

# Understanding teaching excellence in STEM subjects

STEM subjects – science, technology, engineering, maths – are undeniably important if we are to meet the needs of our increasingly globalised world. So knowing what encourages uptake of these subjects to the highest level is of the utmost importance. Good teaching might be an obvious answer, however we don't fully understand what constitutes 'teaching excellence' in STEM subjects. Dr Alfred Thumser, at the University of Surrey, UK, decided to ask bioscience students what they thought. The results were illuminating.

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 these 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's biochemistry teaching enhancement section. Working with Julia Matyjasiak, a BSc (Hons) biochemistry student, Alfred Thumser set out to examine how bioscience students at the university defined 'teaching excellence'.

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 Matyjasiak, 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 researchers surmise that this is the case at most universities, especially for the increasingly important STEM subjects.

However, there's a significant challenge in measuring excellence in STEM teaching: there is no one-size-fits-all approach to 'teaching'. More academic-focused



Thumser and Matyjasiak asked what 'teaching excellence' means to bioscience students at the University of Surrey, UK.

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 if that 'something' is so varied?

## DEFINING TEACHING EXCELLENCE

Alfred Thumser realised that if he wanted to answer this fundamental question, he needed to get the students' perspective on two broad questions: what is the student perspective on 'teaching excellence'; and how does this definition of teaching excellence impact the broader student experience? This is where Julia Matyjasiak's input was critical – as a senior student she was well-placed to help phrase the survey questions. The researchers designed an online survey with three parts. The first presented a scale for respondents to rate 14 different phrases linked to teaching excellence, for example, 'clarity of lecture', 'personality of the lecturer', 'feedback after coursework or exams', 'small-group workshops' and 'difficulty of exams'.

The second part asked the students to rank the impact of various factors on their 'student experience'. These factors were varied, and included lectures

and practicals, the campus facilities and IT support, and peer- and mental-health support.

The third part asked the students what words and phrases described an excellent lecture. Phrases included, for example, 'didactic', 'interactive', 'includes relevant research', 'includes problem-based learning', 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

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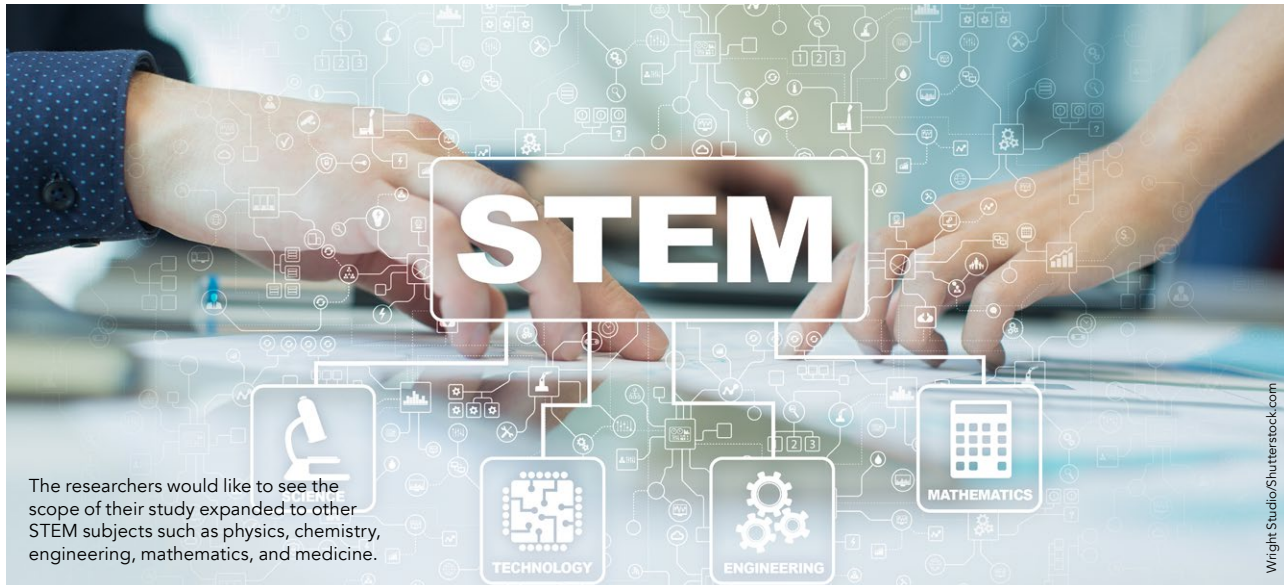


Students cited clear and challenging content and preparedness of the lecturer as important factors in teaching excellence.



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The researchers would like to see the scope of their study expanded to other STEM subjects such as physics, chemistry, engineering, mathematics, and medicine.

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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 lecturers. 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.

**What may have worked in the past may no longer be fit-for-purpose for a student body more accustomed to sharing ideas and having their voices heard.**

#### 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 potential employers.

Alfred Thumser and Julia Matyjasiak's study has provided the groundwork for a broader discussion on encouraging the uptake and embracing of STEM subjects by undergraduate students in the biosciences. The researchers say they would like to see the scope of such a study expanded into other STEM subjects such as physics, chemistry, engineering, mathematics, and medicine. They also propose that STEM faculties establish educational research groups and opportunities for experienced instructors to share best practices, especially with senior faculty who may feel out of touch with innovations in teaching practices.

#### 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.

Given the importance of STEM subjects and the need to encourage their uptake by undergraduate university and technical college students, how they view those subjects and how they are taught is critical. What may have worked in the past may no longer be fit-for-purpose for a student body more accustomed to sharing ideas and having their voices heard.



# Behind the Research

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### Research Objectives

Understanding what constitutes 'teaching excellence' in STEM subjects.

### Detail

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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.

#### Funding

University of Surrey [financial support of student partners]

#### 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

Matyjasiak, J, Thumser, A, (2021) What teaching excellence means to undergraduate students on a STEM programme. In Heron, M, et al, (eds) *Exploring Disciplinary Teaching Excellence in Higher Education*, 21–37 [doi.org/10.1007/978-3-030-69158-5\\_2](https://doi.org/10.1007/978-3-030-69158-5_2)

### 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-intense 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 I, 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. ”



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