

Achieving Gold LEAF Accreditation in a Teaching Laboratory:

Embedding Sustainable Practice through a Whole-Team Approach

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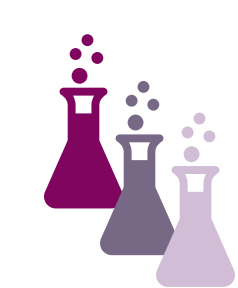
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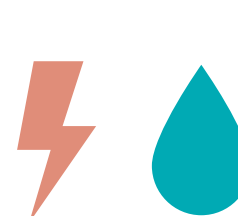
The high-throughput nature of the teaching laboratory creates a resource-intensive environment, posing challenges to embedding sustainable practice in the laboratory. Despite this, through a whole-team approach involving teaching and technical staff, and students, we have implemented a range of sustainable practices and embedded the principles of green chemistry in our curriculum, cumulating with accreditation at Gold level of the Laboratory Efficiency Assessment Framework (LEAF).

Challenges

The chemistry teaching lab environment poses a number of challenges for sustainability:



Students are often expected to conduct reactions on relatively large scales to maximise the probability of success, leading to waste.



Running a large-scale teaching lab requires a large amount of resources, both for reactions (e.g. heating, water cooling) and safety (e.g. extraction).



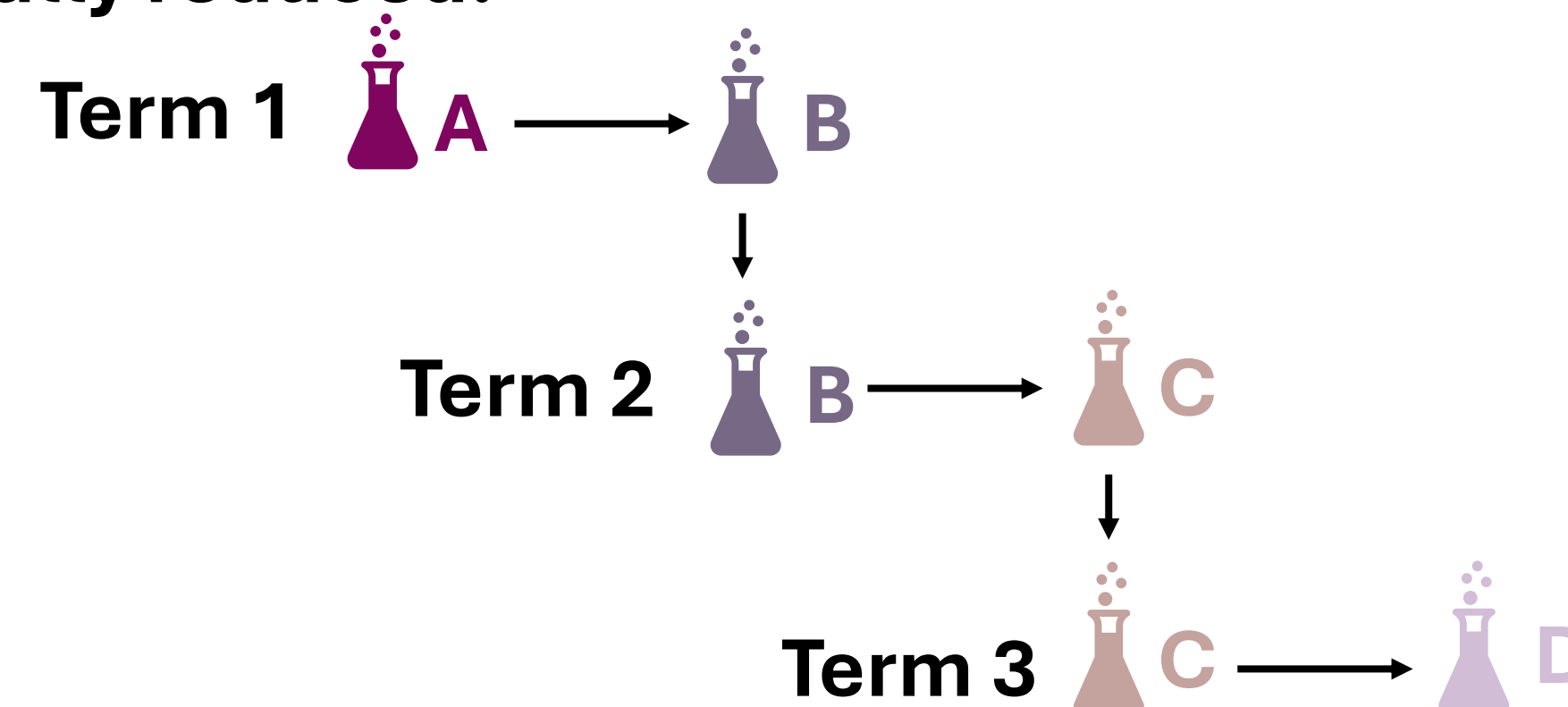
Large student numbers lead to large amounts of consumable waste, often involving single-use plastics (e.g. weighing boats).



Students often arrive in the lab expecting to follow pre-planned activities, and may not view themselves as stakeholders in laboratory sustainability.

Waste Reduction

By designing the laboratory course sequence such that students synthesise products in one lab, which are starting materials for a subsequent lab, waste from synthetic labs is dramatically reduced.



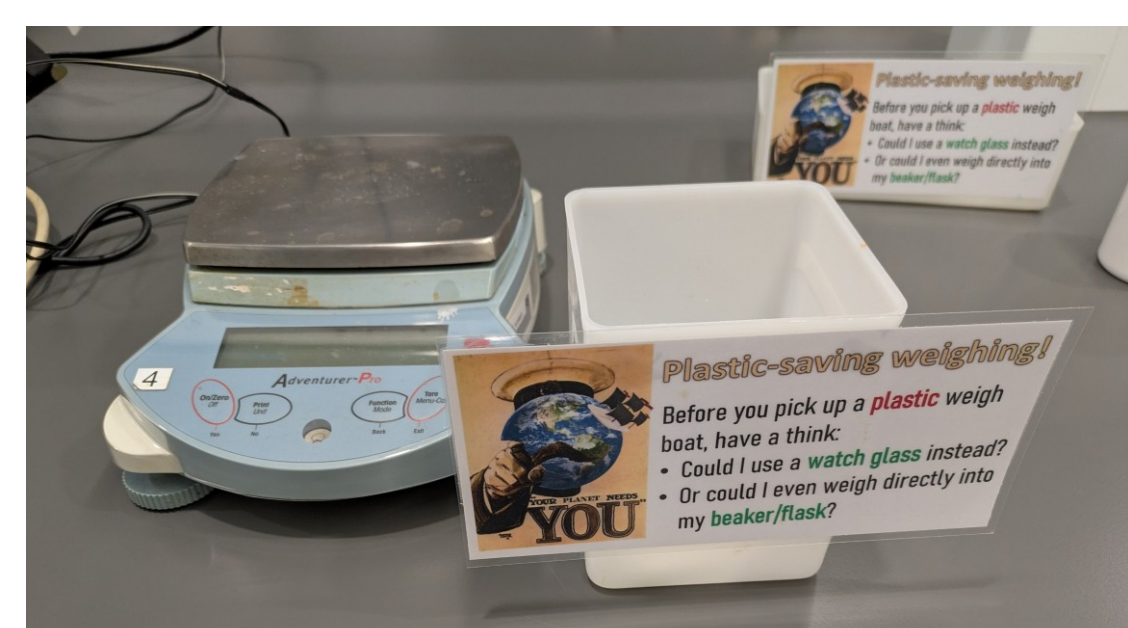
Through optimisation of reaction conditions for laboratory activities, the amount of reagents and solvent can be reduced, dramatically reducing reagent consumption.

Case Study: Synthesis of $\text{Cr}_2(\text{CH}_3\text{CO}_2)_4(\text{H}_2\text{O})_2$	Mass of reagent needed per pair of students (g)	
	Old method	New method
$\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$	10	8
Zn powder	17	10
$\text{NaOAc} \cdot 3\text{H}_2\text{O}$	27	14

Starting material saved over an 8 week term > 2 kg

Student Empowerment

By educating students on decisions they can make to increase sustainability in the lab, students are empowered to consider the environmental impact of simple changes made in the lab.



An example of a common decision is considering when single-use plastics can be replaced by reusable alternatives, e.g. using a watchglass instead of plastic weighing boats.

A culture of sustainability is encouraged through educating students on the importance of small changes in lab practices, such as closing fumehood sashes to reduce energy use.

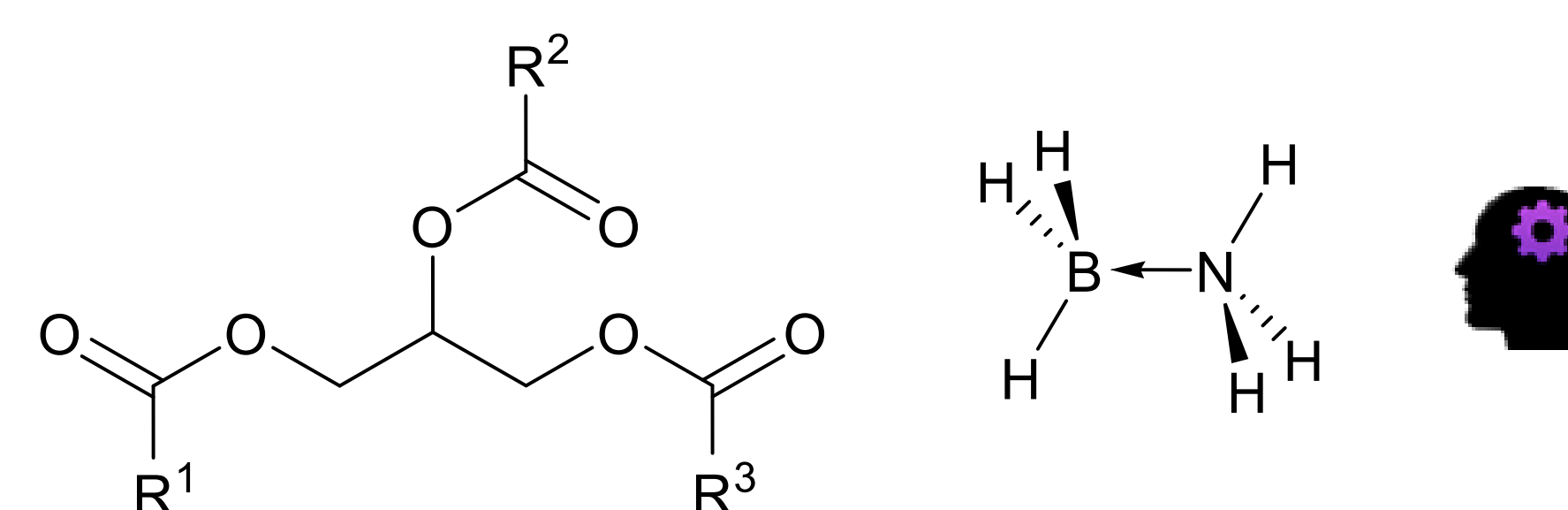


Curriculum

Throughout the curriculum, demonstrations of green chemistry are presented through investigative labs in which students evaluate sustainable practices.

i) Student evaluation of sustainable fuel sources:

Students evaluate potential sustainable technologies, such as biodiesel and hydrogen storage materials, considering the lifecycle of the fuels and their efficiency.



ii) Demonstration of use of green techniques in synthesis:

By exposing students to different synthetic techniques, such as solvent-free reactions or the use of a microwave reactor to reduce heating times, students are encouraged to evaluate and select greener synthetic approaches.

Outlook

Through embedding green chemistry throughout the curriculum, revising experiments to reduce unnecessary starting materials, and by empowering students as stakeholders in creating a more sustainable teaching laboratory, backed up by explicit consideration of green chemistry principles in the curriculum, we received Gold LEAF accreditation in 2025. This process demonstrates the potential for teaching laboratories to be accredited to demanding sustainability standards.

References:

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- 2) Z. M. Smallwood, C. D. Campbell, A. F. Worrall, S. T. Cahill and M. I. Stewart, *J. Chem. Educ.*, 2021, **98**, 3514–3523.
- 3) C. D. Campbell, M. O. Midson, P. E. B. Mann, S. T. Cahill, N. J. B. Green, M. T. Harris, S. J. Hibble, S. K. E. O'Sullivan, T. To, L. J. Rowlands, Z. M. Smallwood, C. Vallance, A. F. Worrall and M. I. Stewart, *Chem. Teach. Int.*, 2022, **4**, 243–257.