling of PET from biomass”

Students organise in Teams “start-ups”. They decide the name of their company and distribute roles within the team to design a whole process from biomass to production of sustainable PET. The students have available on-line educational materials (readings, lectures and activities) to support them during the three workshops designed to produce their final report in three steps.

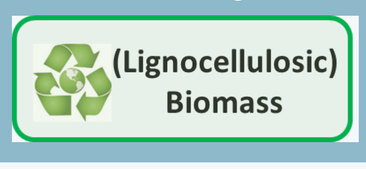
Objectives

- **Workshop 1: Choose an optimal feedstock (biomass) and design adequate pretreatment processes to obtain glucose as raw material**
- **Workshop 2: Use principles of Green and Sustainable Chemistry to produce biobased monomers to obtain Sustainable PET**
- **Workshop 3: Design a sustainable process for (chemical) recycling of PET at the end of life**

WORKSHOP 1

PRETREATMENT OF BIOMASS

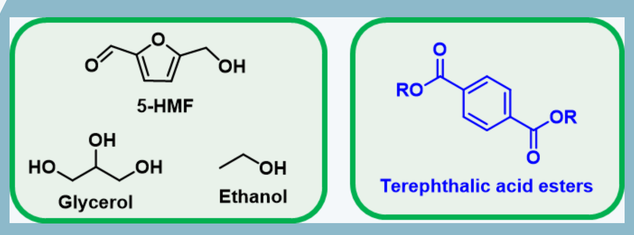
- **Summary lecture** (30 min)
  - Introduction of the problem, context and rules of the activity.
  - Teams' allocation (4-5 students)
- **Teams’ meetings** (1h 30min).
  - Design of a pretreatment of chosen biomass feedstock to obtain glucose



WORKSHOP 2

CHEMICALS FROM BIOMASS

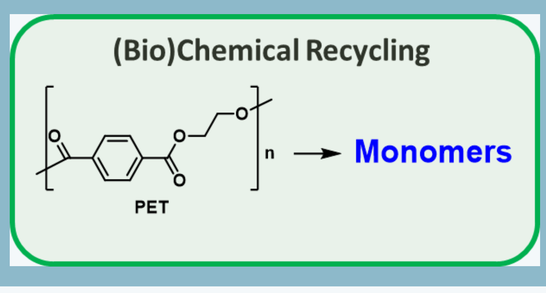
- **Summary lecture and Q&A** (30 min)
- **Teams’ meetings** (1h 30min).
  - Design of chemical processes to produce biobased monomers



WORKSHOP 3

(CHEMICAL) RECYCLING

- **Summary lecture and Q&A** (30 min)
- **Teams’ meetings** (1h 30min).
  - Design of sustainable processes for (Chemical) recycling of PET



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] Aidoo, B., Boateng, S. K., Kissi, P. S., & Ofori, I. (2016). Effect of Problem-Based Learning on Students' Achievement in Chemistry. Journal of Education and Practice, 7(33), 103-108.. [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.