Graduates, knowledge, and society: Reflections on a seven-year study of the educational outcomes of science and engineering

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CGHE webinar series: Exploring the outcomes of educating scientists and engineers

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Graduate Experiences of Employability and Knowledge (GEEK) Project 2020-2023

UK Team: *Paul Ashwin, Jan McArthur, Kayleigh Rosewell, Dee Daglish.*

South Africa Team: *Margaret Blackie, Reneé Smit, Ashish Agrawal.*

US Team: *Jenni Case, Nicole Pitterson, Alaa Abdalla, Benjamin Goldschneider.*

- Part of a 7-year longitudinal study of Chemistry and Chemical Engineering students;
- Previous CGHE project, we tracked them through their undergraduate degrees in 12 departments in England, South Africa and US (42 chemistry and 43 chemical engineering students);
- Continuing to follow them after graduation to examine how they draw on the knowledge and experiences they gained at university (38 chemistry and 33 chemical engineering graduates).

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Reflections on Research Design: Theoretical and Methodological choices

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How we started

- Hugely influenced by this study's approach and outcomes:
  McLean, M., Abbas, A., & Ashwin, P. (2017). Quality in undergraduate education: How powerful knowledge disrupts inequality. Bloomsbury Publishing.
  Key finding: Disciplinary knowledge is the central influence on graduate formation; so much more important than institutional status
- What if we turn our attention to STEM? A lot of work on graduate outcomes looks at humanities / social science – STEM seems sort of self evident? (nothing is self evident…!)
- What a privilege to get this level of funding to craft a hugely ambitious longitudinal and comparative project…

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Key decisions at the outset

- Our approach to comparative work: We recruited a team including all three countries but we did not do national case studies or work as national teams (quite common in comparative studies) – the crossover was a key resource in our approach to analysis – "making the familiar unfamiliar"
- Core dataset were annual interviews with students – crucial was building relationships in order to sustain them over 7 years (>70 students across all sites) Also started with large group of first years, downselected purposivefully for second years, but still sufficient numbers to accommodate anticipated attrition
- Theoretical approach broadly social realist but otherwise agnostic – drew richly on a wide range of theoretical tools informed by what emerged from the data

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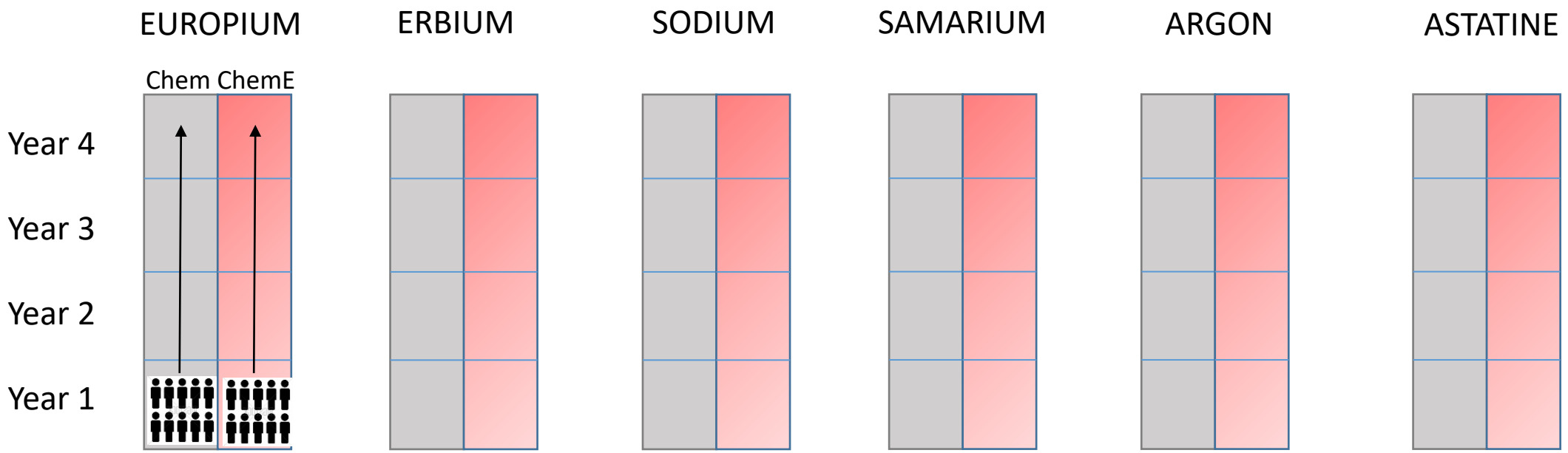
Constructing the case: Phase 1 (UKSA)



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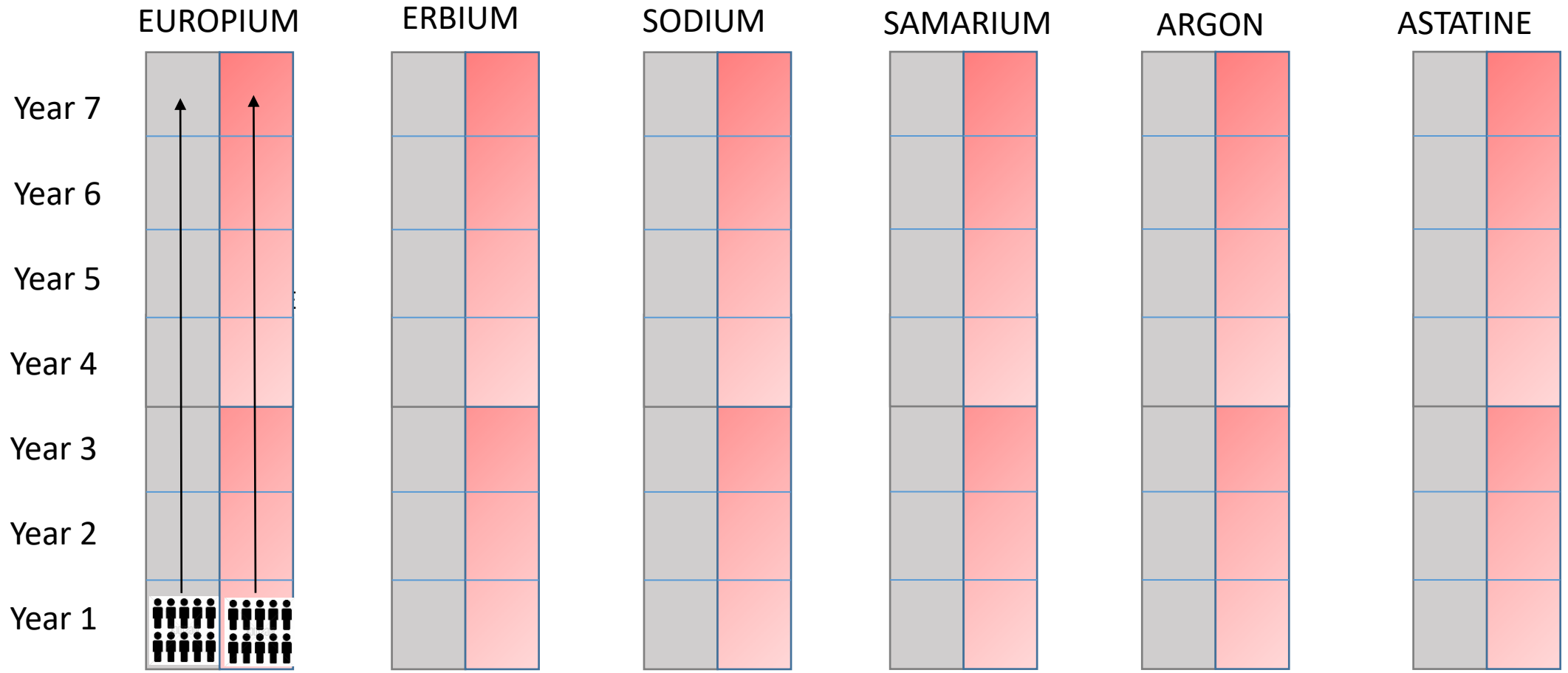

Constructing the case: Phase 2 (GEEK)

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Constructing the case study

- Project initially funded by CGHE (through ESRC) to involve UK and SA sites. Drew in supplemental funding from National Research Foundation, SA, to support post-doc at that site. Opportunity arose to build in a US site – no additional funding but we did it!
- Choice for 2 universities in each country – how to select – different institutional landscapes – opted ultimately for 2 that would give a contrast (and offered bachelors degrees in both science and engineering)
- Why chemistry and chemical engineering?!
  Our focus on impact of disciplinary knowledge on graduate formation – choose these two disciplines that are very close in historical evolution and core knowledge base but also different in orientation

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Four key lessons from a seven year study

1) An undergraduate degree is about seeing bodies of knowledge from the inside - how knowledge claims are made and validated as a scientist/engineer and what the world looks like from these perspectives.
2) Different bodies of knowledge look different and make the world look different.
3) For graduates who see knowledge from the inside, this is the most important thing they report gaining from studying their subject. Those who do not get inside knowledge appear more likely to have felt disengaged from their degree and either focus on gaining very specific skills/bits of knowledge or are unsure what they gained.
4) Seeing the world differently isn't enough to change the world

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Chemistry	Chemical Engineering
	0: I don’t know
1: Chemistry happens when things are mixed in a laboratory	1: Chemical Engineering is the application of chemistry to a large scale
2: Chemistry is seeing chemical reactions	2. Chemical Engineering is about processes of large-scale production
3: Chemistry is learning about molecular interactions	3. Chemical Engineering is the design of large-scale processes of production
4: Chemistry is explaining molecular interactions	4. Chemical Engineering is the design of multi-scalar processes
5: Chemistry is explaining molecular interactions in unfamiliar situations in the world.	5. Chemical Engineering is the design of multi-scalar processes suited to a particular situation

Differences in how students see chemistry/chemical engineering

- Both start with a focus on chemistry. However, they then take very different directions.
- Chemistry is about general explanations, chemical engineering is about design for particular contexts .
- Despite their close relations, they prepare students to be different kinds of graduates who engage with the world in different kinds of ways.

Inside/Outside Views of Chemical Engineering

[I]t's in every facet of life, like it's just there from your medicine to water you drink, the clothes you wear, literally, anything you see, use, touch, chemical engineers have had a hand in that…It's how we interpret the systems we use. So, it's how we understand them, knowing how things will change, depending on different variables and different inputs in the conditions, will help you affect what your process is doing. (Robert, Chemical Engineering, Europium, final undergraduate year).

I guess it's quite broad. It incorporates a lot of things. Not just maths. Not just chemistry. But things like safety as well and economics. (Rabia, Chemical Engineering, Europium, final undergraduate year)

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What graduates gained from studying chemical engineering

The education is just really good at shaping your thinking to help you meet ends, meet goals because you're good at seeing things from individual standpoints and then working them out to make what you want to happen. (Robert, Chem Eng, Europium Graduate, Year 7)

I've picked up so many different skills, like, from software, computer software, to practical skills in a lab, to research skills to even things like… we even covered things like book reviews, being able to write book reviews, and we also looked at the ethical side of things. So, it's just there were so many different things involved in the degree, I think it has just given me such a big range of skills (Rabia, Chem Eng, Europium Graduate, Year 7)

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From ‘helping people in need’ to ‘getting any job’ – Nina’s trajectory

Year 1 (First Year at University)

I have always had a dream for working for the United Nations and using my degree, as I said earlier, to either be developing processes or stuff for communities in terms of water purification or optimising processes that help the people in need. But also using that in terms of what’s happening in the world and finding sustainable solutions… The world does need more chemical engineers

Year 4 (Final Year at University)

In the current economic climate, it’s even harder, but I hope that having a degree behind me makes it easier, in terms of job security, one day. But also, it just enriches my knowledge about a certain area in that I can use that to go forward in my life and help others or come up with new ideas.

Year 7 (Three years into her career)

I wasn’t exactly sure what I was going to do when I had finished studying and still laugh to myself and think back on when I used to say, “Oh, no I would never work in the mining industry,” and here I am. But what I do think is a good fit is that I’m more working on the technology side of it so in that way staying up to date with what’s happening with regards to technology in the world and how it can be applied to optimise different processes…when I finished studying I, kind of, was interested in any job really.

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So what?

- Challenges policy discourses about the important outcomes of undergraduate degrees;
- Shows how these outcomes are rooted in the bodies of knowledge that students engage with in their degrees;
- Highlights how degree programmes need to support students to find their way inside the bodies of knowledge that they are studying;
- For graduates to use their knowledge to change society, we need to develop structures that support them to work with others to do this.

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