

Bridging the gap - now and next for sustainability teaching in IC Chemistry

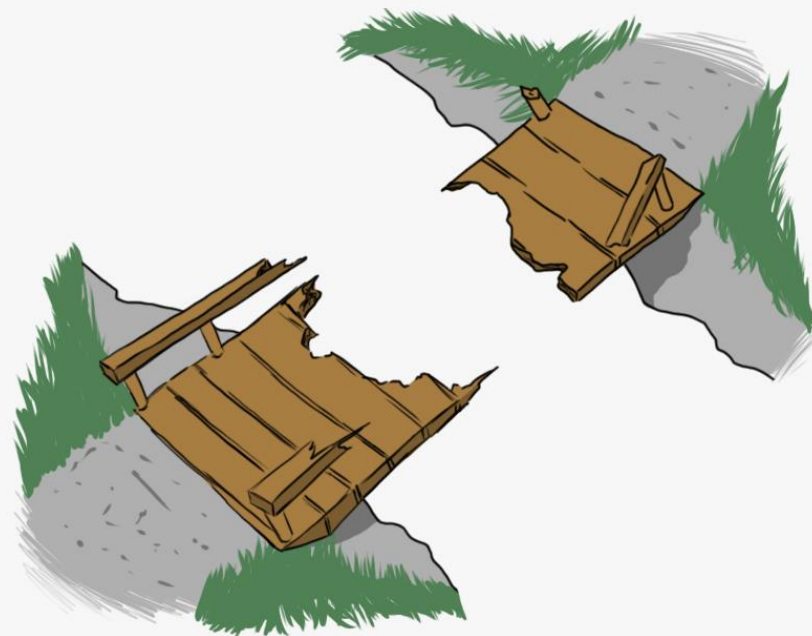
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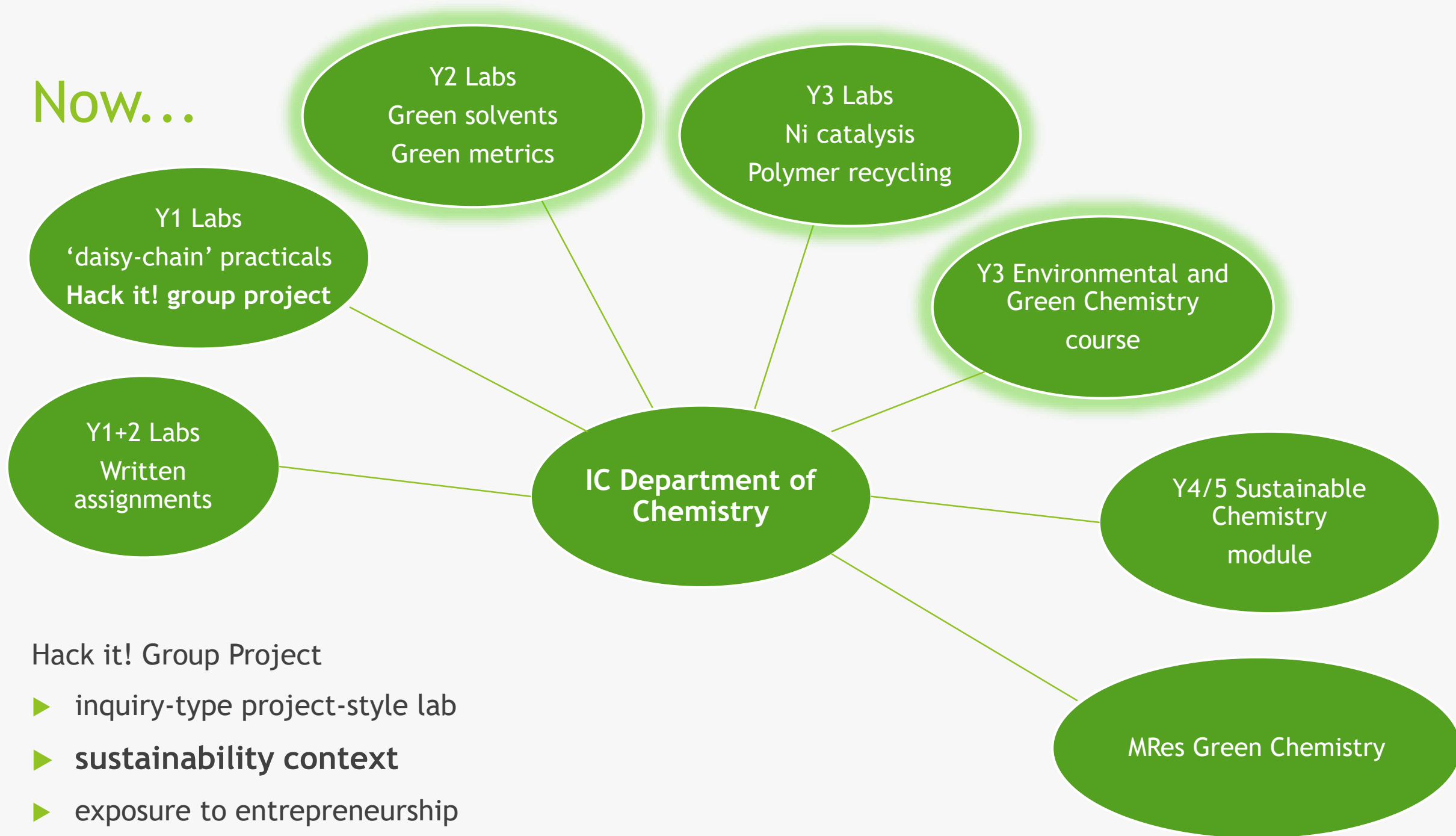
Imperial Festival of Learning and Teaching

24th March 2025

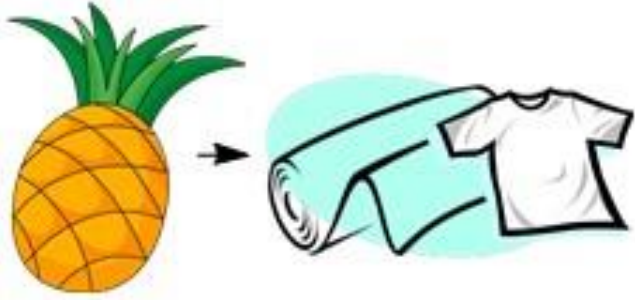
**Imperial College
London**



Now...



Hack it! group project



2014

**Sustainable Textiles
from Pineapple Leaf
Fibres (PALF)**

Ananas Anam



2015-2022

**Bioderived polymers
(Ooho)**

Notpla



2023-2025

**Kitchen waste to
Clean water
(Kw2Cw)**

Hack it! group project

Structure:

- ▶ 2 weeks (6 days) in the summer term
- ▶ Groups of 5-6 students
- ▶ Lab work
 - ▶ Directed investigation - more defined tasks
“more directed work where you are carrying out part of the work of a larger investigation”
 - ▶ Extension - chosen and defined by the group
“an extension of your choice - your opportunity to exercise your innovation and creativity!”
- ▶ Mid-project check-in meeting with SME team
- ▶ Group presentation to peers, staff and SME team

Hack it! group project

Part 1 – Investigate the effect of additives on permeability

- design procedure to measure permeability / water loss
- prepare pearls (see below) to investigate the effect of your allocated 'single component' additive
- develop a method to process your allocated natural material to obtain a second additive, investigate the effect of this additive on permeability

- conduct a source for

Part 2 – IR spectroscopy

- record an
- develop a
- what does

Group	Base	Filler	Single component additive	amount provided	suggested range to test	Natural material
GP_01	Chemical Kitchen	Toothpaste	Wyoming bentonite	1 g	1-2 wt%	Onion peel
GP_02	Chemical Kitchen	Toothpaste	High methoxy pectin	3 g	1-5 wt%	Onion peel
GP_03	Chemical Kitchen	Toothpaste	High acyl gellan gum	3 g	1-5 wt%	Parsnip peel
GP_04	Chemical Kitchen	Toothpaste	Guar gum	3 g	1-5 wt%	Parsnip peel
GP_05	Chemical Kitchen	Toothpaste	Calcium carbonate	1 g	1-2 wt%	Parsnip peel
GP_06	Chemical Kitchen	Ketchup	Wyoming bentonite	10 g	1-2 wt%	Parsnip peel
GP_07	Perkin South lab	Ketchup	High methoxy pectin	25 g	1-5 wt%	Dulse seaweed
GP_08	Perkin South lab	Ketchup	High acyl gellan gum	25 g	1-5 wt%	Dulse seaweed
GP_09	Perkin South lab	Ketchup	Guar gum	25 g	1-5 wt%	Tomato peel
GP_10	Perkin South lab	Ketchup	Wyoming bentonite	10 g	1-2 wt%	Tomato peel

Hack it! group project

Part 3 – Prototype an application of alginate pearls or membranes

You may wish to consider

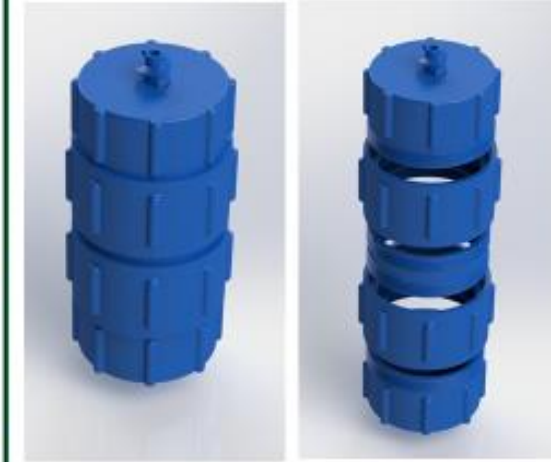
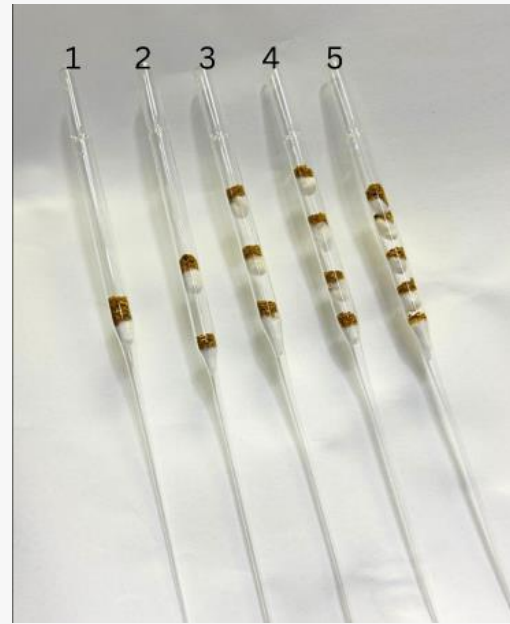
- applications which require water-soluble pearls or membranes
- methods to construct multi-layered membranes
- encapsulating other household substances or using other additives*

Consider the environment-friendly / sustainability focus of this research. This part of the project is very open-ended in order that you can aim your investigation in any direction you find interesting. This may mean you find you're unsure how to make a start – don't worry, this is normal! It's suggested you start by sharing and discussing a range of ideas, then work on narrowing down to a focus you all agree on. If you need inspiration take a look at Notpla's website.

Hack it! group project

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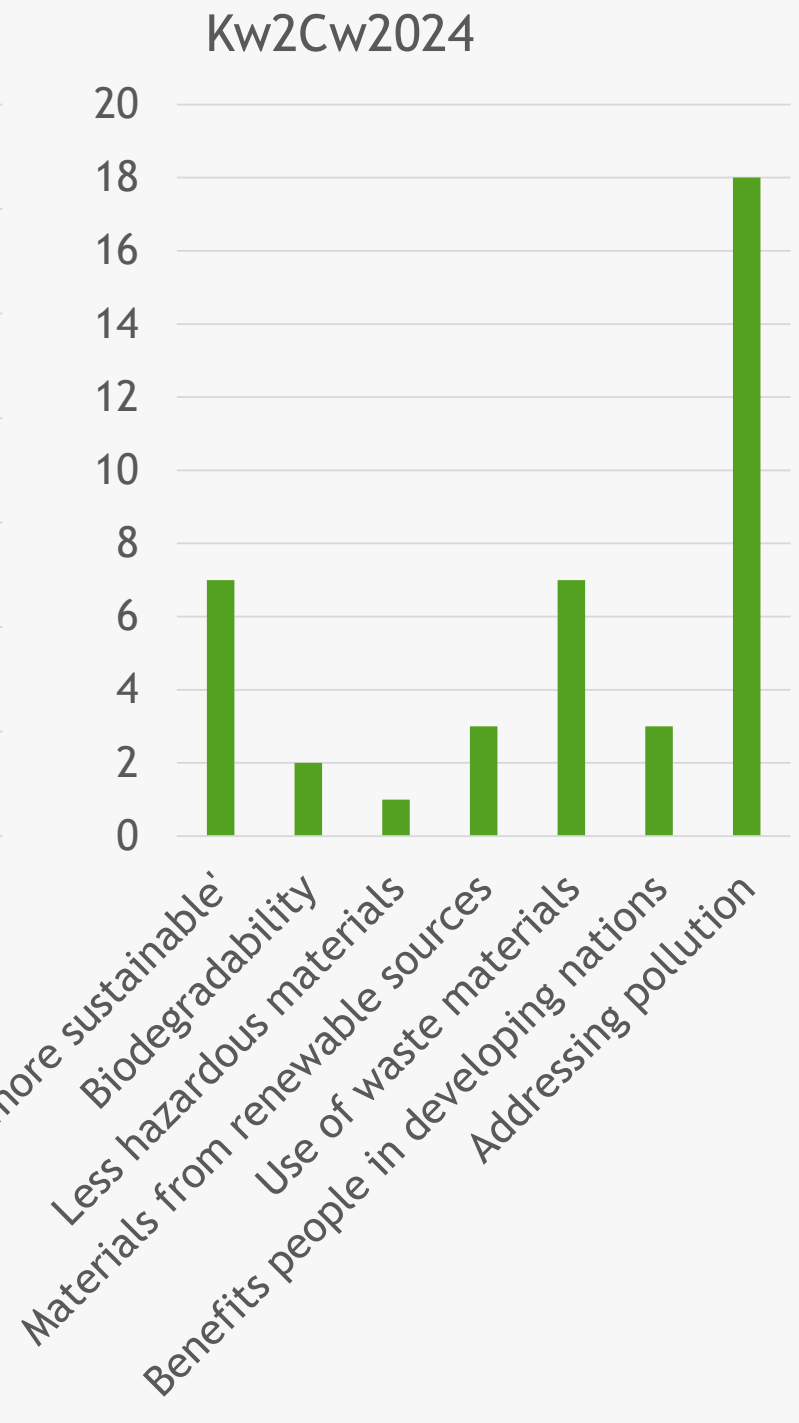
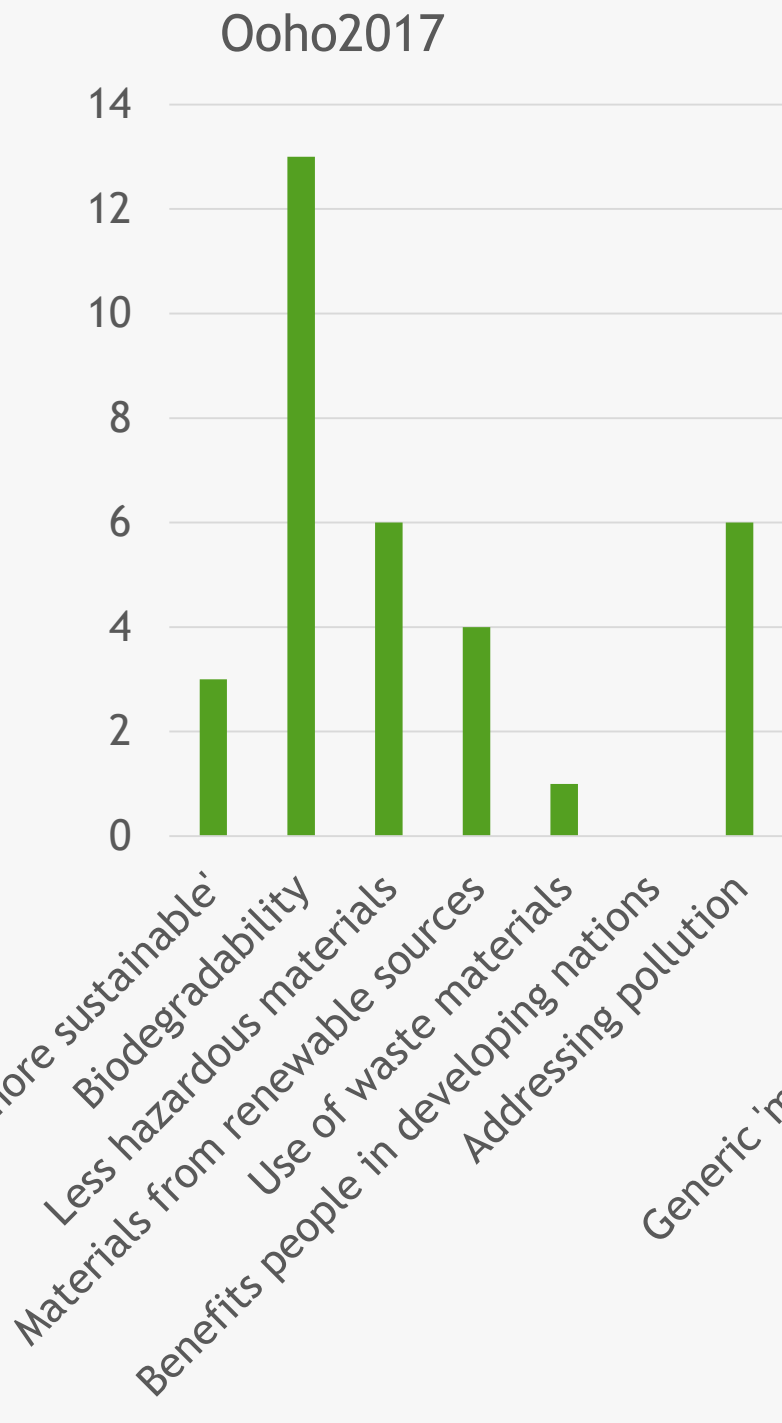
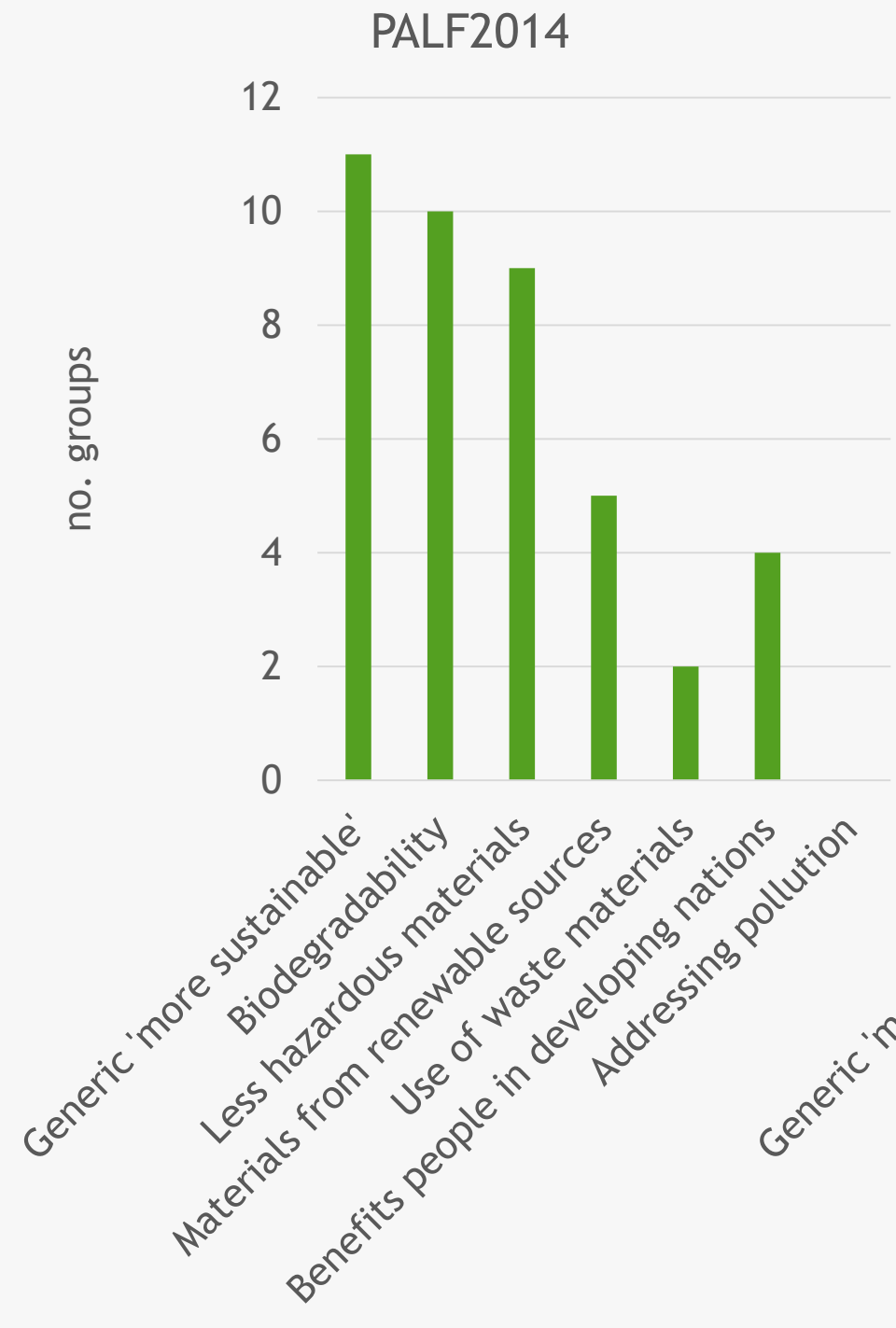


Teaching sustainability

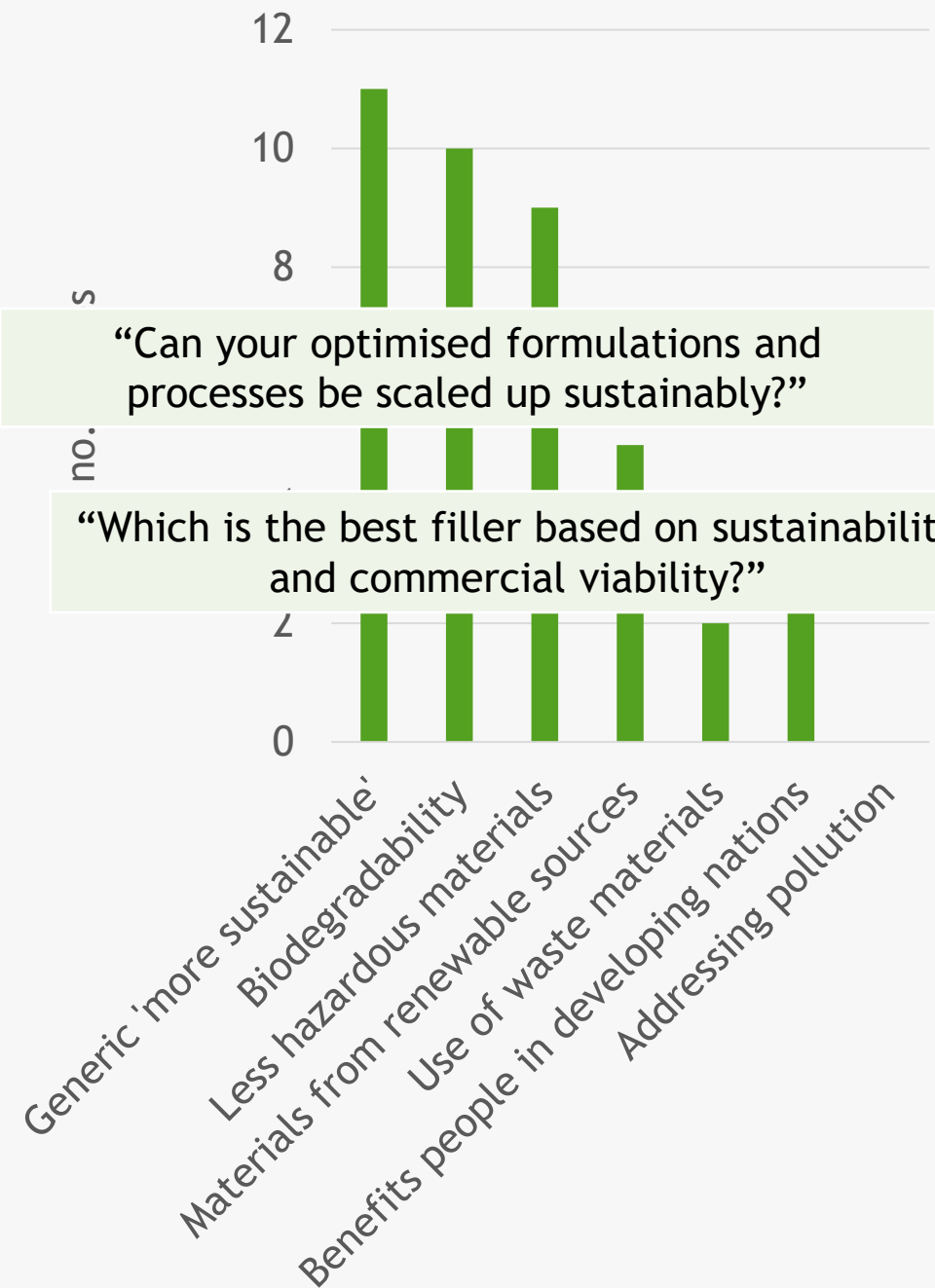
What do students learn from the **sustainability context**?

► Presentations show consideration of a range of concepts:

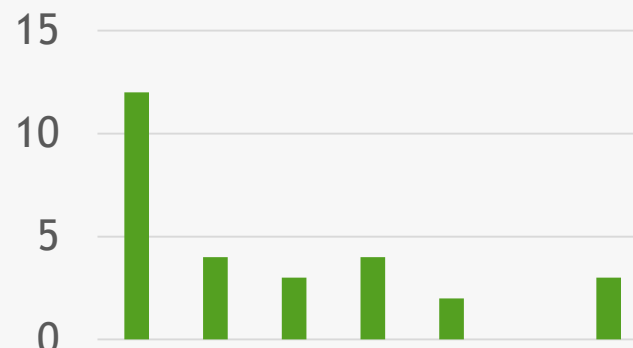




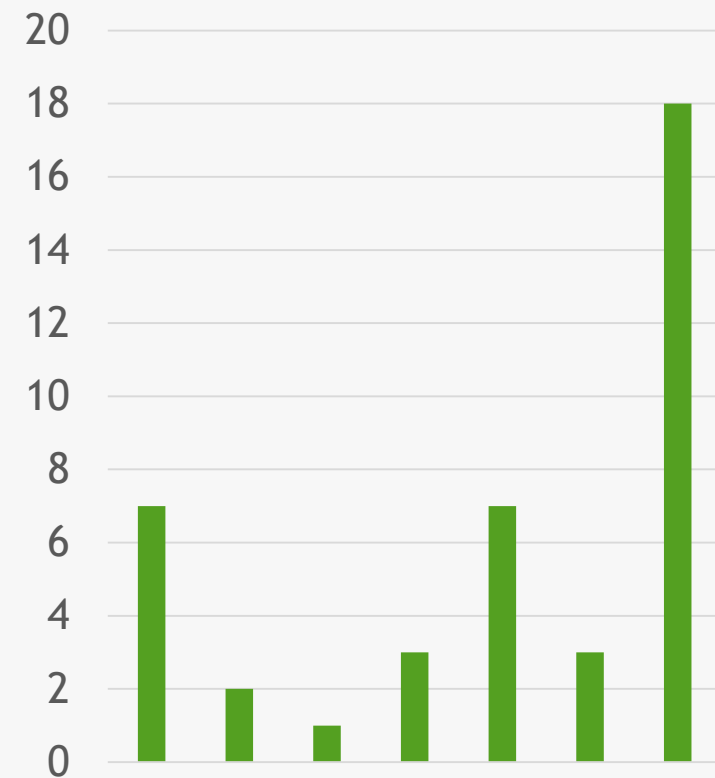
PALF2014



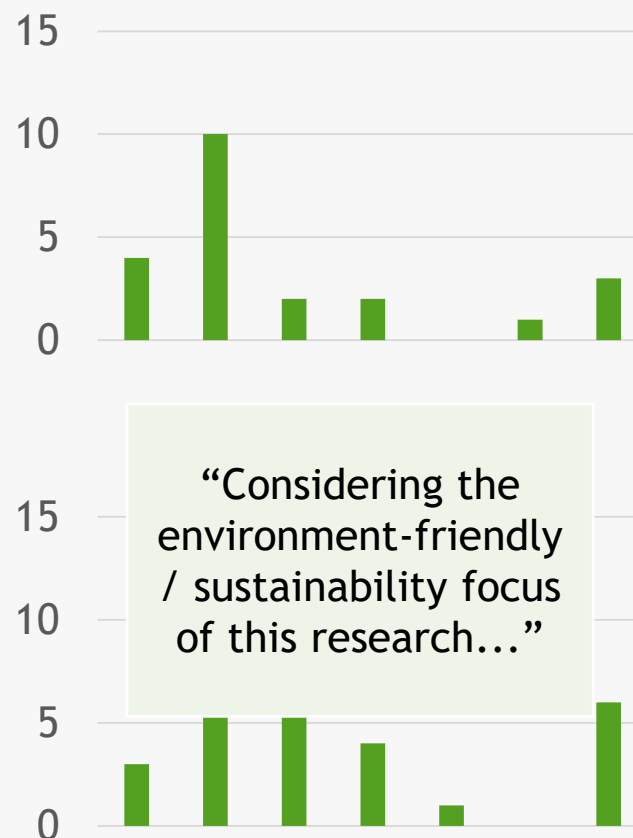
Ooho2015



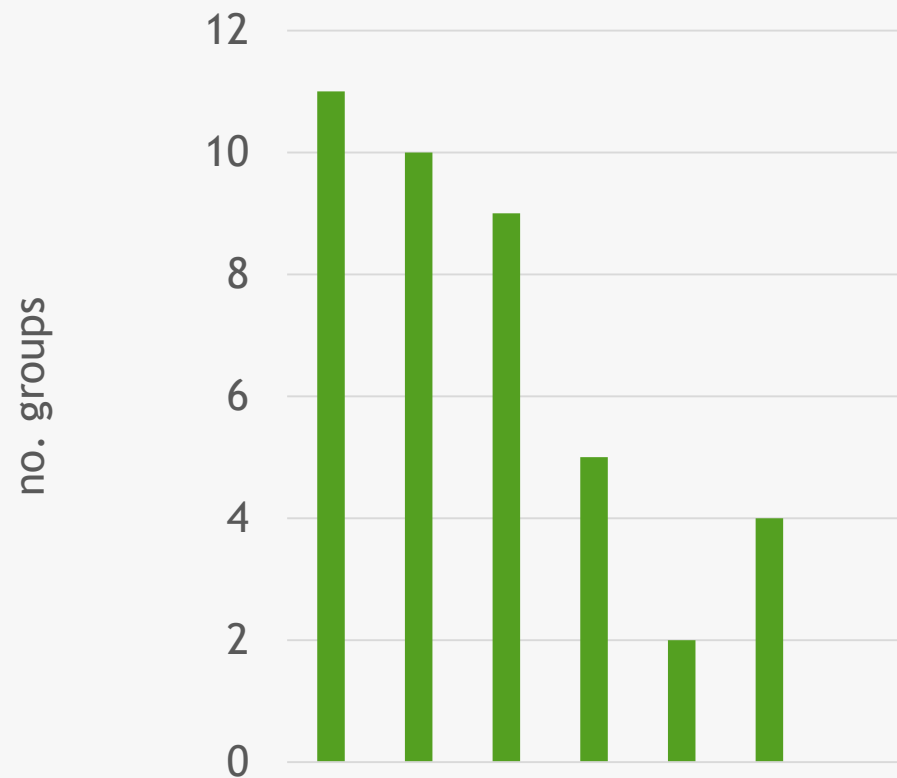
Kw2Cw2024



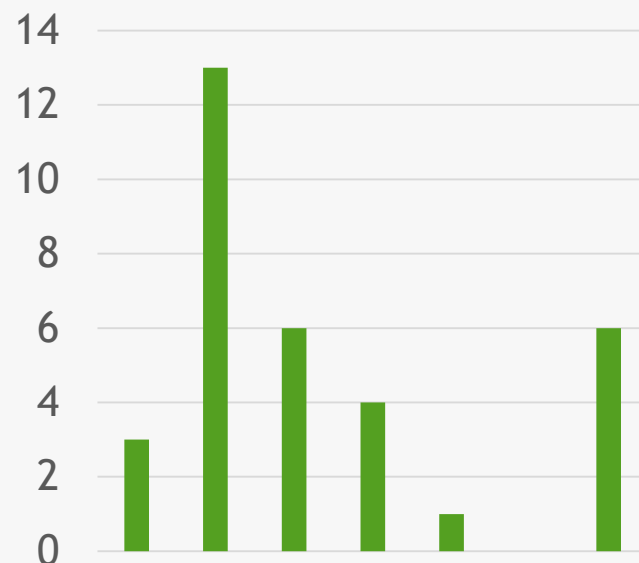
Ooho2016



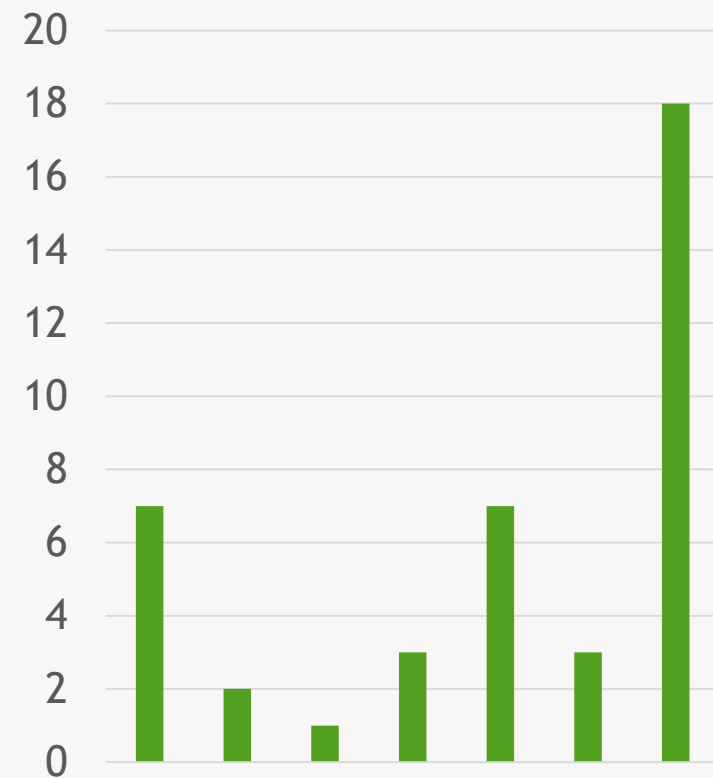
PALF2014



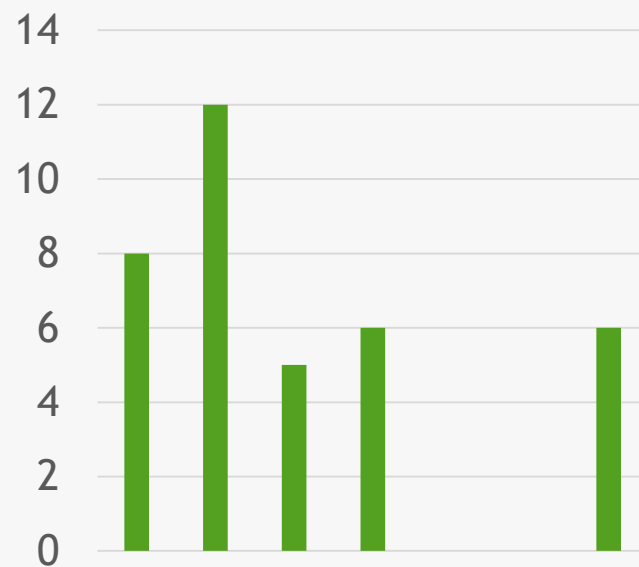
Ooho2017



Kw2Cw2024



Ooho2020 (online)



Generic 'more sustainable'

Biodegradability

Less hazardous materials

Materials from renewable sources

Use of waste materials

Benefits people in developing nations

Addressing pollution

Teaching sustainability

What do students learn from the **sustainability context**?

- ▶ Presentations show consideration of a range of concepts
 - ▶ a minority of groups each year do not show consideration of sustainability
 - ▶ most groups consider several concepts to some extent
 - ▶ a few groups each year engage more extensively

eg. evaluation of their project against the 12 Green Chemistry principles:

Reusing the squash peel
rather than discarding it

(Waste Prevention,
Principle #1)

Use of a plant-based
adsorbent

(Renewable Feedstocks,
Principle #7)

Minimal energy consumption
due to not heating

(Design for Energy Efficiency,
Principle #6)

Teaching sustainably(?)

Does collaboration with a SME enhance sustainability?

Notpla reported:

- ▶ not just an interesting and enjoyable experience working with students...
- ▶ ...but the supply of data to the R&D department justifies the company's time and resources input

also they:

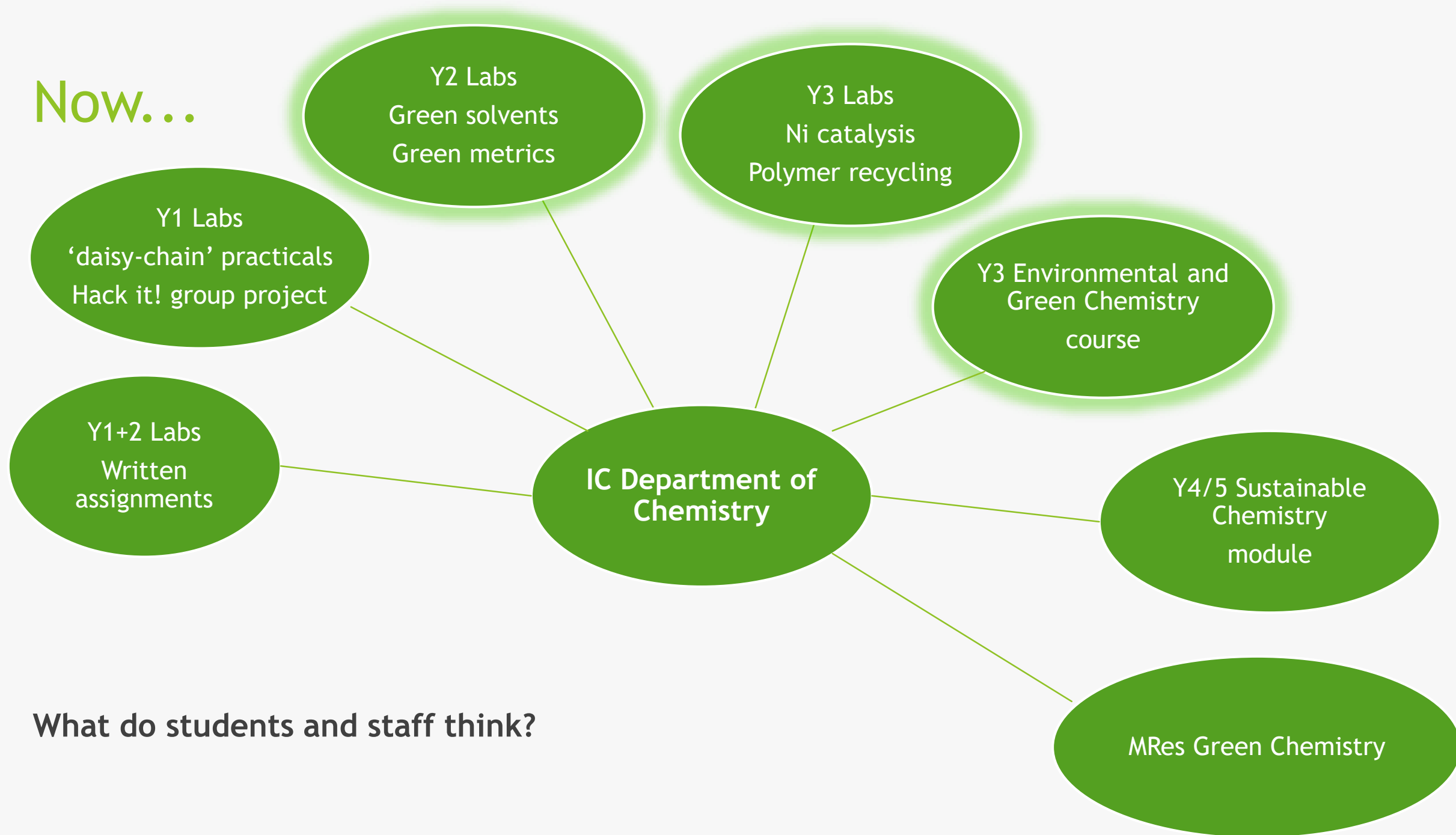
- ▶ suggested different project directions year-on-year, mapping to their current R&D interests
- ▶ promptly reported back issues where students were off-track with respect to what would be useful to the company

... and were tenacious about the sharing of students' results!

The aims of collaborating:

- the company gets bright, creative students working on their research
- students get to do real research **which is of real use to someone**

Now...



What do students and staff think?

Assessing the gap

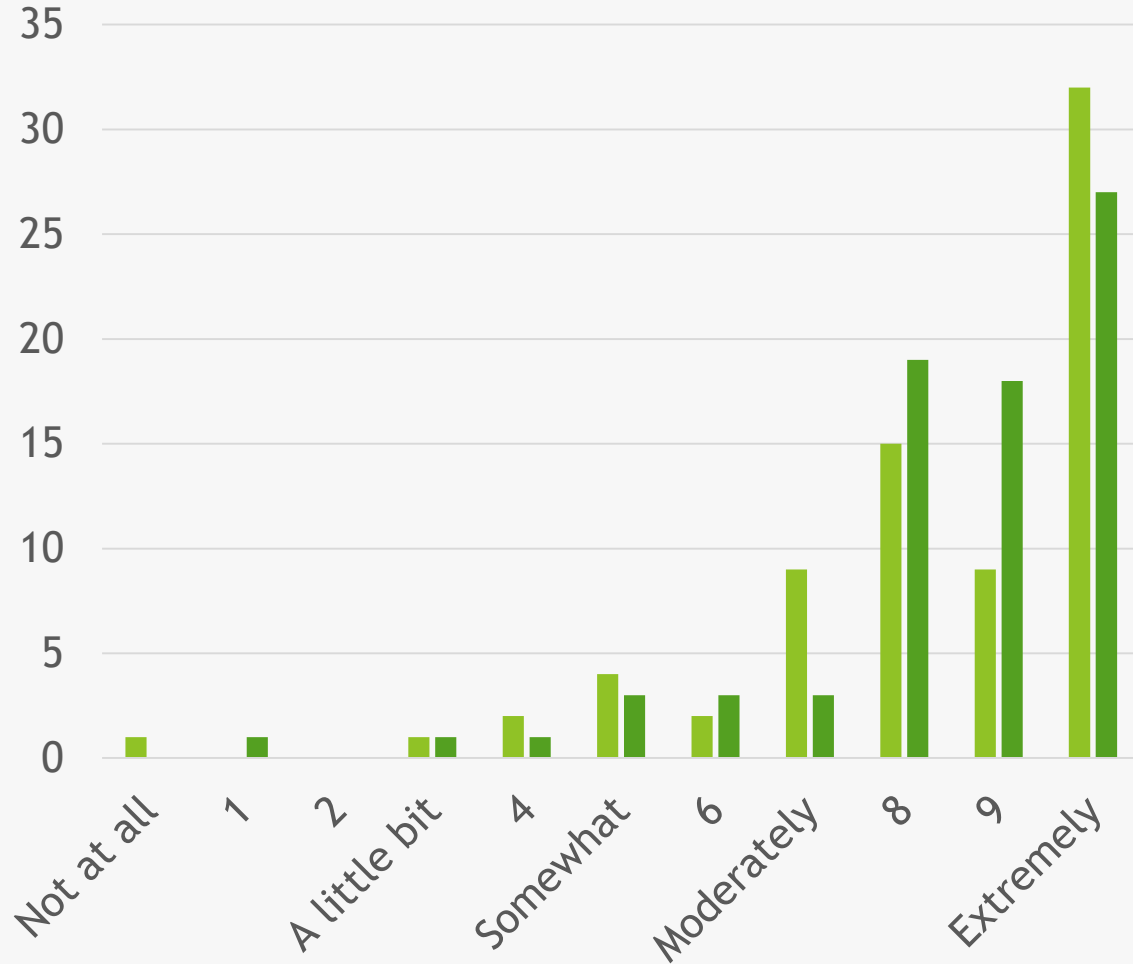
Distribution of Survey:

- Ethics Approval was sought through the College prior
- Surveys were open for longer periods to allow flexibility
- Shared via email

Data Collection and Analysis:

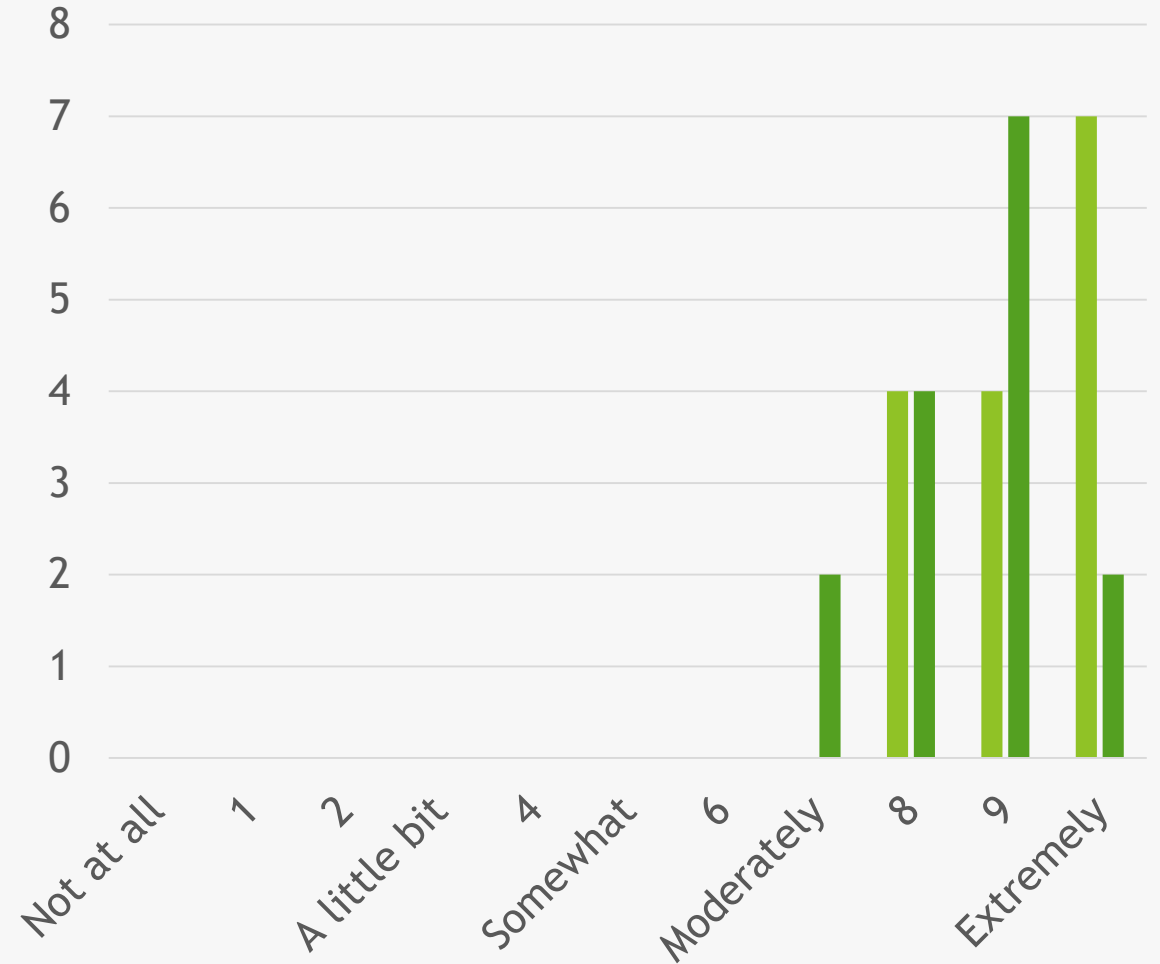
- Surveys were anonymous
- 86 of ~600 students and 17 of ~70 staff members submitted responses
- Thematic Analysis was used

Students



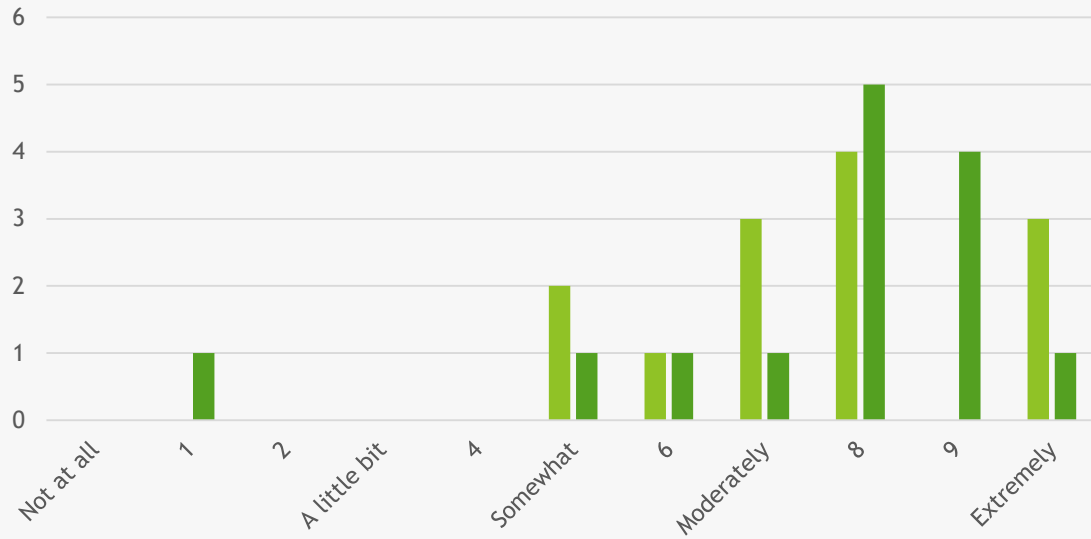
- How urgent do you view the issue of climate change?
- How much do you think things need to change?

Staff

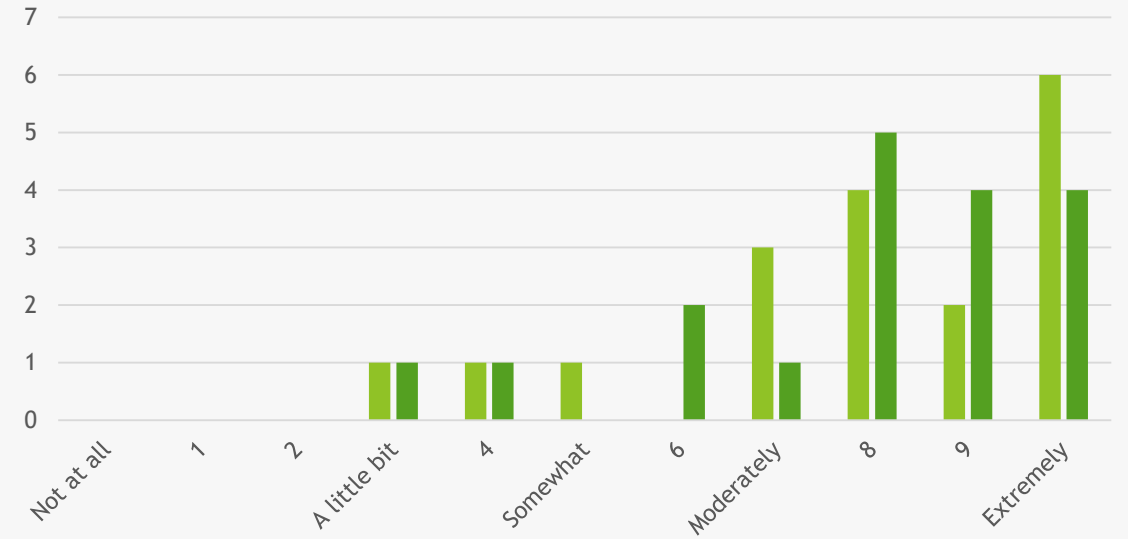


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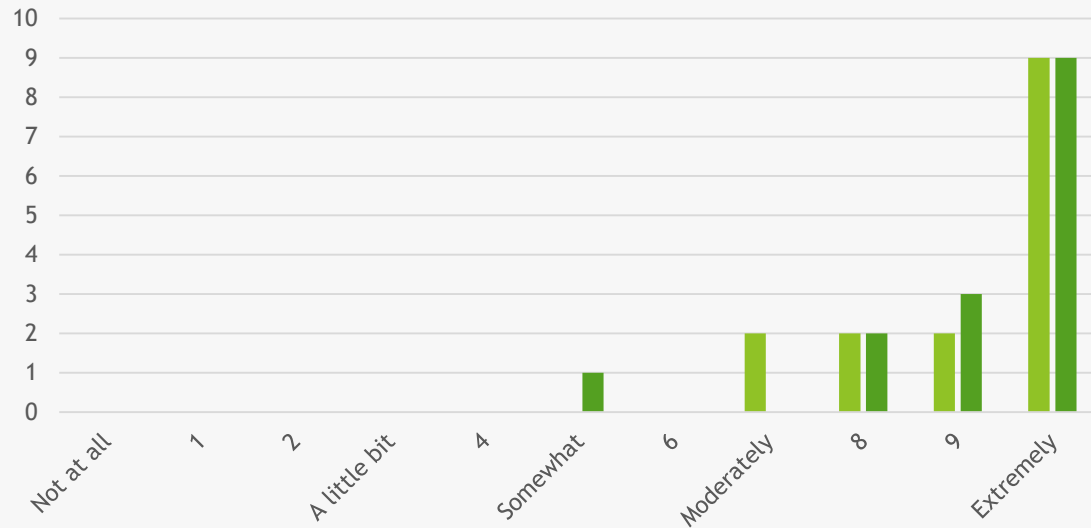
Year 1 students



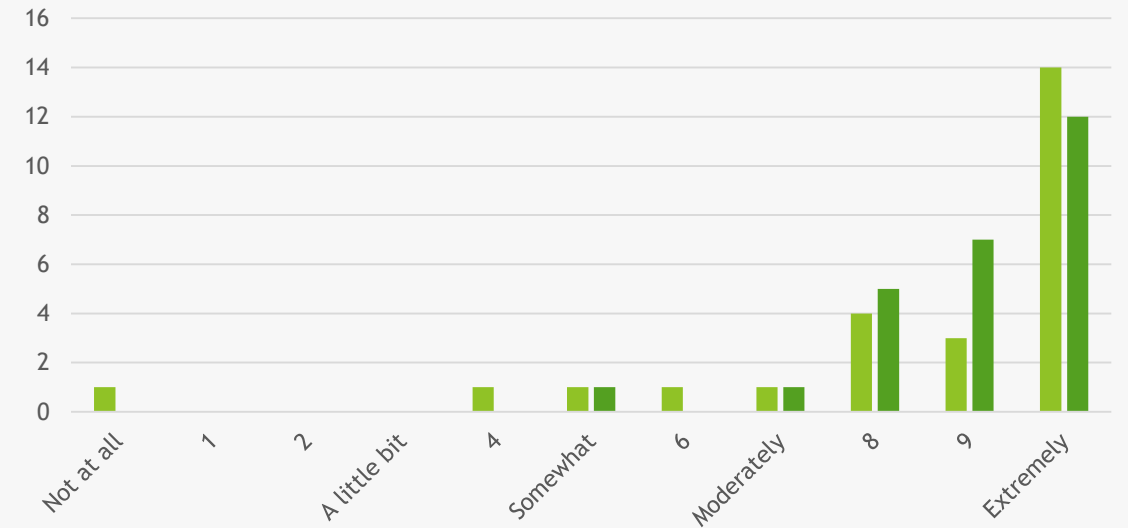
Year 2 students



Year 3 students



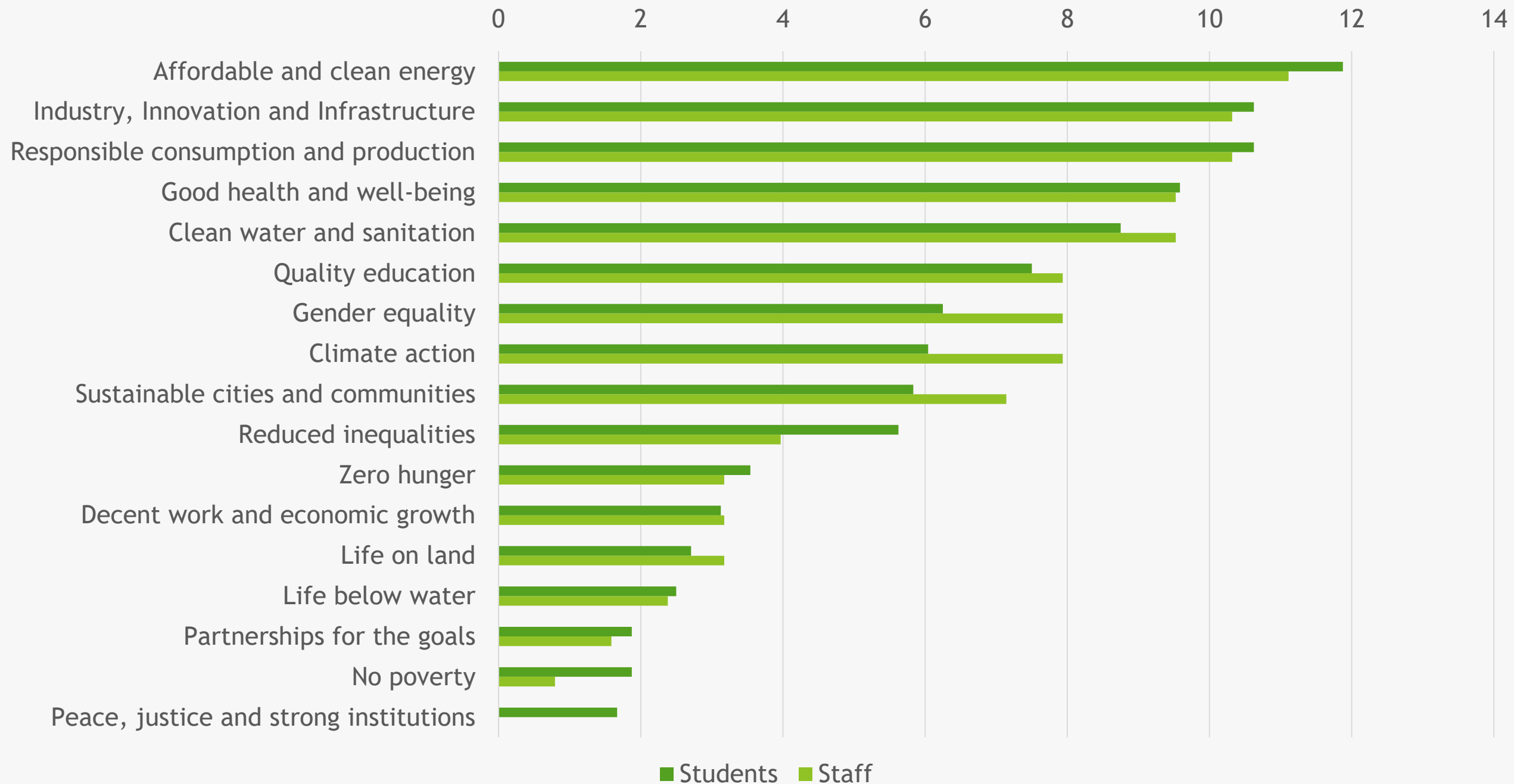
Year 4 students

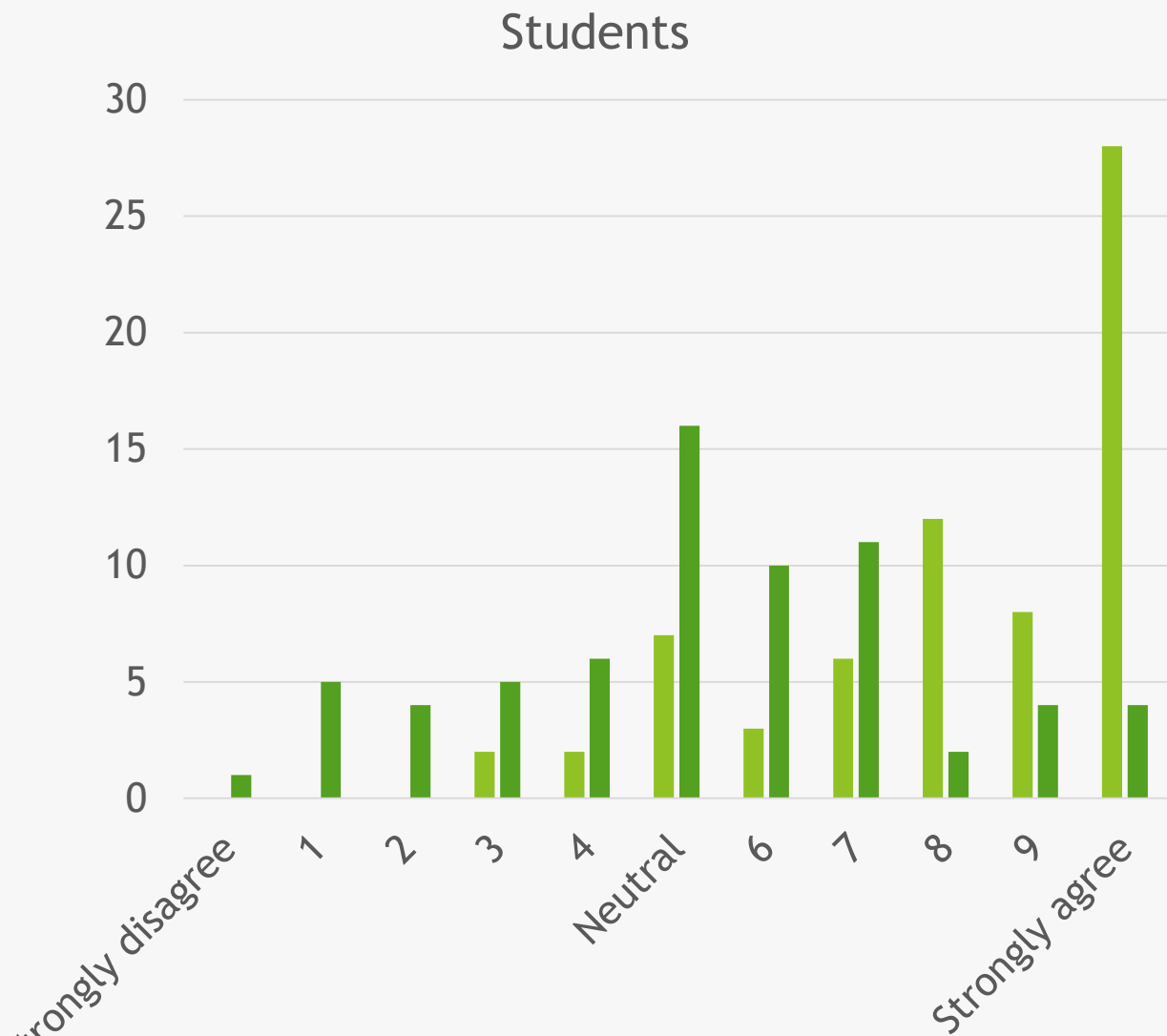


■ How urgent do you view the issue of climate change?
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SDGs most relevant to the chemistry undergraduate course:



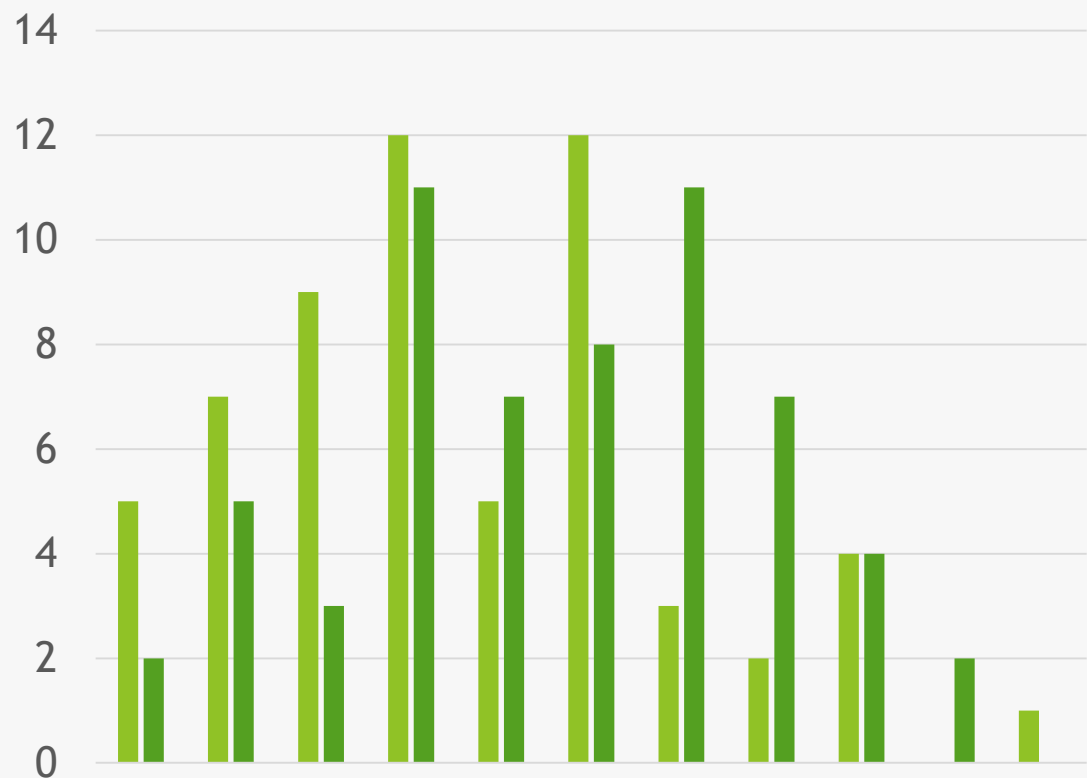


- I think it is important to include sustainability and climate change directly into the chemistry undergraduate curriculum.
- I am satisfied with how much is currently taught about sustainability in my course.



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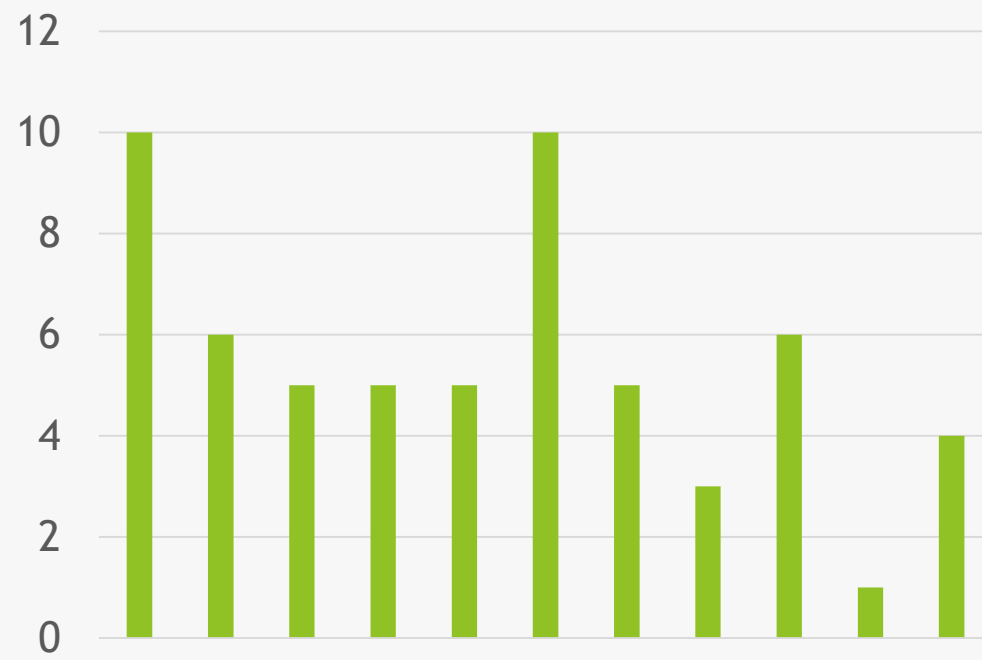
Skills for sustainability



■ I feel like the course has taught me skills with regards to being more sustainable that I can use to make a difference in my personal life.

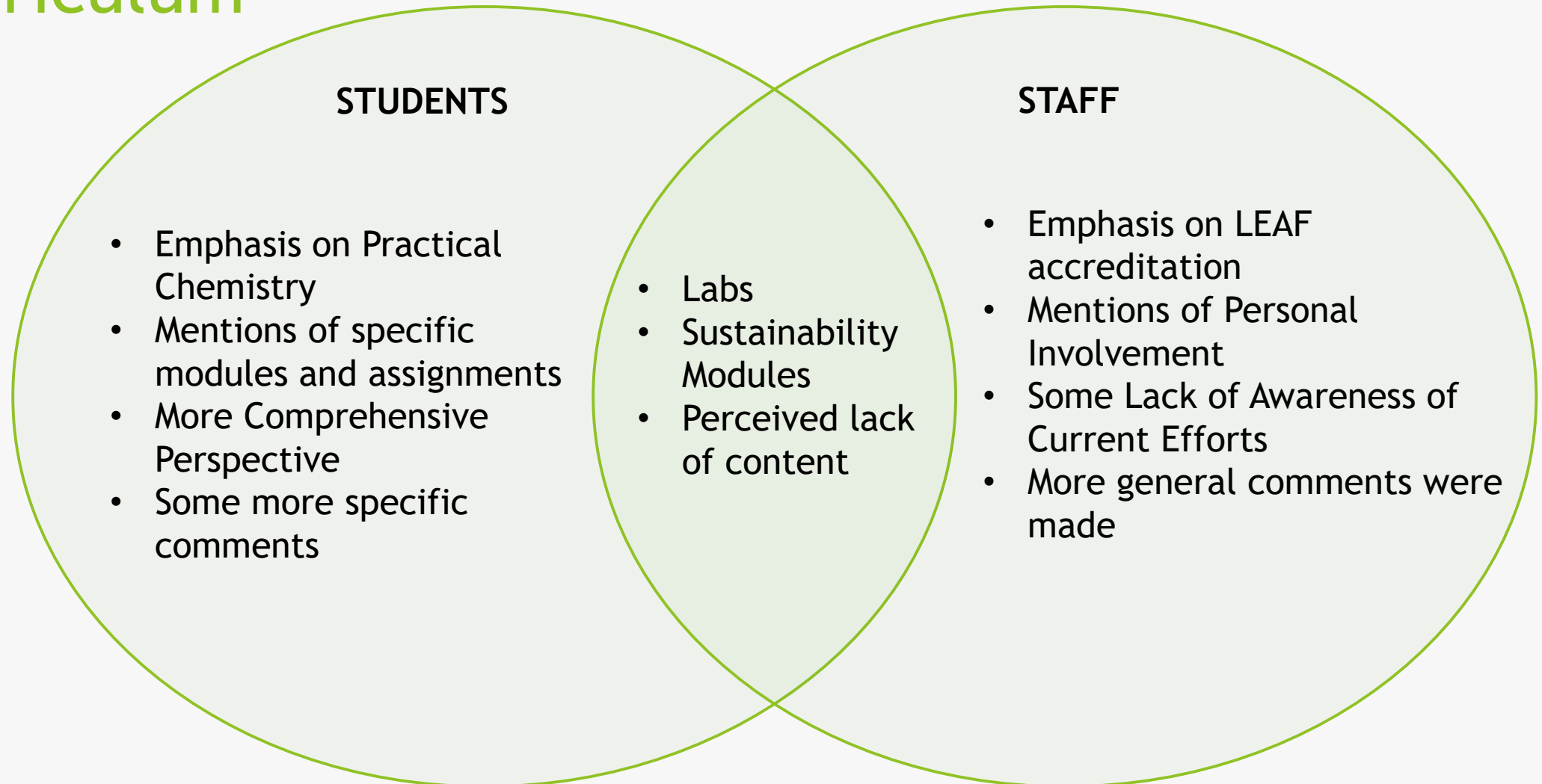
■ The course has taught me skills that allow me to suggest sustainable changes in future workplace.

When sustainability is being taught in the curriculum, I would like to be assessed on it.



Strongly disagree 1 2 3 4 Neutral 6 7 8 9 Strongly agree

Students and Staffs' Views on Current Curriculum



Students' Suggestions on Sustainability in their Course

“Working on start-ups to see and promote sustainability initiatives” - Y4 student

“The current curriculum focuses heavily on developed nations but the methods are not usually available to less developed countries.” - Y2 student

“I’ve seen options in later years, but as a first year I don’t see any sustainable chemistry at all, would be interesting to see more of if possible” - Y1 student

“New research that enhances sustainability, such as organocatalysis and in-water reactions” - Y1 student

“I would like to know more about the costing and the process of ordering chemicals, equipment etc.” - Y3 student

Staffs' Opinions on the Way Forward

“We need to decide on a syllabus of topics that we think that students should know in relation to sustainable chemistry by the end of their degree [...]”

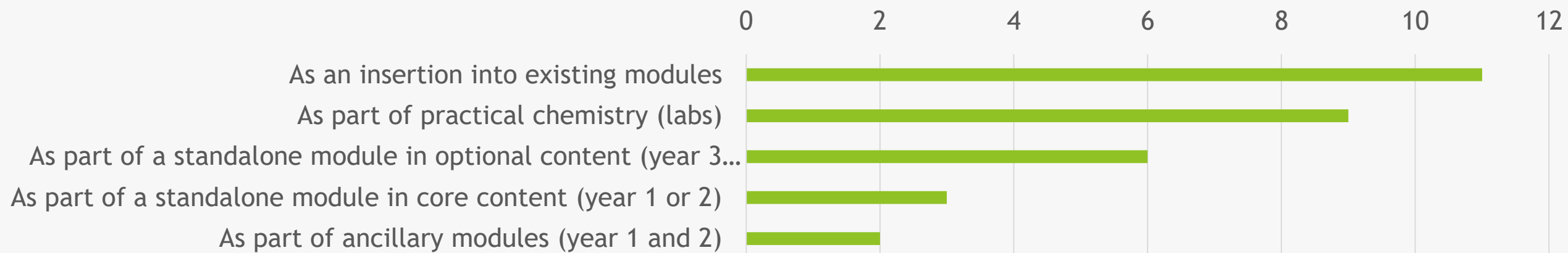
“Requires sustained leadership and coordination - oversight across degree essential for meaningful inclusion to happen.”

“Apply LEAF procedures to teaching labs. Collate how sustainability issues are already included in current teaching, identify gaps and then fill these”

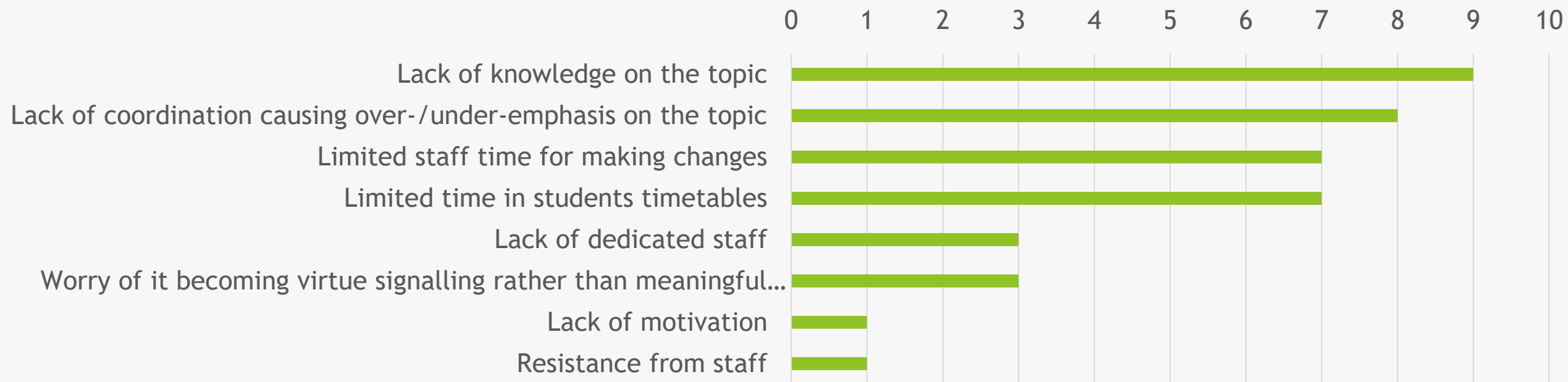
“Integrated in UG teaching right from year 1 and in all lab courses (having a sustainability assessment alongside a risk assessment with students using green metrics to evaluate the reaction they will be doing)”

“Teaching the principles of Life cycle analysis”

In your opinion how should sustainable chemistry be taught?



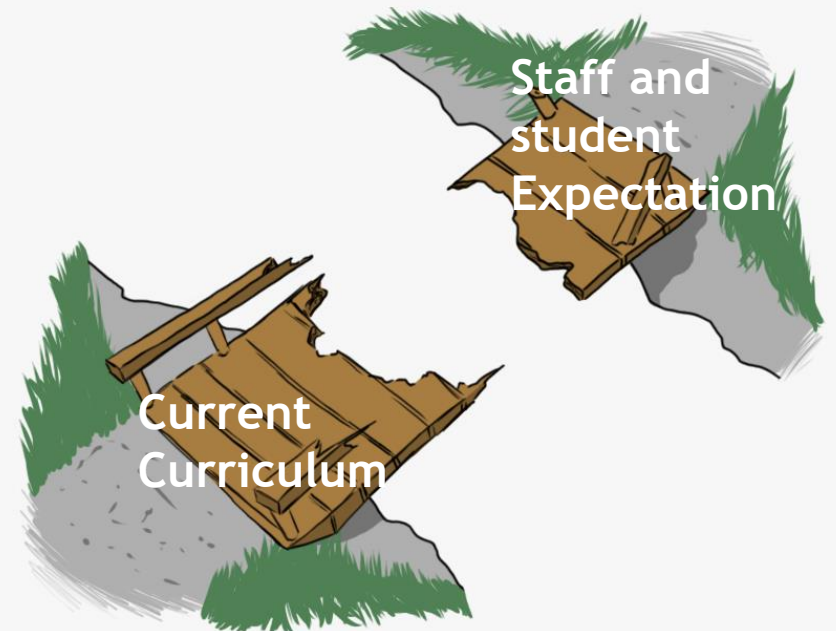
What do you perceive as being the biggest barrier(s) to the department to include more sustainability into the curriculum?



Next...

Bridging the gap

- ▶ ‘Enhancing and extending teaching of sustainability in chemistry’
 - ▶ A StudentShapers-funded summer project
 - ▶ 6 student partners, 2 formal staff partners
 - ▶ feeding into strategic work in the department
- ▶ A Year 1 term 1 workshop for AY25-26
- ▶ Repeat the surveys



Acknowledgements

- ▶ Department of Chemistry students and staff - Hack it! project students, technicians, Dr Jakub Radzikowski, survey participants
- ▶ Dr Bridge Duncombe - initiated the SME collaborations
- ▶ Notpla and Ananas Anam
- ▶ Laidlaw Foundation