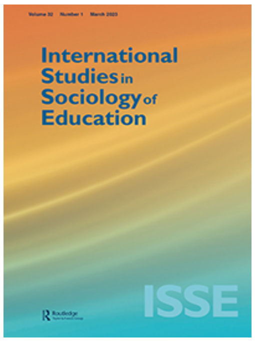

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'Biology is easy, physics is hard': Student perceptions of the ideal and the typical student across STEM higher education

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ABSTRACT

This paper draws upon in-depth interviews with 89 students from two UK universities to explore how students from Science, Technology, Engineering and Mathematics (STEM) degrees describe the ideal as well as the typical student in their respective disciplines. We provide a comparative insight into the similarities and differences between disciplinary identities based on student perceptions. More specifically, we consider how undergraduates from biology, engineering, mathematics and physics construct the ideal and the typical student in their degree, highlighting the popular discourses and desirable traits that appear to characterise students in these disciplines. In addition to a masculinised construction of students in engineering, mathematics and physics, we found a social hierarchy within STEM degrees where biology was perceived as the easier STEM subject. We conclude with a discussion of the impact of such hierarchies on student identities in STEM, and potential implications for equality, diversity and inclusion.

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STEM identity; disciplinary identity; student identity; typical student; ideal student

Introduction

STEM, short for Science, Technology, Engineering and Mathematics, is an acronym made up of various disciplines. Whilst a number of research studies, including in higher education, have focused on the experiences of students in specific disciplines such as mathematics (e.g. Cribbs et al., 2015), engineering (e.g. Gonsalves et al., 2019) and physics (e.g. Hazari et al., 2020), fewer studies have explored and compared disciplinary differences across STEM degrees, especially what is expected of students. This paper uses the concepts of the *ideal student* and the *typical student* to analyse how students describe desirable student characteristics and common expectations of students in their specific STEM disciplines.

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An appreciation of how students make sense of and identify (or not) with the ideal and the typical student within a discipline yields a richer understanding of how disciplinary-specific expectations and discourses (such as in media representations of scientists) can shape student experiences and identities. We draw on 89 in-depth interviews with undergraduate STEM students from underrepresented groups based at two UK universities. Our findings suggest a social hierarchy within STEM, with some disciplines seen as harder, whilst others are perceived as easier. We conclude by discussing the impact that such hierarchies may have on student identities in STEM and the potential implications of the study for equality, diversity and inclusion efforts in higher education.

Conceptualising expectations of university students

Higher education (HE) can be a daunting place for students, especially those from underrepresented backgrounds. In UK HE discourse, this usually refers to those who are first-generation to university or mature students, as well as students from racial/ethnic minority backgrounds, low-income households or with a disability. Existing research highlights a range of issues and challenges for different groups of underrepresented students in higher education, including their struggles with transition into university, a weaker sense of belonging and identity, and poorer degree outcomes (Advance, 2021; Ahn & Davis, 2020; UUK/NUS, 2019).

The idea of 'the student' can differ across nations (and stakeholders within the same nation), as Brooks (2021b) highlights in a comparative study across six European countries (England, Denmark, Germany, Ireland, Poland, and Spain). Despite Europe-wide initiatives, Brooks found government policy documents in England to construct the university student as more of an individual investor, or consumer of education, than their European counterparts, arguing that this is partly due to the reliance on tuition fees to fund English universities. The use of consumer language was also found amongst students' union leaders, which was an anomaly compared to their European counterparts (Brooks, 2021a).

At the institution level, especially in Australia, New Zealand and the UK, universities have advertised the skills and qualities that students can expect to develop by graduation – known as graduate attributes – contributing to dominant discourses around 'the student' across disciplines. These tend to include strong communication skills, critical awareness and cultural competence (Barrie, 2007; Oliver & Jorre de St Jorre, 2018; Wong et al., 2022).

At the individual level, students may differ in the extent to which they respond to broader discourses around 'the student', and these discussions are often focused on specific disciplines or students from marginalised groups. Ulriksen (2009) conceptualised *the implied student* as what is expected of students by students themselves, teachers, and the institution of the university, through an exploration of physics undergraduates in Denmark. We use similar ideas about *the typical student* and *the ideal student* to explore what is implied, or expected, of students within specific STEM undergraduate degrees. These might be ideas students get from media representations of students or academics from their discipline, alongside discussions by school teachers, university staff and their student peers about different STEM disciplines. We distinguish between what is typically expected of students – the popular or dominant discourses of what is normal and typical of students – and what is aspired to as the 'ideal'. This distinction highlights the difference between merely fitting into the standard expectations and what constitutes the desirable or aspirational ideal, the latter of which also seems to align with the constructions of 'successful' students in Nyström et al.'s (2019) study, who explored students' subjective understandings of 'success' in law, medicine and engineering physics degrees in Sweden. While Nyström et al. found students' perceptions of success entailed both high academic achievement and simultaneously possessing other desirable characteristics such as 'being "super nice" "popular" and "friendly"; "sporty" . . . to have fun and be happy' (p. 470), their constructions of success are inevitably influenced by wider social and structural expectations.

Similarly, we explicitly link our exploration of student perceptions of the ideal and typical students to structural inequalities, highlighting how these concepts can be imbued with gendered, raced and classed assumptions alongside other implicit identities. Existing studies of university teaching and learning also often overlook the interconnectedness of disciplinary knowledge and culture (Neumann, 2001), and the field of STEM is often discussed in research as a collective entity, undermining variations between disciplines (Neumann et al., 2002).

Of more concern is how unspoken or hidden expectations can negatively impact students' experiences and identity development, as they can weaken feelings of belonging and contribute to inequalities in higher education. We consider the concept of the *ideal student* a useful lens to unpack the different characteristics that are 'desirable but realistic' for students at university (Chiu et al., 2021; Wong & Chiu, 2021a). Whilst perceptions and constructions of the ideal student can vary between staff and students across disciplines, universities and their respective social identities, such as age, ethnicity, gender and social class (Wong & Chiu, 2021b), a recent UK survey proposed eight overarching dimensions of the ideal student, with diligence and engagement being the most important set of characteristics, and intelligence as the least important (Wong et al., 2021). While there may be concerns that using the ideal student framing could result in a 'list of ideals' that potentially restrict alternative or 'unlisted' expressions of student practices and identities (Wong & Chiu, 2021a), leaving it implicit contributes to the exacerbation of inequalities due to unspoken and hidden rules (Reay, 2017).

Our paper uses these two concepts to understand student expectations of their STEM disciplines: the typical student highlighting what is normally expected of students, and the ideal student identifying what is desirable, specifically how these might differ across STEM disciplines. Our discussion is based on student interpretations of what university staff and student peers expected from them alongside ideas they had from home, school and popular media representations of science and their specific discipline. Students were asked to describe the typical, then the ideal, student in their discipline, before comparing themselves to these constructions. Differences between what is typical and ideal would shed light into how the dominant construction of the typical student in their discipline, as perceived by our students, corresponds to the desirable imagining of the ideal student, and whether there are mismatches in expectations that can be mediated , particularly between STEM disciplines and connections to structural inequalities.

Constructions of students in STEM degrees

Feminist science studies has argued that scientific knowledge is gendered, whereby the gendering of scientific skills and attributes shapes the production, use, and legitimacy of different types of knowledge (e.g. Keller, 1993). Science is assumed to be value-free and objective, despite the 'valued attributes of science [being] most ascribed to men' (Fox, 1999, p. 441). For instance, Mendick (2006) argues that different STEM disciplines can be seen to have different personalities which are gendered and hierarchised, whereby some are perceived as more masculine, difficult, or objective than others, such as mathematics or, as Becher (1990) argues, physics. This gendered hierarchy of disciplines can be understood using the concept of *hegemonic masculinity*, whereby stereotypical masculine attributes are valued over those which are stereotypically feminine (Connell, 1987). For example, gendered binaries of objective/subjective, hard/soft, rational/emotional being ascribed to particular STEM disciplines, like physics in comparison to biology, produces a gendered hierarchy of legitimacy between disciplines. Furthermore, biologically essentialist ideas about men being better at science or more adept at particular kinds of scientific knowledge persist, which influence students' perceptions of their peers and disciplines (Saini, 2017).

Broader feminist and decolonial discussions about scientific knowledge production highlight that ideas about rationality and objectivity are often 'the imperial, western male masquerading as humanity' (Ramazanoğlu &

Holland, 2002, p. 37), whereby 'rational men' are seen as knowledge producers whilst others, including women, non-binary people, and non-elite men (such as indigenous and racialised men), are more subjective, emotional and thus not legitimate knowers. These racialised, gendered and colonial histories of Western scientific knowledge production position some knowers and knowledge as superior to others (L.T. Smith, 2021), feeding contemporary hierarchies of knowledge and stereotypes of who is a scientist.

Stereotypes of scientists, as Archer et al. (2010) note in relation to school children, influence who chooses to pursue science at university and beyond. Existing research found that prominent portrayals of scientists may be far removed from the identities that students imagine as desirable or realistic, with scientists often seen as white, middle-class men, alongside specific stereotypes such as clever but socially inept old men with wild hair (Chimba & Kitzinger, 2010; Losh, 2010; Wong, 2016). While stereotypes around being socially inept may be less explicitly gendered, racialised or classed, they are entangled with privileged subject positions, constructing scientific forms of hegemonic masculinity. Such gendered scientist stereotypes are perpetuated by media representation such as *The Big Bang Theory* which affirms 'gendered power structures that often suppress women and subordinated masculinities' (Blosser, 2018, p. 149). The work of scientists is also commonly associated with long working hours (Masnick et al., 2010), constructing a 'typical' science identity which is impossible to access for many underrepresented groups, such as those with caring responsibilities or disabilities who may be unable to work long hours or forego work-life balance in the pursuit of science. Due to these stereotypes and hierarchies of scientific skill and attributes, marginalised groups often find it harder to fit in, succeed, and claim scientific authority in STEM disciplines, as discussed by Blackburn's (2017) review of literature on women in STEM in US higher education. Similarly, Ong (2005, p. 595) argued that women of colour in physics are often 'in question' because they stand out from the norm – cis, heterosexual, able-bodied, neurotypical, white men – and therefore must 'compromise their identities as women, as minorities, or both', which is also applicable to other minoritised groups in other STEM disciplines (e.g. McGee & Bentley, 2017).

Research informed by the lens of identity has grown in STEM education research, notably Carlone and Johnson's (2007) *science identity model*, highlighting the importance of recognition by self and by others as a 'competent' science person, which is often disrupted by gender and race or ethnicity. It is therefore useful to make sense of individual student experiences, especially those from underrepresented backgrounds, and how they embody and experience different STEM identities. The traditional and dominant discourses and imageries of science (as typically for 'white men'), and indeed, most other areas of STEM, create stereotypes which perpetuate what is considered normal, expected and accepted, whilst other minoritised identities appear more challenged or questioned, or only conditionally belong (Chiu et al., under preparation).

Disciplinary hierarchies within STEM may therefore be intertwined with perceptions of disciplines as being more/less difficult, which is coded as more/less masculine, with the typically masculine regarded as more prestigious than those coded as feminine (Connell, 1987; Neumann, 2001). For example, STEM degrees in countries such as the UK and US are renowned as having gender gaps, except for biological sciences (Advance, 2021; Parson & Ozaki, 2018). E. Smith (2011) found that biology has better gender ratios, whereas the recruitment of women into physics and engineering has broadly stagnated, although there are specialised subdisciplines within engineering degrees that may have a better gender balance (further research on this is needed). Generally, women studying biology degrees may not share the same experiences as those studying physics or engineering degrees (Günter et al., 2021). Nevertheless, better gender ratios in disciplines such as biology may present a double-edged sword for gender equality in STEM, as they may be perceived as more feminine and thus 'easier' (Fisher et al., 2020).

Using these insights into STEM student identities, we focus on students' constructions of the ideal and the typical student within specific STEM disciplines. We argue that making such discourses explicit helps to challenge what is considered normal, acceptable, or desirable in STEM higher education, and how this is related to intersecting inequalities, thus contributing to the exclusion of underrepresented groups from STEM.

The study

Data in this paper draws from a large qualitative study that explored the lived experiences of STEM students from underrepresented groups in UK higher education. Underrepresented students included groups that are often a statistical minority in STEM education, namely self-identification as women or non-binary, an ethnic minority, first-in-family, LGBTQ+, and any form of disability, including those who are neurodiverse and/or have specific learning difficulties (SpLDs). The project explored how underrepresented students in STEM experienced and navigated UK higher education, with a focus on STEM/disciplinary and professional identities, sense of belonging, and career aspirations. This paper focuses on how students construct, and identify with, the *ideal* and *typical* student in particular STEM disciplines. Students who are underrepresented in STEM provide an important perspective on the 'ideal' and 'typical' students in their disciplines because they are more likely to know how it feels to *not* be the norm.

This means their STEM identity may be more difficult to achieve because they do not fit the dominant constructions of a student in their discipline and may be subject to discriminatory or presumptive comments about their ability to do STEM subjects, as discussed earlier. Our aim here is to unveil the common as well as distinctive characteristics that are popular and expected, namely 'typical', and also those which are desirable, namely the 'ideal', for undergraduate students in physics, mathematics, engineering and biology.

The study is situated in two medium-sized English universities with a range of STEM undergraduate degrees. Both universities are 'pre-1992' and consider themselves to be research-intensive institutions. Potential students were recruited through email invitations that detailed our project aims and selection criteria, namely underrepresented students in undergraduate STEM degrees. Interested students signed up to take part through a survey link, submitting demographic information before being invited to book an available time for an online interview.

Between June and November 2020, we conducted 110 semi-structured interviews. Due to the coronavirus pandemic, interviews were conducted virtually. All interviews began with a video introduction from the researchers, detailing the study aims and interview procedures. Participants were then asked to turn off their cameras to strengthen the quality of the audio recordings, which were transcribed verbatim, with sensitive details removed and identifiable information anonymised. The interviews lasted 50 minutes on average and students were asked about their views, experiences and reflections of their STEM degree education, including: their choice of study, sense of belonging and identity at university, post-degree plans, and the ways in which their social identities, as an underrepresented student, may have shaped their educational experiences. When discussing their identity at university we asked two questions about their perceptions of the typical, and then the ideal, student in their discipline, and how they thought they compared to these typical and ideal student descriptions. A post-interview reflection was written after each student interview to summarise and reflect on the co-construction of knowledge, which is considered as supplementary data.

The majority of our participants, 89 out of 110, can be categorised into the disciplines of physics (n = 26), mathematics (n = 10), engineering (n = 16) and biology (n = 37), including a small number of joint degrees. Our umbrella terms engineering and biology covered the following subdisciplines only: chemical, design and electronic engineering; biochemistry, biological sciences, biomedical sciences, biotechnology and microbiology. For ease of comparison, students outside of these broad disciplines were excluded in this paper; the remaining 21 students studied a range of applied sciences degrees, including building surveying, computer science, ecology, food science, medicine and meteorology. Our paper focuses on 89 interviewees, of whom 62 were women and 27 were men. 23 identified as White British, 8 as White European and 58 as ethnic minorities, of which 30 are UK-domiciled and 28 are international students (mostly Asian). To strengthen anonymity, student ethnicities are reported in broad terms, such as Black British, British East Asian, British South Asian, International Asian, Mixed, White British and White European. Our sample also included 34 students who were first-in-family to attend university, 20 LGBT+ students and 23 students who had disabilities.

Data analysis was informed by a social constructionist perspective, which considers realities and experiences to be socially constructed and discursively produced (Burr, 2003). We initially imported our interview transcripts into the software *NVivo* for data management, with provisional coding and production of themes and subthemes through an iterative process of data analysis, moving back and forth between the data and analyses through the comparison of data (Corbin & Strauss, 2014). A coding framework was then established, with a codebook of definitions for each code after the authors independently coded three interview transcripts by relevant themes. Provisional codes were discussed and compared, and any differences on the application of codes debated until a consensus was reached. Next, we focused on the codes and subcodes related to students' constructions of, and identification with, the idea of the ideal and typical student in their STEM discipline. We separated the data by discipline to compare differences and similarities, and while there were considerable overlaps in how participants across STEM degrees described their disciplinary ideal student, we found more nuances in their discussions of the typical student in different disciplines.

Physics student

The ideal physics student was described by our interviewees as analytical, clever, competent, curious and hardworking, with an intuitive grasp of complex concepts and skills in coding, mathematics and problem solving. Peter (British East Asian man) envisioned the ideal student in physics as being able to 'learn … in a quick amount of time', as well as to manage 'stress' when coping with 'large workloads'. More specifically, Amelia (Mixed heritage woman) said an ideal physics student is 'very smart' and a 'fast learner' with 'great practical skills … great programming skills [and] a problem solver [who is] very knowledgeable about everything, even other disciplines'.

Our physics students constructed the typical physics student in similar ways, underpinned by the characteristics of competence, commitment and competitiveness. As Francesca (Black British woman) elaborates:

> You've got to be passionate about physics because physics is hard. So, if you don't like it as much as you say you like it, you're probably going to tear your hair out and drop out within six months of doing the degree … you've got to have … mad resilience … you're going to be re-writing this code 20 times, re-doing that problem 20 times.

The typical student in physics is likely to be passionate about the discipline and ought to be resilient because the discipline is considered to be difficult. Avara (British South Asian man) said physics students often go the extra mile and 'study physics a lot in their spare time … maybe even beyond what the course requires', and such commitments usually reflect their intrinsic motivations and interests, rather than as a sign of struggle. Ailbert (International Asian man) added that physics students would often share inside jokes, which intertwines with disciplinary knowledge:

> They make jokes about physics or use physics to make jokes, which is quite nerdy, but I guess that's the way we work … I see that around my friends … I think I am also turning into a very nerdy physicist … we're all trying to achieve the status.

Here, an understanding of, and the ability to make, jokes that incorporate physics is likely to strengthen students' identities in physics, through mutual understandings and recognition of what it means to be a physics student. Although Ailbert was the only person to talk about physics jokes, such insider languages, practices and discourses can have a gatekeeping function that includes and excludes individuals from being recognised as an 'authentic' physics student. In short, students' perceptions of the ideal and the typical physics student appear fairly similar, suggesting a coherent recognition and understanding of what constitutes a student in physics.

Although most students said they can relate to these desirable characteristics, as articulated above, our data also suggest that some students struggled to reconcile these constructions with their own identity, especially in the context of gendered and raced stereotypes. For example, Aletia (British mixed woman) added that physics students would typically be 'a man … young 20s … not very talkative … not a great conversationalist … [likes] maths, computing … those sorts of things'. Aletia does not conform to this typical physicist; her experience in physics was one of standing out 'like a sore thumb in the department. Nobody really understands me'. Such differences can have a knock-on effect on one's sense of belonging, as discussed by Ella (White European woman) who admitted 'feeling so out of place' because she was 'not like everyone else' on her physics degree, namely a young man with interests in computing. Others also described 'the physics student' as a white middle-class man, adding ethnicity and social class. Francesca (Black British woman) said people in physics are normally 'either white, or male' and Arusa (British South Asian man) believes that 'physics is a lot whiter compared to other degrees'. Such identity stereotypes and student ratios can challenge underrepresented students' physics identities, as previously discussed (Ong, 2005).

Mathematics student

According to mathematics students, the ideal student is analytical, clever, hardworking, passionate and resilient. Karl (White British man) described the ideal mathematics student as someone who is strong at 'problem-solving' and commands 'a good base understanding of mathematics [with] natural talents [and] intelligence', suggesting an innate ability, or intellectual superiority.

Somewhat similar, but more specific, the typical mathematics student is depicted as antisocial, logical, nerdy and technical, aligning with popular stereotypes of mathematicians. As Matthew (British mixed man) elaborates, they are 'a bit socially awkward [and] a bit more dedicated to their studies'. Similarly, Lauren (While British woman) described mathematics students as 'antisocial [who] prefer numbers to interacting with other people'.

Whilst both ideal and typical students are broadly constructed as mathematically competent, the typical student is also said to be antisocial – a characteristic missing in the ideal student. With this in mind, might sociability be an unstated feature of an ideal mathematics student? For example, an antisocial identity was unattractive for students like Karl (White British man), who stressed that he is actually 'fairly *normal* and I have social skills and I do sport'. Karl acknowledges that mathematics students can be socially ridiculed and appear at odds with non-mathematics students, so he emphasises that he is sociable, sporty, engages in non-academic extracurricular activities and therefore probably an unusual student in mathematics. Similarly, Nicole (White British woman) argued that students in her cohort did not always fit the nerdy stereotype:

> There's kind of a split . . . half of them are typical maths nerds . . . love maths, live and breathe maths, always working, getting good grades, don't really socialise much apart from with each other . . . but then the other half are just completely . . . *normal* . . . just like everybody else . . . they could be doing any degree, you wouldn't know they were doing mathematics.

Here, students who are hard-working, high-achieving and passionate about mathematics are considered to be typical, as well as ideal, but an alternative form of mathematics identity is also evident, one where students can and do engage in *normal* activities, 'like everybody else'. Whilst it is unclear how prominent this latter identity is, the availability of a broader identity for mathematics students is welcomed for greater diversity, especially given the 'antisocial' typical identity is largely intertwined with gendered assumptions about mathematics students being men.

When asked about their own identity and experiences, mathematics students, including women, have acknowledged the efforts of staff in support of greater gender equality. Nicole (White British woman) said her department 'run[s] a lot of girls-only schemes or promoting women and that sort of thing', although Aabha (British mixed woman) admitted 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'. Thus, existing efforts by staff appear insufficient or ineffective for some women already studying mathematics degrees. The experiences of women students such as Aabha seem to reflect wider stereotypes about mathematics, especially as a masculine domain, in which the typical mathematics student is understood to be a man, making it harder for women to feel like they belong (Mendick, 2006; Ong et al., 2011).

Engineering student

Although engineering is a multifaceted discipline, with different specialisations, students' descriptions of the ideal engineering student are mostly consistent: analytical, clever and engaged, as well as having effective time management with a work-life balance. Meghan, for instance, (British South Asian woman), constructed the ideal engineering student as someone who is 'really smart [and] ahead of the game'. More specifically, Huan (International Asian woman) said they would command a 'good understanding of physics' and do more than expected by 'reading journal articles'. Interestingly, the ideal engineering student is also described as people who are open or receptive to learning from mistakes or failures. Cora (White British woman) said they would 'ask for help [if they] get stuck' and Banyu (International Asian man) explained that the ideal engineering student must:

> Not [be] afraid of learning [from] mistakes . . . [because] as [an] engineer most of the time the solutions that you're proposing will never be viable . . . but learning from those mistakes that you have made before that is what makes you learn, in order to become an ideal engineer.

Similarly, the typical engineering student is constructed as approachable, hardworking, passionate and collaborative, especially since 'most projects are done in groups' (Beth, White British woman). Asaroyoma (Black British woman) observed that engineering students are typically quite sociable – 'loves to go to the union bar' – whilst Nayla (British mixed heritage woman) added that 'everyone's quite confident . . . very warm and open'. For Rahma (Black British woman), engineering students are typically 'very analytical [and] all really hardworking', but she and a few others also recognised that 'some of them are kind of lone wolves in terms of how they do their work'. Thus, the typical engineering student appears to fall into at least two distinct camps – the 'very warm and open' and the 'lone wolves'. Compared to the ideal engineering student, which is perhaps described in an academic/study context, our students seem to have focused on different aspects of what it means to be an engineering student between the ideal (from a learning perspective) and the typical (from a social perspective).

Reflecting on their own experiences, Deku (International Asian man) said engineering students in his cohort do enjoy banter with each other, although he admits that these conversations are often initiated by British men and actually 'quite heteronormative', highlighting a straight masculine culture in engineering (Gonsalves et al., 2019). Relatedly, Susie (White British woman) admitted to a low sense of self-efficacy and claimed that a lot of her fellow students, especially women, 'don't know how good they are' and described students like her are 'usually quite frustrated . . . very on edge at all times'. She explained:

> They think that if they don't get the best marks . . . they're not worth it because there's no one telling them, "hey, that's perfectly fine", because . . . there's a lot of focus on that first [class grade] being the be all and end all.

Susie added that engineering students who achieve lower grades than they anticipate often experience poor mental health, with self-doubt and feelings of not being good enough. The apparent emphasis on achievement could mean students with lower confidence or grades might struggle to self-identify as a viable engineering student. Concerningly, the gendered and raced history of engineering continues, with interviewees explaining that engineering students were usually white men or presumed to be white men. For instance, Asaroyoma (Black British woman) said, as a minority ethnic woman, that she 'don't think I fit it very well, to be honest', but insisted that 'even if I feel like I don't quite feel I fit the mould, I'll still just sort of get on with it and just do it to the best I feel I can'. As with mathematics, women engineering students in particular may not readily be accepted as an example of a typical student in engineering, which is still gendered and raced as a white masculine space.

Biology student

The ideal biology student was described as curious, collaborative and hard-working, striving for a work-life balance. According to Thea (White British woman), the ideal student in biology would be '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'. Similar to the ideal engineering student, Heather (British East

Asian woman) added that the ideal biology student ‘asks questions if [they] don’t understand anything’, as well as giving ‘110% into their coursework [and] does extra reading in their spare time’.

The typical biology student is similarly constructed as the ideal biology student, suggesting a close alignment between what is ideal and typical of students in biology. The typical biology student was described as collaborative, friendly, hardworking, passionate, sociable and supportive. Odessa (White British woman) said the typical student in biology is ‘willing to work hard’ and work ‘with other people … on collaborative projects’, especially since their ‘department puts a lot of emphasis on [wanting] to change the idea [that] scientists are people who are literally working by themselves in a lab’. Odessa reiterated that ‘science is all about collaboration’ and explained ‘people who are unsuccessful at biology aren’t able to communicate with people’. Similarly, Heather (British East Asian woman) believes biology students in her degree are ‘the friendliest bunch’ across her university, with a deep passion for the discipline.

Most students seem to consider sociability as a typical and key characteristic of biology students, rather than as a rarity. Sarah (White British woman), for instance, used adjectives such as ‘bubbly’ and ‘outgoing’ in her description, while Sanaya (British South Asian woman) reiterated the importance to strike a healthy work-life balance, stating that ‘they know when a good time is to be working hard and … when it’s time to relax’. Interestingly, Yemi (Black British woman) added that although biology students are ‘quite studious … they wouldn’t wear the studious badge on their foreheads’, which suggest a form of identity management where biology students consciously distant themselves from a particular student stereotype of science, presumably as overtly (and perhaps overly) studious.

The typical biology student is therefore constructed as friendly and approachable, with a measured work-life balance. Compared to other STEM disciplines, students recognise that biology tends to 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. Our students also agreed that most characteristics, as described in relation to the ideal and the typical biology student, are personally relatable. This suggests that an identity in biology appears available and viable for a range of students. While students such as Aaren (White British man) felt that he ‘already fit the stereotype of what I’ve just described pretty well’, those who were currently less confident remained optimistic that their biology identity will eventually develop. As Lakshani (British South Asian woman) remarked, ‘over time I’m becoming what I believe a biologist is, but it’s a slow process’. In short, the ideal and the typical biology student, constructed as friendly, hardworking and sociable, appears to be a more achievable identity for our interviewees than the other STEM identities discussed so far.

Disciplinary differences and hierarchical constructions

When students described the ideal and the typical student in their discipline, there were occasional conversations where students discussed the wider STEM context, especially how they perceive and are perceived by other STEM students. Whilst not directly asked, our data suggest disciplinary differences and a hierarchy in how different STEM subjects are recognised by students.

In particular, there appears to be a popular discourse amongst our interviewees from physics, mathematics and engineering that positioned their own degrees as difficult and challenging, and hence highly regarded, vis-à-vis other STEM degrees which were implicitly positioned as easier or less prestigious. Biology was the only discipline to be explicitly mentioned or inferred as the 'weaker' STEM subject, including by biology students themselves, which may have challenged and demeaned their STEM identity. For example, biology student Chiara (White British woman) recognised that 'biology is never really held in as high regard as the other' subjects in STEM. She explained that her university has a global reputation in particular STEM disciplines (but not biology), which may have prompted students from those highly regarded disciplines to question the value or status of other subjects.

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'. For instance, physics student Mei-Ju (International Asian woman) agreed that students on her degree have mocked or been dismissive towards students in other STEM programmes, especially biology, which is perceived as inferior. She explained:

> I think there is a hierarchy within the scientific communities . . . like how people say that physics is just applied maths, and chemistry is just applied physics, biology is applied chemistry . . . some [STEM] students might believe the hierarchy is a thing, believe that the subject they're studying is superior.

While Mei-Ju's assessment of a STEM disciplinary hierarchy merits further research, with a direct study that focuses on how different STEM students view and understand other STEM disciplines, her observation seems consistent with the experiences as shared by biology students, including David (White British man), who said he felt 'looked down by students in the physical sciences'. It is currently unclear whether students from physics, mathematics and engineering, for instance, all shared these hierarchical views of STEM, or whether these views are more prominent in some STEM disciplines (e.g. in physics, see, Becher, 1990). As we elaborate elsewhere (Murray et al., 2022), these experiences can challenge students' sense of belonging at university and produce imposter feelings. Non-biology STEM students, drawing on these discourses, are able to embody, celebrate and maintain an 'intelligent' identity in STEM, whereas biology students may struggle to gain similar levels of legitimacy, recognition and acceptance of their STEM identity beyond their discipline. As discussed below, given biology is generally better represented by women, this apparent STEM discipline hierarchy may also be gendered.

Discussion and conclusion

This paper explored STEM undergraduates' constructions of the ideal and the typical student in physics, mathematics, engineering and biology. We found characteristics that seem desirable for all STEM students, as well as more specific attributes that highlight disciplinary differences, including a hierarchy of 'harder' and 'easier' STEM subjects. This section discusses what these ideal and typical characteristics might mean for student identities in STEM, and the potential implications for equality, diversity and inclusion in UK higher education.

Some students described the typical student in their discipline using structural identity categories (e.g. white men), which meant it was difficult, and even impossible, for them to fit into, demonstrating how disciplinary identities could be elusive for underrepresented students. They also highlighted typical 'personalities', such as the geeky or less sociable mathematician or physicist, which were not desirable for some students in those disciplines. While the ideal student was often constructed more in terms of skills rather than identities or personalities, these skills were sometimes understood as 'intuitive' or 'natural' rather than learnt or developed, which can feed into biologically essentialist understandings of why certain groups are underrepresented in STEM.

For instance, the ideal student in STEM higher education was generally considered as competent, hardworking and passionate; students across all four disciplines in our study mentioned these characteristics. While this is consistent with popular discourses of STEM as an intellectually demanding field (Losh, 2010), cleverness as a trademark of STEM students can be exclusionary, promoting a fixed idea of who can embody and sustain a STEM identity and which types of knowledge are seen to require intelligence. As mentioned already, this is often a gendered and raced essentialism (Fox, 1999; Keller, 1993; L.T. Smith, 2021; Saini, 2017), which also feeds into the hierarchies between STEM and non-STEM degrees, and between STEM disciplines; those subjects seen as more masculine are also seen as more difficult and requiring greater intelligence (Connell, 1987; Nyström et al., 2019; Ramazanoğlu & Holland, 2002).

It is interesting that biology students were the only ones *not* to mention cleverness or intelligence as an ideal trait in their discipline. Perhaps biology students – some of whom actually study human biology – are more discerning about the spuriousness of using biological essentialism to define ideal or typical students in STEM. The ideal biology student was described as collaborative, with a good work-life balance, in contrast to the excessively studious imagining of the 'authentic' scientific genius, historically a white Western man (Keller, 1993; L.T. Smith, 2021; Mendick, 2006). Such imaginings of the ideal STEM student rely on students' dedication of time and energy to their discipline, which is harder for some students than others. Students in any discipline with caring responsibilities, disabilities, paid work, or who simply desire a greater work-life balance might be perceived by others as less committed to their degree. Thus, while ideal traits like commitment, passion and being hardworking seem 'neutral', they can also be infused with gendered, classed and ableist assumptions about how much students can dedicate to their discipline. The exclusionary history of science that values skills traditionally seen as embodied by only some white men (Fox, 1999; Keller, 1993; L.T. Smith, 2021; Ramazanoğlu & Holland, 2002; Saini, 2017) makes it harder for underrepresented groups to be *seen* by themselves and others as skilled scientists. This is detrimental to their science identity, whereby it is important for one's science competence to be recognised (Carlone & Johnson, 2007). It is perhaps no coincidence that women are often nearly equally represented in biological sciences degrees – 49.1% in the UK (Advance, 2021) – but in the minority for physics (40.5%), mathematics (37.2%) and engineering (19.8%). This may have contributed to a gendered hierarchy of value between STEM disciplines, whereby biology is seen as more feminine and therefore less valuable and easier in comparison to more masculine-coded disciplines.

Our findings showed considerable overlaps between the ideal and the typical student. In physics and mathematics, the attributes of commitment and competitiveness are regularly mentioned as both ideal *and* typical. In engineering and biology, students highlighted the importance of being collaborative and approachable, moving away from the socially inept stereotypes as in the traditional sciences (Losh, 2010; Wong, 2016). However, the valuing of sociability in engineering is not enough to close its persistent gender gap; Seron et al., 2016) argue that the professional socialisation of engineering students through group projects and internships often involves everyday sexism against women which pushes them out of engineering. Thus, the 'sociable' elements of engineering, which are professionally valued, are also spaces where sexism is reproduced through the side-lining of women. Additionally, while engineering is a more 'applied' discipline, the increasing focus in UK HE on graduate attributes means that its vocational value in the graduate job market maintains its hierarchical positioning as a 'difficult' and 'valuable' masculine-dominated field. Interestingly, the typical student in mathematics was described as antisocial, but not as an ideal student, suggesting a potential mismatch between what is typical and ideal. The examples of Karl and Nicole (see earlier) imply that there are student identities within mathematics that deviate from the antisocial stereotype, and here we can infer that sociability might be a desirable characteristic for the ideal mathematics student. Similarly, some physics and engineering students were keen to carve out alternative identities (see, also Ulriksen, 2009) and ideals in their bid to be seen as 'normal' and sociable, ironically aligning more with the (often denigrated) ideal and typical biology student.

Relatedly, a social hierarchy appears to divide STEM disciplines into harder and easier subjects, operating in parallel with the aforementioned gendered hierarchies of stereotypical traits. STEM students appear to place biology at the bottom of the STEM ladder, labelled as easy. Such discourse can undermine biology students' development of their disciplinary identity in the broader STEM domain, beyond the discipline of biology and a biology identity. Biology students may struggle to gain recognition as creditable future scientists by students from the wider STEM community (Carlone & Johnson, 2007). In other words, the STEM identity of biology students may be overlooked by students in physics, mathematics and engineering, because these students do not consider biology to be of similar value or prestige as their own disciplines, despite desiring the 'sociability' that was prevalent in biology students' ideal and typical student discussions. Worryingly, some biology students accept the denigration of their discipline's value within, highlighting the prominence of this STEM hierarchy of value amongst students' understandings of their disciplines.

Similar to the challenges that women often experience in men-dominated STEM education, our findings highlight that biology students, regardless of gender, can encounter prejudice from non-biology STEM students (Fisher et al., 2020). Whilst women in physics, mathematics and engineering may experience gender inequality in these men-dominated environments, we find that the science identities of students in biology – a discipline with greater representation of women – are also questioned because biology commands a lower social status within STEM according to students. Thus, we argue that STEM disciplines are often understood to exist in a gendered hierarchy of value, with mathematics, physics and engineering positioned above biology. Student constructions of who the 'typical' and 'ideal' student is in each discipline establishes biology as a more open, sociable and gender balanced discipline, in comparison to the perception of physics, maths and engineering as 'harder', masculine-coded and more valuable. This feeds into hegemonically masculine imaginings of the rational, analytically rigorous physicist, mathematician or engineer, in which seemingly neutral traits attributed to these disciplines reinforce biologically essentialist stereotypes about some more privileged men being better at certain sciences.

Within departments and universities, concerted efforts will therefore be required to challenge this STEM hierarchy, with a better mutual recognition of the values that different branches of STEM contribute to their fields. This is important for academic staff to appreciate in order to avoid reproducing disciplinary hierarchies and value judgements, especially when teaching undergraduates. Such stereotypes and hierarchies of value are detrimental to student STEM identities, often carrying implicit gendered, raced and classed assumptions that undermine equality, diversity and inclusion efforts in STEM. Additionally, STEM staff ought to consider their curriculum and ensure that their students recognise and acknowledge the respective importance of various STEM subdisciplines. Whilst wider stereotypes (especially gender) may be difficult to disrupt, there are ongoing efforts and publications of case-studies (e.g. Advance HE, 2022) that showcase inclusive practices and the breaking down of such stereotypes within STEM contexts (e.g. Ballen et al., 2017), which are important resources for STEM staff professional development.

STEM staff can play an active role in challenging disciplinary stereotypes and hierarchies of knowledge and subjects by providing opportunities for interdisciplinary working where students can experience and appreciate other STEM subjects. This might involve a greater interdisciplinary approach in STEM teaching, for example, group projects with students from different degree programmes (e.g. Hauke, 2019), or students studying shared modules across degree programmes that promote 'connections across subjects and out to the world' and gain new perspectives from different disciplines (Fung, 2017). These shared modules might be taught by staff across different disciplines to role model interdisciplinary working and research, for example, the 'Story of a Paper' framework (Saffell, 2013) that highlights the benefits and challenges of interdisciplinary work.

This paper contributes to understandings of the 'typical' and 'ideal' students in STEM disciplines (Chiu et al., 2021; Wong & Chiu, 2021a, 2021b), adding a comparative exploration from the perspective of underrepresented university students. We highlight how typical and ideal students are constructed in ways that may *seem* neutral – for instance, the ideal physicist as committed, passionate and hardworking – but such ideals are harder to achieve, or seen as achievable, for some underrepresented students, bringing in gendered, raced, classed and ableist assumptions about who looks and works like a scientist and if their science identity is recognised. This can also feed into broader hierarchies of value between STEM disciplines, whereby we found that biology – a more gendered balanced discipline that valued sociability – was perceived as less valuable than other disciplines, even by biologists. Building on long-standing feminist science studies discussions, we argue that this devaluation of biology is gendered, whereby more masculine-coded STEM disciplines with a greater gender imbalance – mathematics, physics and engineering – were seen as more valuable. The nuances of how students situate themselves in their respective degrees and differentially value their own disciplines and others have social implications and can affect student belonging in higher education. For more inclusive STEM education, any potential differences in expectations and devaluation of certain STEM disciplines and students, should be openly discussed and addressed, especially in the dismantling of outdated stereotypes and gendered hierarchies of value between STEM disciplines.

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