The ideal student in physics, mathematics, engineering and biology

Making sense of the expectations of university students

In the education context, we may have a sense of the minimum expectations of university students, whether in the form of entry requirements, grading systems, attendance, or university policies. Whilst minimum expectations such as these are usually explicit, our ideas and imaginings of what it means to be a university student are more often implicit, subjective and seldom openly discussed.

We might have some ideas about what a 'typical student' is like, such as their typical characteristics, traits or behaviours. By comparison, we might also have some ideas about what an 'ideal student' is like. These ideas are linked to our experiences and identities. In other words, what one person imagines as 'the typical' and 'the ideal' could be entirely different from the person next to them. Or, if they have somewhat similar experiences in life, and share similar backgrounds or identities, there may be some more commonalities in their ideas. However, whether typical or ideal, these ideas are usually expected of students, but not necessarily stated.

We are therefore interested in the learner characteristics that we recognise and reward in higher education, and whether some students may be more likely to aspire, identify or embody these characteristics. We question, how can we be more inclusive, open and transparent about our expectations of students? How do we include students in this conversation? And what if we shift our attention away from minimum expectations, to focus on the strengths and aspirations of these students instead?

The concept: 'the ideal student'

Our concept of the ideal student allows us to recognise and be critical about our preconceptions of what it means to be a university student. It relies on being realistic and transparent, helping us to distinguish 'ideal' expectations from 'typical' expectations, by unpacking different characteristics that are desirable but realistic of students. We believe that unspoken expectations can be harmful to those who are underrepresented in higher education. Therefore, our intention here was not to create a list of ideals that are inaccessible or unreachable, but to encourage explicitness about our expectations of students, and offer a platform for these expectations to be negotiated between students and staff. This was the motivation for our research into how underrepresented students perceive the ideal and typical students in their STEM degrees.

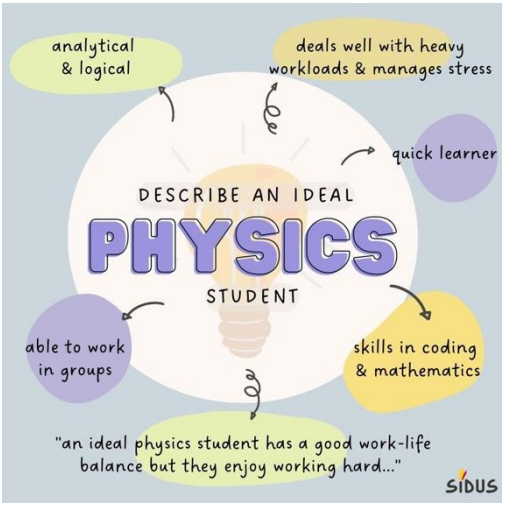
The study

The SIDUS Project (Supporting the Identity Development of Underrepresented Students) is an education research project funded by Imperial College London. It aims to better understand the experiences and identities of underrepresented students in STEM undergraduate programmes. Between the Summer and Autumn of 2020, we interviewed 110 STEM undergraduate students who were enrolled at two medium-sized universities in England, and who self-identified as being underrepresented – by gender, ethnicity, social class, sexuality, disability, neurodiversity and/or a specific learning difficulty. We asked students about their experiences of their STEM degree programmes, as well as how they constructed and identified with a typical and ideal student in their degrees. Our aim was to find out which characteristics are expected but also desirable for students in physics, mathematics, engineering and life sciences disciplines.

The typical and ideal student in STEM higher education

Physics student

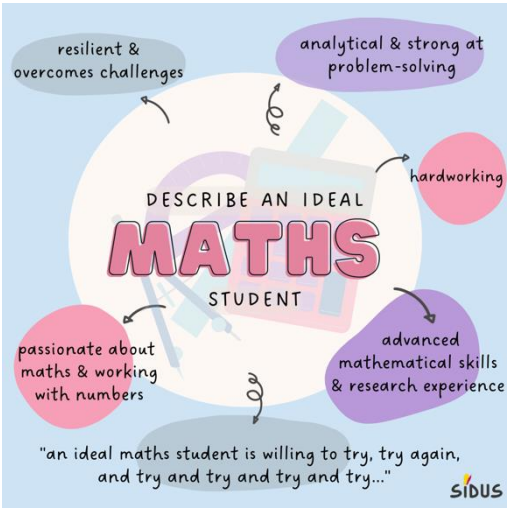
Students' perceptions of the ideal and the typical physics student were fairly similar. The ideal physics student was described as analytical and logical, with skills in coding, mathematics and problem solving. Similarly, the typical student in physics was described as resilient and passionate about the discipline.



However, some students struggled to identify with their ideas of the typical and ideal physics student. For example, Aletia (British mixed woman) said that a typical physics student would be 'a man… young 20s… not very talkative… not a great conversationalist… [likes] maths, computing…'. Aletia does not conform to this idea and as a result, said she stands out 'like a sore thumb in the department, nobody really understands me'. These differences can have a knock-on effect on students' sense of belonging, as Ella (White European woman) explains, she felt 'so out of place' because she was 'not like everyone else'.

Mathematics student

According to mathematics students, the ideal student is analytical, strong at problem solving and resilient, with advanced mathematical skills and research experience. The typical maths student was said to be antisocial, logical, nerdy and technical, aligning with popular (but gendered and racialised) stereotypes of mathematicians. In both ideal and typical terms, maths students were described as hard-working, high-achieving and passionate about their discipline.

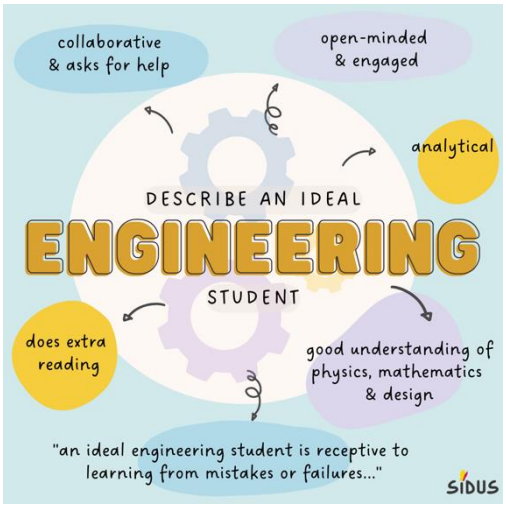


However, when asked about their own identity and experiences, Aabha (British mixed woman) said that 'as a woman, I'm maybe not confident enough to ask for help… when I need'. She and a few others explained that some lecturers 'just wait for people to put their hands up [and] it's typically boys who ask the really detailed, advanced questions'. The experiences of women like Aabha are therefore shaped by wider social stereotypes, as mathematics is deemed a more masculine subject. Therefore, the typical maths student was sometimes thought to be a white man, which can make it harder for students who are underrepresented by ethnicity and/or gender to feel like they belong.

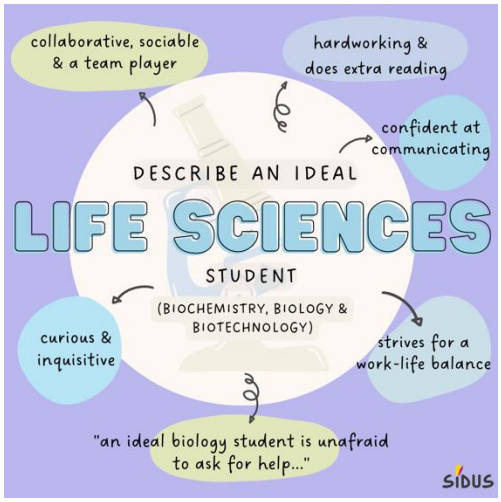
Engineering student

The ideal engineering student was described by students as analytical, engaged, collaborative and someone who has a good understanding of physics, mathematics and design. Interestingly, the ideal engineering student was also described as being open or receptive to learning from mistakes or failures. Similarly, students constructed the typical engineering student as approachable, hardworking, passionate and collaborative.

However, reflecting on his own experiences, Deku (International Asian man) said typical engineering students in his cohort enjoy banter with each other, but these conversations are often initiated by British men and are 'quite heteronormative'. Moreover, Asaroyoma (Black British woman) said, 'I don't think I fit it in very well, to be honest', but insisted that 'I'll still just sort of get on with it and … do the best I … can'. As with mathematics, underrepresented students may not identify with a typical or ideal engineering student, as engineering continues to be racialised and gendered as a predominantly white masculine space.



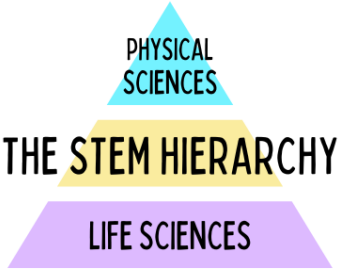
Life sciences student



The ideal life sciences student (including students in biochemistry, biology and biotechnology degrees) was described as curious, collaborative and hardworking, and who strives for a work-life balance. According to Thea (White British woman), the ideal student in biology is 'inquisitive [and] curious in nature', as well as 'extremely focussed on the degree', with 'social skills [and] the confidence to communicate and convey what they're so interested in and good at'. The typical biology student was similarly described as collaborative, friendly, hardworking, sociable and supportive.

Most students seemed to consider being sociable as a typical and key characteristic of biology students. Compared to other STEM disciplines, students suggested that life sciences disciplines attract greater diversity, especially women. Odessa (White British woman) said 'it's nice having it not being dominated by… a majority of guys', which is the case in physics, mathematics and engineering. Students also agreed that most of the typical and ideal characteristics of life sciences students were personally relatable. To sum up, the ideal and the typical biology student appears to be a more achievable and accessible identity than the other STEM identities discussed earlier.

Differences and hierarchies between STEM disciplines



We found that when students described an ideal and typical student in their STEM degrees, they sometimes described a hierarchy of 'harder' and 'easier' STEM subjects. Whilst not directly asked, students in physics, mathematics and engineering disciplines positioned their own degrees as more difficult than other STEM degrees. Biology was the only discipline to be explicitly mentioned as the 'weaker' STEM subject, including by biology students themselves. For instance, Qiang (International Asian man) shared that his peers from other STEM disciplines can be discourteous about his biology degree: 'I don't know whether it's jokes or just a funny thing that's going around

campus, but people [other STEM students] look down on [biology students]. People think it's an easy subject…'.

Physics student, Mei-Ju (International Asian woman) agreed that students in her degree have mocked or been dismissive towards students in other STEM programmes, especially life sciences. Given life sciences disciplines are generally better represented by women, this hierarchy between STEM subjects seems to be gendered, as more masculine-dominated STEM disciplines, including mathematics, physics and engineering, are seen as more valuable. This can make it difficult for life sciences students to feel a sense of belonging outside of their disciplines, or even as sense of credibility as scientists in the wider STEM community.

Future directions: Supporting underrepresented students in STEM higher education

So, what does this mean for practice? Drawing on our findings, we outline some suggestions for educators on how to better support underrepresented students in STEM higher education.

- Within departments and universities, we suggest staff are open and transparent about their expectations of students, including their ideal expectations, which are usually implicit. It is important that staff negotiate these expectations with students, especially those who identify as being underrepresented.
- Targeted efforts are needed to break the perceived STEM hierarchy. We suggest this requires a better mutual understanding of the values of different STEM disciplines among STEM students. To do this, STEM staff ought to consider their curriculum, and ensure students can recognise and acknowledge the importance and value of other STEM disciplines and subdisciplines.
- STEM staff may also provide opportunities for interdisciplinary working, where students can experience and appreciate how STEM subjects can be complementary. In practice, this might involve a greater interdisciplinary approach in STEM teaching. For example, group projects or shared modules with students from different degree programmes.
- Whilst wider social stereotypes (especially gender) may be difficult to disrupt, there are ongoing efforts and publications of case-studies that showcase inclusive practices and ways of challenging stereotypes in STEM contexts (e.g., see more here). We suggest these studies will be important resources for STEM teaching staff's Continuing Professional Development.

The full research paper is free to read (see reference and link below).

Full reference:

Wong, B., Chiu, Y.L.T., Murray, Ó.M., Horsburgh, J. and Copsey-Blake, M. (2022). 'Biology is easy, physics is hard': student perceptions of the ideal and the typical student across STEM higher education. *International Studies in Sociology of Education*.

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