Understanding teaching excellence in STEM subjects

One of the more significant developments in senior secondary and tertiary education over the last thirty years has been the increased importance of teaching STEM subjects – science, technology, engineering, and mathematics – to meet the growing impacts of technological developments in an increasingly globalised world. However, for various reasons, the pace of change in the education of these subjects has been such that pedagogic concerns remain over knowledge and skills gaps, how the output of tertiary education will meet the needs of changing industry, and the under-representation of women and historically disadvantaged communities in STEM classes. Perhaps one of the keenest issues is how those subjects are taught; in particular, understanding how the quality of teaching influences students’ eagerness to embrace them.

This was the question behind the illuminating and quite surprising research carried out by Dr. Alfred Thumser, a teaching-focused biochemist at the University of Surrey, UK, and leader of the University of Surrey, UK, and leader of the University of Surrey, UK, and leader of the University of Surrey, UK, and leader of the University of Surrey, UK, and leader of the University of Surrey, UK, and leader of the University of Surrey, UK, and leader of the University of Surrey, UK.

The hypothesis behind the research was simple: surely more students would embrace STEM subjects if they were well taught?

DISPENSING WISDOM

Most STEM lecturers aim to be good researchers and teachers – unless, perhaps, they are employed at a research-focused university, where pressure to publish means teaching can come further down the list of priorities. As a consequence, teaching then often follows the classic didactic lecturing model – the authority dispenses wisdom to a grateful student body expected to soak it up. One outcome of this is a constant state of tension between the identities of researcher and teacher, and the rather peculiar academic notion that valuing teaching somehow sullies academic credibility.

But for those academics who do value teaching, how do they know if they’re doing a good job? According to Alfred Thumser and Julia Matyjasiek, any measure of teaching excellence is usually indirect, obtained via module evaluations with relatively low response rates and student-led teaching awards, but there is no established measure of ‘teaching excellence’. The respondents wanted to answer this fundamental question, he needed to get the students’ perspective on teaching excellence.

DEFINING TEACHING EXCELLENCE

Alfred Thumser realised that if he wanted to answer this fundamental question, he needed to get the students’ perspective on teaching excellence. The third part asked the students what words and phrases described an excellent lecturer. Phrases included, for example, ‘didactic’, ‘interactive’, ‘includes relevant research’, and ‘has challenging content’. The respondents were encouraged to leave remarks and comments supporting their selections.

The researchers anonymised the survey and, via email, invited students from across the School of Biosciences and Medicine to take part. The results identified two broad clusters of ranked and submitted phrases that helped define teaching excellence, most notably linked to traditional didactic lectures. The subjects such as physics and mathematics might be conducive to more didactic, lecture-based methods, while those with a stronger vocation- or skills-based focus, such as engineering and computer sciences, may benefit from more student-centric, active-learning strategies. So, how can you measure excellence in something that ‘something’ is so varied?

What is the student perspective on ‘teaching excellence’, and how does this definition of teaching excellence impact the broader student experience?
highest-rated phrase linked to teaching excellence was 'clarity of lecture content'. Related comments noted that lecturer planning and preparation were essential for the students, as were challenging content, clear explanations, and engaging lectures. At the other end of the scale, the students strongly disapproved of content-intensive lectures, repeated content, and irrelevant information. Among the comments supporting the findings, the students highly rated evidence that lecturers invested time and energy in preparation, while they were frustrated by ill-prepared lecturers who would discuss irrelevant topics.

**AGAINST SPOON-FEEDING**

The survey responses also served up some surprises, most notably that students didn’t want to be spoon-fed from instruction to examination, even though this could provide an easier path to graduation. Lecturer support was critical for the students, but they didn’t want a guiding hand throughout. What they did want – and this emerged across all the study programmes and year cohorts – was good feedback on their assignments and assessments. They wanted to be direct agents in their progression, with interactive involvement of academic staff.

In this way, the students emphasised that ‘teaching excellence’ was only one part of an overall positive student experience. The ‘supportive’ components that were key for a positive experience emerged from the second cluster of phrases in the survey. Here, the students pointed to things such as the instructional facilities – the lecture theatres, laboratories, and IT rooms; the broader campus environment; the student support structures, such as those around mental health and financial support; and active learning sessions, such as small-group workshops, seminars, and visits by scientists and professional employers.

**STUDENT-STAFF PARTNERSHIPS**

Now that we have an idea of how students measure teaching excellence in STEM subjects, we have some guidelines for developing teaching methods that meet those measurements. The researchers say that upending the traditional model of one-way didactic instruction and creating more interactive faculty and student learning communities could nurture more enthusiastic and successful students. This could have a significant impact on enrolment in STEM courses at universities.

There would be another benefit to such communities of learning. They would encourage the introduction of different perspectives and provide a continually evolving and refreshed level of academic rigour. It would also introduce students to the complexities of teaching STEM subjects and enhance the prestige and scholarship of that teaching.

**Research Objectives**

Understanding what constitutes ‘teaching excellence’ in STEM subjects.

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**Bio**

Dr Alfred Thumser is a teaching-focused biochemist at the University of Surrey, leading the biochemistry teaching enhancement section. He has a laboratory-based research background in enzymology, lipid metabolism, and metabolomics. His more recent aim has been on developing students’ soft skills and supporting colleagues in their pedagogic development.

**Collaborators**

- Julia Matyjasiak (co-author)
- Dr Marion Heron, Reader in Educational Linguistics, Surrey Institute of Education (editor)
- Laura Barnett, Lecturer in Higher Education, Surrey Institute of Education (editor)

**References**


**Personal Response**

What is it about STEM subjects in particular that makes it so important to rethink the way they are taught?

The teaching of STEM subjects has historically been driven by content-intensive lectures and courses. This approach is potentially problematic in addressing the exponential generation of, and access to, more and more information. Thus, one could argue that a change in teaching approach is required and, for one, would argue that a different approach to the teaching of STEM subjects may be desirable, focusing less on the delivery of content and rather developing the critical thinking and soft skills of students to prepare them for the ever-changing professional environment they will encounter once they leave university. In this regard, STEM lecturers develop partnerships with students and alumni, as well as colleagues in academic development, industry, and other universities, to broaden their own teaching horizons.