

1 **Sustainable Analytical Chemistry Laboratories: The Critical Role of**
2 **Education**

3 Caroline Pollard^a and Helena Rapp-Wright^{b*}

4 ^aLeverhulme Research Centre for Forensic Science, University of Dundee, Dundee,
5 United Kingdom

6 ^bMRC Centre for Environment and Health, Environmental Research Group, School of
7 Public Health, Imperial College London, London, United Kingdom

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9 *Corresponding author E-mail address: h.rapp-wright@imperial.ac.uk

Supplementary Information (SI):

Table S1. Summary of some greenness metric tools available in analytical chemistry workflows. Includes metric name, inclusion of sample preparation and instrumentation, number of procedural steps, and references for further information.

Metric's name	Sample preparation included	Instrumentation included	Number of steps	Reference
Analytical Greenness Metric for Sample Preparation (AGREEprep)	Yes	No	10	1
Analytical GREENness calculator (AGREE)	Yes	Yes	12	2
Analytical Method Greenness Score (AMGS)	No	Yes	9	3
Sample preparation Metric of Sustainability (SMPS)	Yes	No	8	4
Blue Applicability Grade Index (BAGI)	Yes	Yes	10	5
Green Analytical Procedure Index (GAPI)	Yes	Yes	15	6
Analytical Eco-Scale	Yes	Yes	6	7
HPLC-Environmental Assessment Tool (HPLC-EAT)	Yes – solvents only	Yes – solvents	NA	8
White Analytical Chemistry	Yes	Yes	12	9

NA: not available.

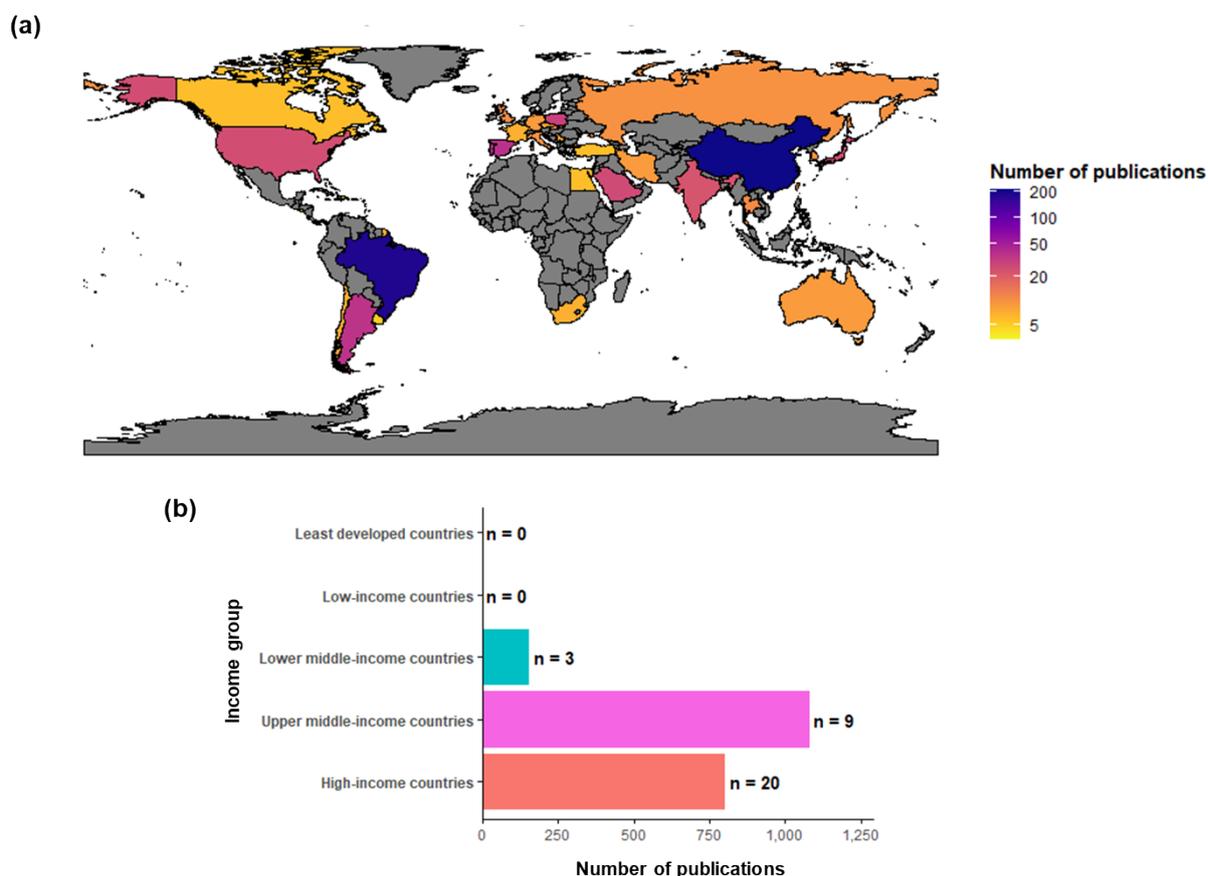


Fig. S1 (a) Global heatmap representing the geographic distribution of publications by funding and (c) corresponding bar chart summarising publication counts by World Bank income group, based on the OECD Development Assistance Committee (DAC) list of ODA recipients¹⁰ (n = number of countries per group). Data panels (b) and (c) were obtained from Scopus using the following search: "analytical chemistry" AND ("sustainability" OR "green") with filters PUBYEAR > 2003 AND PUBYEAR < 2025, SUBJAREA, "CHEM", and DOCTYPE, "ar" (accessed on 29 August 2025). Heatmap colour intensity is log₁₀-scaled and reflects publication volume between 2004 and 2024.

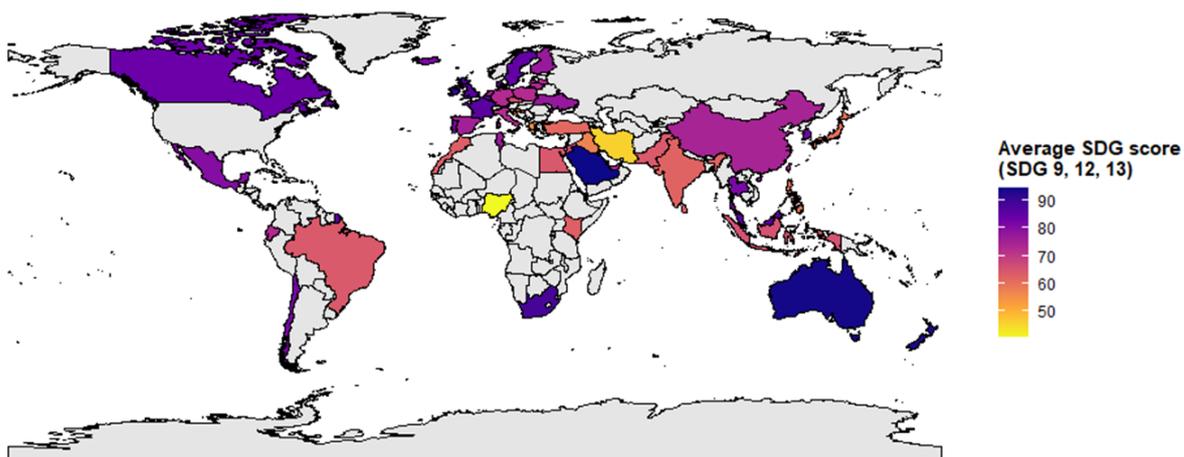


Fig. S2 Global heatmap showing the country-level average performance of universities on SDGs 9, 12, and 13. Colour intensity represents the mean SDG score (scale 0–100) across all universities within each country, with darker colours indicating higher overall average performance. Data sourced from the Times Higher Education (THE) Impact Rankings 2025 and restricted to institutions offering chemistry programs.¹¹

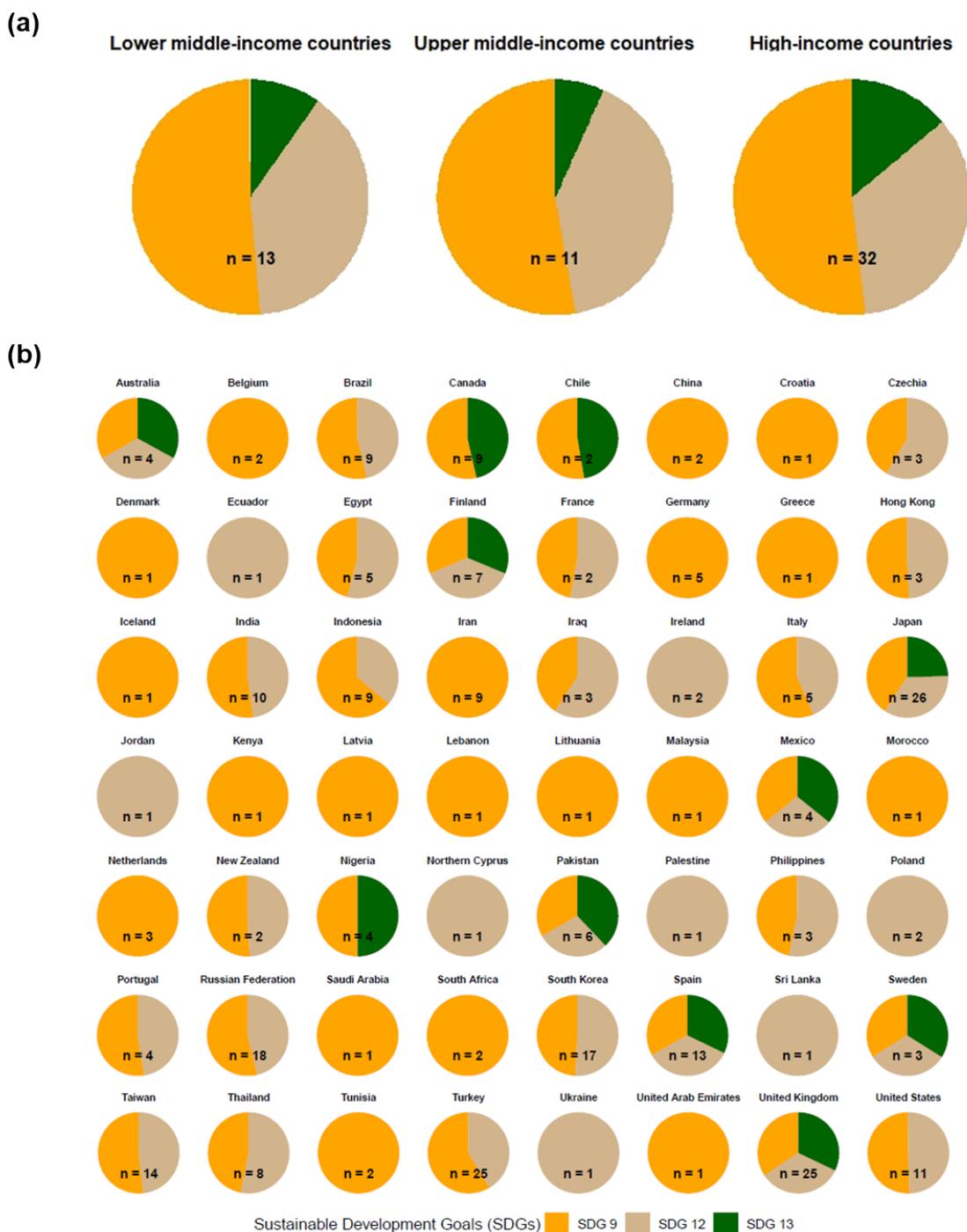


Fig. S3 Pie charts showing the relative contribution (%) of SDGs 9, 12, and 13 to (a) the total SDG score within each World Bank income group, classified according to the OECD Development Assistance Committee (DAC) list of ODA recipients,¹⁰ calculated from country-level averages (n = number of countries included in each income group); and (b) individual countries (n = number of universities per country included). Data sourced from the Times Higher Education (THE) Impact Rankings 2025 and restricted to institutions offering chemistry programs.¹¹

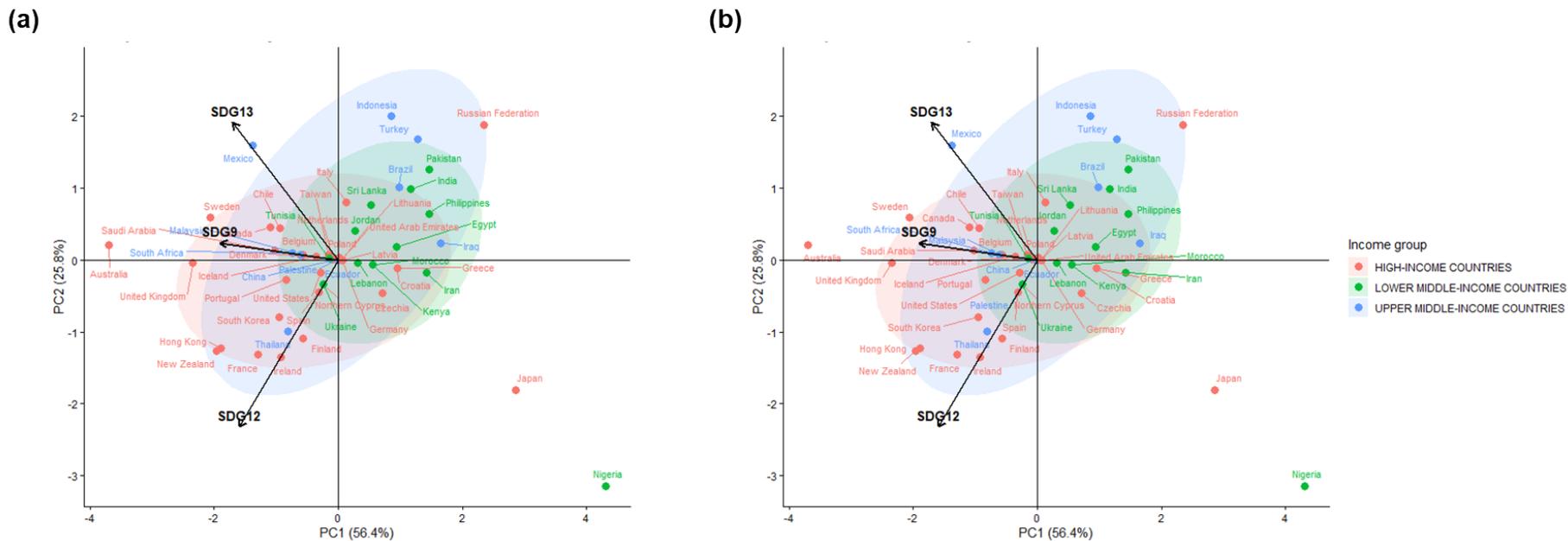


Fig. S4 HJ-biplots of average SDG scores (9, 12, and 13) of universities per country: (a) including all countries, and (b) only countries with complete data for all three SDGs. SDG indicators were standardised (mean = 0, SD = 1) prior to PCA to prevent dominance of variables with higher variance. PCA was performed on centred and scaled data. Countries are coloured by World Bank income group,¹⁰ shaded ellipses indicate income group dispersion, and SDG vectors represent the contribution of each goal to the principal components. Data retrieved from the Times Higher Education (THE) Impact Rankings 2025.¹¹

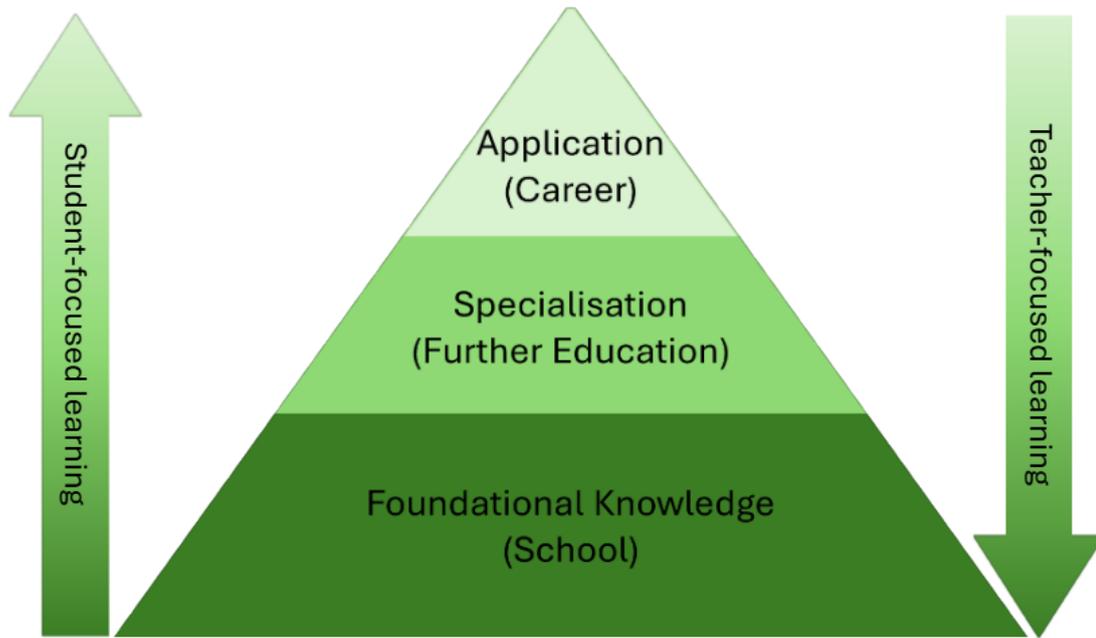


Fig. S5 Workflow illustrating the pyramid of educational progression: from foundational knowledge to career application.

Table S2. Examples of some sustainability-focused chemistry summer schools for further-education students, including programme, name, student level, thematic focus, duration, and cost (as of 01 December 2025). References provided for additional information.

Programme	Student level	Topics	Length	Duration	Cost	Reference
IUPAC Postgraduate Summer School on Green Chemistry	PhD; postdoc	<ul style="list-style-type: none"> • Benign synthesis routes • Green catalysis • Alternative solvents • Renewable and green raw materials • Green chemistry for energy • Clean processes • Green Chemistry education • Sustainable Polymers 	5 days	Annually	300 - 750€	12,13
The ACS Green and Sustainable Chemistry Summer School (GSCSS)	Graduate; Postgraduate Chemists/Engineers	NA	7 days	Annually	Free	14
Green Chemistry, Technische Universität Berlin	Undergraduate students from the courses of Chemistry or Chemical Engineering or Environmental Engineering	<ul style="list-style-type: none"> • A functional understanding of the field of green chemistry • A working understanding of the 12 principles of green chemistry • An understanding of several real-world examples where organisations used green chemistry to improve the sustainability performance of their products • An appreciation of how the practice of green chemistry enhances competitiveness, innovation and faster time to market 	11 days	NA	Students: 1050€ Working professionals/non-students: 1250€	15

Green Chemistry and Circular Solutions	Students; Early Career researchers and Professionals	<ul style="list-style-type: none"> • Sustainability assessment of value chains • Advancements in vegetable oils recycling • Production of chemicals from vegetable oils (edible and used) • Quality assessment of waste vegetable oils • Regulatory framework of vegetable oils using and recycling • Closing the loop: circular economy strategies in industrial waste reuse 	3 days	NA	Free	16
Summer School on Sustainable Chemistry for Sustainable Development	Postgraduates; PhD students; Young professionals	<ul style="list-style-type: none"> • Safe-and-Sustainable-by-Design (2024) • Climate crisis (2023) • Hydrogen Economy (2022) • Agriculture (2021) • Water (2020) • Renewable Energy (2019) • Sustainable Building and Living (2018) • Sustainable Chemistry and e-Waste (2017) • Sustainable Textiles (2016) • Sustainable Chemistry in International Cooperation (2015) 	5 days	Annually	NA	17
GreenChemAfrica	Students; ECRs; Professionals	<ul style="list-style-type: none"> • Green Chemistry • Greening Processes/Solvents • Greener Synthetic Strategies • Feedstock and Recycling • Life Cycle Assessments of chemical reactions and modelling 	6 days	Annually	NA	18

NA: not available.

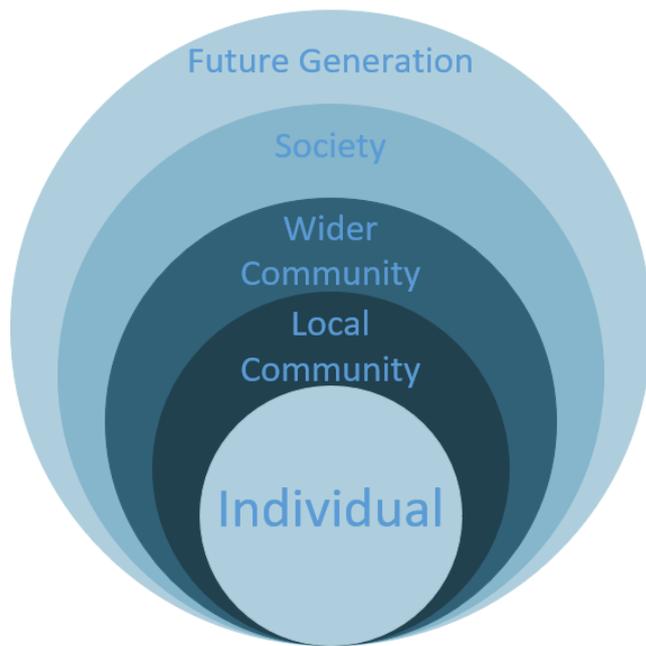


Fig. S6 Illustration of the ripple effect of education: knowledge gained by an individual can extend outward, influencing local and wider communities, society, and future generations.

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