Chapter 2
"My Love for It Just Wasn't Enough to Get Me Through": A Longitudinal Case Study of Factors Supporting and Denying Black British Working-Class Young Women's Science Identities and Trajectories

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2.1 Introduction

> I like it [science], don't get me wrong, I loved it, but it was, I just don't think that … like my love for it just wasn't enough to get me through […] I wish my grades were a bit better and I found it easier, but […] I just don't like how I'm feeling. (Vanessa, age 18)

In this chapter we seek to understand and identify the factors that contributed to why Vanessa—a Black working-class young woman in England who from an early age had "loved" science and, with strong family support, aspired to a science career—came to feel by age 18 that her love of science was "not enough" to support her science identity and trajectory, something that she found painful and uncomfortable.

It is well established that students from Black communities have long been under-represented in and excluded from post-compulsory science, technology, engineering and mathematics (STEM) in most western industrialised countries, such as the US and UK (e.g., Campaign for Science and Engineering (CaSE), 2014; National Center for Science and Engineering Statistics (NCES, 2015); National Science Board, 2015). Racialized patterns of participation in STEM are complex in that they differ both between and within different communities, being differentiated by social class, gender, ethnicity and subject area (Mcmaster, 2017). However, it has been noted that, compared with other minoritized communities, Black students experience particular injustices. For instance, Black students are among those least likely to study STEM subjects at post-compulsory levels (Mcmaster, 2017), record higher attrition rates from STEM degrees compared with other ethnic groups (Chen, 2013),

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are less likely to attain higher degree grades and more likely to attain lower degree outcomes compared with White students, and experience lower rates of STEM career progression compared to students from other ethnic backgrounds (Joice & Tetlow, 2020). Research has also drawn attention to the racial trauma experienced by high attaining Black students who are successful in carving out STEM trajectories (McGee & Stovall, 2015).

The reasons for the exclusion of Black students from post-compulsory science are multiply rooted, with the literature identifying a range of factors, including societal and institutional racisms, the exclusion of minority ethnic groups from scientific knowledge in Western societies (Baker, 1998), racisms within schools, colleges and universities and low teacher expectations of Black students (e.g., Atwater, 2000; Brickhouse & Potter, 2001; Carlone & Johnson, 2007; McGee & Martin, 2011; Rascoe & Atwater, 2005) and exclusionary STEM disciplinary cultures (e.g., Rosa & Mensah, 2016). Dominant norms and associations of science with whiteness and masculinity make it particularly difficult for Black girls to feel included and be recognised as authentic scientists in the classroom. As Atwater (2000) discusses, Black girls experience constant representational violence within science classrooms. Indeed, race, class, and gender intersect in ways that "can make membership in a school science community impossible or undesirable for black girls" (Brickhouse & Potter, 2001, p. 965; see also Brickhouse et al., 2000). These injustices are also found in higher education and STEM workplaces, as exemplified by Carlone and Johnson's (2007) investigation of Black women scientists' experiences, in which "the institutional and historical meanings of being a scientist" equated with "being a white male" (p. 1207). As a result, Black girls and women remain acutely and persistently under-represented in STEM, despite comparatively high achievement and positive dispositions towards science (Young et al., 2017).

Given these immense challenges and injustices, in this chapter we consider: how did one Black British working-class young woman, Vanessa, manage to identify with science over time? And how and why was her trajectory curtailed? We employ Black scholars' extensions of Bourdieusian theory as our conceptual framework for exploring these questions through the case study of Vanessa and her parents, Robbie and Akimi, in the hope of shedding light on the broader factors that enable and constrain Black working-class young women's science identities and trajectories.

2.2 A Bourdieusian Approach to Theorising Vanessa's Science Identity and Trajectory

In this chapter we try to understand the factors, relations and conditions that shaped Vanessa's science identity and trajectory over time. Our focus on her *science identity* involves identifying what supported or mitigated her sense of self in relation to science. Science identity has been shown to be a valuable lens because, as Avraamidou (2019) explains, it is both a personal and political multidimensional concept, which encompasses forms of recognition (e.g., who is/not recognised as

being a legitimate 'science person') and how science is represented, configured and produced through intersectional norms, values and systems of oppression. As Avraamidou (2019) argues, "science identity provides not only a valuable lens for exploring science (non)participation but also a lens for better understanding the complexities of becoming a science person which are tied to political, structural, and societal problems" (p. 324). Science identity is not a static, discrete 'thing' but is performed and enacted, a process of becoming that is intertwined with and inseparable from other axes of identity and the conditions and relations of production. Importantly, identity is closely bound up with learning, shaping and mediating what learning is possible and desirable (see also Nasir & Hand, 2008).

Our focus on Vanessa's *science trajectory* considers the extent to which she pursued, or not, science qualifications and a STEM-related career pathway, recognising that trajectories are not solely agentic constructions but are influenced by a range of wider forces, conditions and injustices. As numerous scholars have noted, identity can powerfully mitigate young people's science participation and trajectories (Calabrese Barton et al., 2013; Holmegaard, 2015; Rahm & Moore, 2016). Hence, we seek to understand the factors that shaped Vanessa's changing science trajectory over time, between the ages of 10–18.

We engage with the concept of identity through a Bourdieusian lens (e.g., Bourdieu, 1984, 1990, 1993, 2010), drawing in particular on extensions of Bourdieusian theory by Black scholars, as discussed below. But why use Bourdieu? This question is pertinent given that Bourdieu's work is well known for prioritising social class over considerations of race. However, as various commentators have pointed out, race is not absent in Bourdieu's work (Puwar, 2009) and in recent years Black scholars have been using and extending Bourdieu's conceptual tools to advance theory and develop nuanced understandings of the reproduction of oppressions in the lives of Black young people and families, particularly in relation to the school system, as exemplified by Lofton and Earl Davis's (2015) work on Black habitus among college students and developments of the idea of Black cultural capital among middle-class Black students (Meghji, 2017; Wallace, 2017) and parents (Rollock et al., 2011).

As Wallace (2017) explains: "Bourdieu's conceptual toolkit (habitus, field and capital) offers tools for unearthing the complexities of, and contributions to, social (dis)advantage, including their racialised dimensions" (p. 907). We find Bourdieu's work particularly helpful to exploring science identity because it (i) foregrounds structure and the forces and practices of socially reproduction, helping to explain how and why inequalities in science participation are so enduring and resistant to change, and (ii) highlights the pedagogic work undertaken by schooling – in our case, school science practices – which result in racialized, classed and gendered patterns of participation (e.g., Archer et al., 2020).

At the heart of Bourdieu's theory is his proposal that social life can be understood as produced through the interactions of *habitus, capital* and *field*. *Habitus* bears a resemblance to the notion of identity in that it produces a sense of the self (as both an individual and a member of a collective). Habitus can be thought of as an embodied, socialised framework of dispositions which provides our practical

'feel' for the world and a sense of ourselves in relation to others. Habitus is cultivated over time, through our experiences and interactions and produces the sense of "who I am", in both individual and collective terms (e.g., as a Black, working-class young woman from London). Importantly, habitus contains the imprints of our social positioning and experiences and, in turn, structures our views of and interactions with the world. Hence a young person's habitus both reflects and structures their engagement with the fields in which they have grown up (Bourdieu, 1990). In this way, habitus is shaped by, grounded within, and orientated to engaging with the fields in which an individual has been socialised. Moreover, habitus is not merely a set of dispositions that reside 'in the mind', but is also embodied, such as through a person's taste, bodily gestures, accent, gait, and ways of being. In this way, the formative role of the field and a person's experiences in the world can be detected in their embodied (gendered, classed and racialized) habitus, as discussed by Lofton and Earl Davis (2015) in their analysis of Black college students in the US.

The majority of research that has used the concept of habitus has focused on its reproductive nature, such as its role in producing classed patterns of participation in higher education and the feeling as to whether university (e.g., Archer et al., 2003; Reay et al., 2001) and/or science is "not/for me" (e.g., Archer et al., 2017). However, a smaller body of work has sought to unpick the conditions required for a transformative and reflexive habitus (e.g., Yang, 2014) to explain how and why some people 'go against the grain' of social reproduction, such as White working-class students who access elite universities (Reay et al., 2009), showing how habitus is not produced in a singular, straightforward way, and how variations in young people's experiences between different fields can produce distinctive forms of habitus that are not simply aligned with social reproduction and, in turn, how students' encounters with a new, unfamiliar field, such as that of elite higher education, can lead to aspects of their habitus being 'restructured' and 'transformed' (Bourdieu, 2005; Travers, 2017).

Habitus does not exist in isolation, but is formed and operates in conjunction with *capital* and *field*. *Capital* refers to the economic, cultural, social and symbolic resources that a person (or collective) possesses, the value of which is determined by the field. Over the years, considerable attention has been given to delineating different forms of capital and the role that such capital plays in producing unjust patterns of educational participation and outcomes (e.g., Lareau & Horvat, 1999; Noble & Davies, 2009). Here, we focus in particular on work that has sought to explicate the idea of Black cultural capital, which has been proposed and explored as an important counterpoint to the tendency for Black students and communities to be defined in deficit terms as 'lacking' cultural capital. Wallace (2017) defines Black cultural capital as "dominant tastes and expressions adopted and adjusted by the Black middle classes to signal class status and racial identity simultaneously" (p. 907). His conceptualisation includes both use value and exchange value forms of cultural capital (or dominant and non-dominant, in Wallace's (2017) terminology), including specific forms of symbolic Black cultural capital (such as knowledge of Black composers) and knowledge of how to navigate racialized relations (e.g., in

educational spaces). Wallace (2017) suggests that "Black cultural capital reflects the simultaneous negotiations of 'race' and class in the acquisition of resource advantages that more often than not are defined by white middle class interests". The concept of Black cultural capital has predominantly been explored in relation to Black middle-class students and parents (for instance, showing how it can be deployed to challenge White hegemonic practices and knowledge within schools, Wallace, 2017), but in this chapter we also consider its role in relation to Vanessa and her parents, as a Black working-class family and, specifically, the potential of Black science capital in supporting her science identity and trajectory.

Capital does not exist or hold value in isolation – the nature, volume and types of capital that someone has will be shaped by the *field* (socio-spatial contexts of power relations that set the 'rules of the game'), in that the *field* determines the value of *capital* and the potential for its translation and accrual. In this way, the structure of *capital* represents the "immanent structure of the social world" (Bourdieu, 1986, p. 242). For instance, our prior work noted that changes in the field can open up or close down the value and potential of particular science-related forms of *habitus* and *capital* in shaping the likelihood of a young person seeing themselves as a science person and/or continuing with science after the age of 16 (e.g., Archer et al., 2015). Likewise, field shapes the ways in which social identities and inequalities are articulated and understood, so that, for instance, race functions differently across different socio-historical and spatial fields (Bourdieu & Wacquant, 1992).

We thus understand expressions and enactments of science/identity as socio-spatially and temporally produced structured agency (i.e., they can be spontaneous and improvised – but also always constrained in possibility and desirability by embodiment and structure produced through the interaction of habitus, capital and field). That is, the form and possibilities of a young person's identity performances will be shaped by their racialized, classed and gendered (etc.) socialised dispositions, experiences, social positioning and embodiment in interaction with the power relations and socio-spatial organisation of the *field* in question.

In this chapter, we additionally draw on Bourdieu's ideas about how societal inequalities are cemented and perpetuated through *symbolic violence*, that is, "violence which is exercised upon a social agent with his or her complicity" (Bourdieu & Wacquant, 1992, p. 167). Symbolic violence refers to how people are inculcated to accept the values and interests of the dominant as 'natural', justified and 'just the way things are'. In this way, the many different advantages enjoyed by dominant (e.g., White, male, middle-class) groups are accepted as a reflection of their superior intellect and talents, and the oppressed and disadvantaged positions of Others are represented as due to a lack of, for instance, intelligence, motivation, character and so on. In other words, symbolic violence is a "process whereby individuals, through their experience of the social world and of the various institutions and structures that compose it, come progressively to develop taken-for-granted ways of thinking and behaving that reflect this lived experience" (Connolly & Healy, 2004, p. 16). For instance, we have previously found that the pedagogic work that is undertaken by school physics in England to 'naturalise' the association of physics with cleverness and masculinity makes it difficult for many young women to identify with and progress in the

subject (Archer et al., 2020). In this chapter, we extend these ideas to consider how dominant practices and representations of science may exclude Vanessa from a science identity and trajectory through a process of symbolic violence that hides the racialized, gendered and classed nature of the exclusion so that Vanessa and her family come instead to attribute the causes to a personal 'lack' of love and attainment.

2.3 Data Sources

The chapter discusses data and analyses from the ASPIRES study, an ongoing, 13 year, mixed methods, longitudinal study of young people's science and career aspirations, conducted with students in England between 2009–2023. To date, the study has collected survey data from a total of 40,000 young people students through five waves (Wave 1 (age 10–11) = 9319; Wave 2 (age 12–13) = 5634; Wave 3 (age13–14) = 4600; Wave 4 (age 15–16) = 13,421; Wave 5 (age 18–19) = 7013), and has conducted over 700 longitudinal interviews with a subsample of students and their parents (with 60 students tracked over the 10–18 period). Surveys and interviews were conducted at the same five time periods, when students were age 10–11, 12–13, 13–14, 15–16 and 18–19; survey measures related to aspirations in science and the science self-concept (see Moote et al., 2019).

We start by providing some brief contextualising analyses from the survey data and then focus in depth on one of the interview students, Vanessa, and her parents, Robbie and Akimi, who are described in more detail below. We selected Vanessa's case study in order to explore in-depth and over time the challenges faced by young Black working-class women in identifying and participating in science. Vanessa's case was particularly apt (and potentially able to shed light on the quantitative findings) because Vanessa reported a strong interest in and linking of science through the early years of the study, yet over time came to decide that science was 'not for her'. In discussing Vanessa's case study, we draw on four interviews conducted with her between the ages of 10–18 (in the last year of primary school, age 10; twice during secondary school, age 13 and 16; and once during sixth form (post 16) college, age 18) and four interviews with her parents (Akimi and Robbie) at each of these time points.

2.4 Survey Findings: Black Students Do Not Lack Science Interest, Aspiration or 'Identity'

We recognise that it is difficult, futile even, for quantitative surveys to attempt to capture the richness and complexity of science identity. However, survey data can be useful for helping to identify broad patterns and trends in how people construct and represent their identities and to help situate more in-depth qualitative work. Accordingly, before focusing on Vanessa's case, we want to first consider some broad-brush patterns that we noted in the ASPIRES project survey data, which help

to show how Vanessa's case, while necessarily unique, also relates to and exemplifies issues facing Black students in England more broadly.

The point that we would like to highlight from the survey data is that analysis of each of the waves shows that between the ages of 10 and 18, Black students reported comparatively higher levels of science aspiration and science self-concept than White students. Specifically, odds ratio analyses show that Black students were approximately one and a half times more likely than White students to aspire to become a scientist and/or work in science. Across all survey waves/age points, Black students also reported significantly higher self-concepts and more confident learner identities in science (e.g., feeling that they do well in science, learn things quickly in the subject (M = 17.65, SD = 4.21), compared to White students (M = 16.70, SD = 4.33; $t(31{,}809) = 9.615$, $p < .001$), with Cohen's d.22 indicating a small effect size.

In other words, our analyses of the survey data raise some intriguing questions and challenges to mainstream policy assumptions and approaches, which tend to assume that a key factor underlying the under-representation of Black students in post-compulsory science is due to a lack of aspiration and self-confidence (e.g., Cabinet Office, 2011; Department for Education (DfE, 2010), see also numerous interventions aimed at 'raising aspirations' and mentoring Black students). Instead, our data indicate indeed that Black students are more likely than their White peers to express science aspirations – yet these aspirations do not seem to translate into science participation and retention (e.g., Mcmaster, 2017). We now turn to Vanessa's case study to further explore the potential reasons for this pattern.

2.5 Introducing Vanessa

Vanessa is a young woman of Black African (Nigerian) heritage, who comes from a science-keen, working-class family. She lives with her mother, Akimi, in a council flat in a tower block in inner London. Her father, Robbie, who lives locally, has a degree in pharmacy from Nigeria. For reasons that we would interpret as due to societal and institutional racisms, he had not been able to realise the full potential exchange value of his qualifications in Britain and worked in a relatively low paid job as a science technician in a "very challenging" local London secondary state boys' school. Vanessa's mother completed secondary schooling in Nigeria, studied for 2 years in a teacher training college and now works as a care assistant in a residential care home.

2.5.1 Vanessa Age 10

When we first met her, at age 10, Vanessa aspired to become a doctor ("I like helping people … when they're hurt and I like looking at blood"), which she saw as a potential route towards "a better life". At home, Vanessa's family expressed a strong

interest in and valuing of science. Robbie held a degree in pharmaceutical science from Nigeria, although as he reflected the first time we met him, "I still cry for not climbing on education-wise". Akimi strongly motivated Vanessa to do well in order to have a well-paying job to become more socially mobile. Both parents valued education and qualifications as the way to get on in society, but especially so for members of the African diaspora (e.g., "You see, for us coming from Africa, we had no option. For us, education is the only way", Robbie).

From an early age, Vanessa described how her family had influenced her own aspirations towards a science profession, explaining:

> Because my dad's a scientist he would like me to get a bit interested in science … and I do find science a bit interesting […] He seems to buy quite a lot of science things for me as well. (Vanessa, age 10)

Vanessa felt that her family was not unique in their valuing of science, but reflected a wider common valuing of science among families of African heritage:

> But actually, some African people like science a bit more, because science in Africa seems to be what's getting more money. At the moment because science people like to look at germs and sicknesses, because in Africa … they get sick a bit quickly, so they like doctors and scientists who can find out how it's happening and it's going around. (Vanessa, age 10)

Robbie also talked about an African cultural valuing of science (e.g., "because back home in Africa, we know that science, it's something very good"). The family also invested what little spare money they had in paying for extra tutoring to support Vanessa's academic attainment, a practice that has been found to be common among minority ethnic families in the UK (Shah et al., 2010).

Vanessa attended a local inner London primary school. From age 10, she loved school science and named science as her favourite subject ("I like it a lot"). She maintained this love of science despite finding the school science curriculum of variable interest ("sometimes … a bit boring, sometimes it's interesting") and being relatively alone among her peers in this respect ("I think that most people don't like science because the noise we get when we hear we've got science is just so horrible", age 10). Indeed, Vanessa told us "When they [students] upset the teacher, I feel upset too … I don't like the way they treat our teachers". Vanessa also described herself and her close friends as different to the other girls in her class, who she categorised as "just a bit too girly".

She felt that the national Standard Assessment Tests (SATs; taken by children at the start of their final term in primary school) dominated teaching content and timetabled lessons and she was disappointed by the increased time that was given to literacy and numeracy (the two areas that are nationally assessed), in preparation for the tests. She also expressed her frustration that even once the tests were over, science was still not taught ("And now we've finished our SATs we don't do science anymore").

2.5.2 Vanessa Age 13

At age 13, Vanessa had shifted a little in her aspirations and now wanted to become a forensic scientist ("I want to be a forensic scientist […] I don't really want to be a doctor anymore. Because I found the forensic thing more interesting"). At home, her family science interest and support remained strong, and Vanessa described how Robbie was able to help support her science learning due to his science knowledge and expertise:

> [In science class], if I don't get it, it's like better because my dad can then just come and help so it's easier for me to learn. (Vanessa, age 13)

The family still also paid for Vanessa to receive additional tutoring support to help her attainment.

At this age, Vanessa also recounted how her science interest and aspirations were further fostered and shaped at home through her consumption of forensics-related television programmes, notably the US popular drama series, *CSI: Miami.* She explained that she had really enjoyed a forensics-themed school session in Year 7 (age 11/12), and when they had heard of her interest, her aunts had recommended that she should watch the programme. In explaining her enjoyment of *CSI: Miami,* Vanessa commented specifically on the diversity of characters she had seen in science roles on the programme (e.g., a lead character in the series is a female African American forensic scientist).

By the time of her age 13 interview, Vanessa attended a local London secondary school, where science remained Vanessa's favourite subject:

> There's just something about it like I look forward, like 'Oh, I've got Science, yeah' it's the lesson you kind of look forward to going to … I work harder in science than anything else. (Vanessa, age 13)

While she still enjoyed the subject, Vanessa suggested that most of her peers disliked school science due to a lack of practical science ("Because they find science really, um, boring because these days we don't do that much experiments anymore."). At this age, she started to express some common gendered views of science:

> If you're really girly you just don't see yourself working in Mechanics, do you, and you don't see yourself doing Physics. If you're girly, you probably see yourself more with Biology and Chemistry. (Vanessa, age 13)

However, Vanessa still continued to draw distinctions between herself and other girls, in that she wore "my trainers and jogging bottoms" and more "relaxed" clothes whereas her girly friends and peers wore "the skirts and the dresses and the nail varnish", adding "I'm not really the skirt and … heels kind of person".

Like the majority of other young people in our study, Vanessa suggested that "I think it's the clever people" that do science and she thought of science as a "hard" subject – a point that was also consistently repeated across her later interviews. She

identified being "really focussed and determined" and "wanting to do better" as legitimate ways to do, and be recognised in, science:

> I don't think you have to be clever; you just have to be really focussed and determined. Cos I wasn't like amazing … I'm not amazing at science, but I do have the mind of wanting to be better in it. (Vanessa, age 13)

Whereas Vanessa felt that 'hard work' would enable her to continue with science, Robbie expressed concerns:

> One thing about science is you need to be very, very good, yeah? It's almost as good as nothing having just an additional science at GCSE. You need to be able to do the triple sciences if you are want to, you know, carry on big time in science […] I still feel I probably am not doing enough. (Robbie)

In particular, Robbie worried that not only is it necessary to study the prestigious triple science (equivalent to three GCSE qualifications) route but a student needs to be not just good but "very, very good" in the subject in order to succeed. He described how he was conducting additional after school study sessions with Vanessa and paying for her to have a tutor, to try to raise her attainment. But he still worried that he might be still "not doing enough".

Robbie expressed his frustration with what he perceived to be noisy and disruptive classes and a lack of science teacher specialism at Vanessa's school, conditions which he described as being "worse than in most countries in the third world". He found the state of science teaching and learning in English schools particularly perplexing given his experience of growing up in Nigeria, which had originally been colonised by Britain, when discipline and respect had been key discourses within colonial propaganda ("We were colonised by these people! They came to our country and told us 'now listen, your teacher is your second God, you have to respect them'. Well now coming here [to England] … it's not like that. And sometimes we ask, what is happening? You know?").

2.5.3 Vanessa Age 16

At age 16, Vanessa still aspired to be a forensic scientist:

> I'd like to be a forensic scientist… I'd like to work with the police actually and kind of do all that forensic stuff – finding out how the crime happened, what happened, the time, weapons used and all of that stuff. (Vanessa, age 16)

Vanessa's parents continued to be interested in and support her science trajectory, a point that Vanessa recognised as helping maintain her interest and attainment in the subject:

> Science was like the one thing I had a parent that could really help me with. So, it's kind of like Science was the one thing I was a bit okay with, cos I had someone that could really help me in science. And then I think … it started from that to actually liking it, and then … [My dad] knew all the sciences, but he's strong on his Chemistry. (Vanessa, age 16)

However, Vanessa explained that Akimi encouraged her to consider a medical career rather than forensic science ("My mum, she still wants me to do Medicine, she kind of wants me to work like in a pharmacy. My dad, he just kind of wants me to do what I like, but something good that would obviously pay the bills in the end"). At home, Vanessa continued to love watching *CSI: Miami*:

> I've been probably just watching a lot of CSI. That's probably my one big thing. Like I can't stop! CSI: Miami, that's just the only one I watch. (Vanessa, age 16)

The programme's content and characters also shaped her view of tAAhe profession as an ethnically diverse and gender-balanced field (e.g., "I think it's quite a … I think it's a diverse … it's quite unisexual. Like from what I've seen there's the same amount of women in Forensic as men, from what I've watched").

At school, Science was still Vanessa's favourite subject and she studied for the prestigious Triple Science route ("I liked it, it was interesting") which could potentially enable her to apply for Advanced level science courses. Vanessa obtained "mostly B grades" in her science General Certificate of Secondary Education (GCSE) exams at the age of 16, which Robbie described afterwards as "average". Vanessa applied to take Advanced level (A Level, the 2 year, national post-compulsory academic qualification) courses in Biology, Chemistry, English Language and Psychology, however, while B grades are widely accepted for entry to courses like English and Psychology, as Robbie explained, the sixth form college that she attended would not allow her to study Chemistry A level with a B grade (a situation that is common across schools in England). As a result, she applied instead for Sociology, and was accepted on to this course. Both Vanessa and her father were disappointed and "not exactly pleased" with this outcome, with Robbie lamenting that she was "not strong enough" to continue to A level in Chemistry.

Usually, schools in England are expected to provide 16 year-old students with careers education, advice and guidance. However, Vanessa recounted that she received very little relevant or useful careers education support and in particular, had not experienced any support relating to science careers ("they bring people into school but they don't have many people that are like scientific or anything").

2.5.4 Vanessa, Age 18

By age 18, Vanessa's ambitions had changed, and she now planned to study for a degree in Criminology ("I've chosen Criminology to study at uni"), an aspiration that she still related to her interest in solving crimes but which, much to her parents' regret, had moved away from a science-based approach to social science. Vanessa felt that a Criminology degree would enable her to pursue her interest in solving crimes without requiring formal science qualifications or content. At the time of her last interview, she had received a number of offers from UK universities.

Her interest and identification with science had also changed substantially compared with former interviews, as she emphasised "I don't really want to do anything science based". When asked to explain further, she replied:

> I think I don't know I just find it difficult. I like it, don't get me wrong, I loved it, but it was, I just don't think that … like my love for it just wasn't enough to get me through […] I wish my grades were a bit better and I found it easier, but […] I just don't like how I'm feeling. (Vanessa, age 18)

In a poignant echo to Vanessa's quote, (although the two interviews were conducted entirely independently, at different times and locations), Robbie similarly concluded in his final interview: "She loved the sciences, but just loving a subject is not enough".

Vanessa also described how she no longer focused on science-related content within TV programmes in the same way that she had previously:

> Like when I'm watching like CSI and like criminal cases and stuff, like and documentaries on people that have gone to jail and finding out stuff like that, there is like, you do see the Science, bits of it, like the Science aspects coming through, but that's not what I focus on anymore. (Vanessa, age 18)

When asked what she felt she had gained from her experiences of school science, Vanessa reflected: "What have I gained? Um, not much, nothing that I remember now, so yeah". She continued to explain that she did not feel it had given her much 'useful' knowledge that she could apply in her current life ("science doesn't help you a lot in life, but it does help a tiny bit"). Vanessa explained that she had started studying for Biology A level, but a year later she dropped the subject because:

> I kind of looked at my grades and I thought what would match, like what subjects would be best? […] Because that was my lowest, I got the lowest grade in that, so I dropped that […] It was harder than I thought. … Because I got, I mean I got Bs in everything really, but I just thought like English and my writing skills are better, so I thought I'd be better off with something like Sociology and Psychology, which are essay-based". (Vanessa, age 18)

When we asked Vanessa about her subject choices and the decision to drop Biology, and whether she had spoken to anyone else before making the decision, she replied "No, not really, I kind of just said what I was going to do and just did it".

In both their interviews at this time, Vanessa and Robbie expressed a strong regret that Vanessa had not been able to continue with science and both said that they wished they had known and been told about alternative science qualification routes, such as the more vocationally-orientated Business and Technology Education Council (BTEC) qualification that might have enabled her to continue with science (e.g., "I wish I'd took BTEC", Vanessa; "If we had the knowledge we have now, we probably would have taken the BTEC route, you know, through applied science or so. But I mean it was too late", Robbie). Robbie was particularly disappointed that, by not taking any post-16 science qualifications, the door to Vanessa pursuing a science degree was now closed – a situation that he strongly wished were otherwise ("I had wanted her to do a degree in pure science, but that's no longer possible now"). Vanessa also explained that she had not received any individualised careers advice

or guidance sessions in the previous 2 years and had only been offered the occasional job fair or generic speaker, which was, she noted "not actually personalised for me".

2.6 Discussion

We now consider (i) how and why Vanessa was able to develop and sustain over time an identification with and aspirations for science and (ii) how and why she ultimately came to feel that her "love" of science was "not enough" to sustain a science trajectory. We argue that it was her home and family habitus and capital (notably her Black science capital) that enabled the former, while the school system produced the latter, in ways that we interpreted as symbolic violence.

2.6.1 Supporting Vanessa's Trajectory: Black Habitus, Black Cultural Capital and Black Science Capital

In various prior studies, family support has been identified as a key factor supporting the STEM trajectories of Black (Rosa & Mensah, 2016; Russell & Atwater, 2005) and Hispanic (Brown, 2002) students. Similarly, in Vanessa's case, her science identity and trajectory were substantially fostered, maintained and possibilised by her family, particularly her parents. We interpret Vanessa's parents as not only having engaged and motivated their daughter towards science (through cultivation of a science rich habitus), they also generated and deployed capital in key ways that supported and enabled Vanessa's science identity and trajectory.

First, the family diasporic habitus shaped Vanessa's own habitus towards a strong valuing of science. For instance, Robbie and Akimi's hopes and dreams for intergenerational social mobility and a "better life" for their daughter (generated through their experiences of migration, racism and poverty in Britain) had strongly shaped Vanessa's early aspirations. Robbie's belief that "education is the only way" to achieve social mobility echoes a discourse and strategy that have been noted among various diasporic communities in Britain (e.g., Archer & Francis, 2007). Second, despite their working-class social positioning in the UK, following Wallace (2017) we interpreted the family as mobilising forms of Black cultural capital and, more specifically, Black African cultural capital, and in particular, Black (African) science capital, to support Vanessa's science identity and trajectory. For instance, despite limited finances, the family deployed economic and cultural capital to support Vanessa's engagement with science and to foster her interest in and connection with science – as illustrated by Robbie's purchasing of numerous science kits for Vanessa throughout her childhood and his constant motivation, expectations and

sharing of his own science interests and expertise with his daughter over the years. His academic support, tutoring and monitoring to support Vanessa's science attainment can also be understood as deployments of capital to try to secure educational advantage and 'success' – albeit from a position of trying to enable social mobility rather than social reproduction (as in the case of the middle-classes). Robbie and Vanessa's narratives around the valuing of science within African culture might also be interpreted as examples of Black cultural capital that draw on rich cultural values and expertise with the aim of challenging or overcoming class and racial disadvantage. In other words, we understand Vanessa's diasporic, Black African family habitus and capital as not just valuable but indeed essential to sparking, fostering and sustaining Vanessa's science identity and trajectory – hence in contrast to many popular policy assumptions, Vanessa's cultural context and resources were assets, not deficits, that supported her engagement with science.

In addition to the family habitus and capital, we suggest that Vanessa's consumption of *CSI: Miami* might also be interpreted as a form of Black cultural capital in that the programme was specifically recommended by her aunts (as an example of Black family social capital) and the identity of the Black female scientist lead character in the series appeared to be an important cultural resource that helped foster and possibilise Vanessa's own forensic science identity and aspirations in relation to both race and gender. In line with our Bourdieusian framework, we understand the series as not constituting a fixed form of capital per se (in which the 'value' is intrinsic to the TV programme would be universally accrued by any viewer), but rather that the value of the programme as a potential source of capital is determined by the field. Hence in this case, Vanessa is able to leverage capital from her consumption of the series – and this leveraging is enabled through specific interactions of habitus and capital. We interpret the value of Vanessa's consumption and love of the TV series as underlining the importance and value of inclusive media representations of science and scientists – while also noting that this was the only popular representation of a Black, female scientist that any participant in the study identified, suggesting that they remain rare and elusive. Moreover, we suggest that the presence of diverse representations (and role models) alone is insufficient – we interpret Vanessa's case as illustrating the range of additional 'work' that needs to be done through interactions of habitus, capital and field, to leverage and realise the potential value of these representations within the science identities and trajectories of young people.

While Vanessa's engagement with *CSI: Miami* and the science kits that her parents bought her constitute examples of informal, everyday science learning and engagement, we also noted that Vanessa did not additionally benefit from experiences of informal science learning through designed or community settings (e.g., she did not attend any science clubs or visit science centres and so on). While we cannot judge the impact of this on Vanessa's identity and trajectory, we do note that a range of studies of 'successful' Black science students (particularly those who went on to study for a science degree) draw attention to the value and role of culturally rooted, informal science learning contexts for supporting Black students' identity and trajectories in science (e.g., Calabrese Barton & Tan, 2010; Rahm, 2010;

Rosa & Mensah, 2016) and mathematics (e.g., Nasir, 2002; Nasir & Hand, 2008; Walker, 2006, 2009, 2011) For instance, Ortiz et al. (2019) examined identity formation among Black students, highlighting the importance of both formal and informal STEM educational experiences over time, emphasising how experiences as early as kindergarten can be important.

2.6.2 Closing Down Vanessa's Science Identity and Trajectory: The Role of Schooling

Whereas we identified family and home support and experiences as being instrumental in developing and supporting Vanessa's science identity and trajectory, we found that school science and the education system were closely implicated in closing down and denying her science identity and trajectory, a theme that is also present in the narratives of the six women detailed in Rosa and Mensah's (2016) study. For instance, throughout Vanessa's time at school, national assessments seemed to play a key role in shaping the possibilities for her to access and engage with science, restricting the amount of time that her primary school gave to science teaching and lessons and directly preventing her entry and participation in science qualification routes in secondary school through the requirement for higher grades in science than is required for many other subjects. While Vanessa's family support, habitus and Black (African) cultural, social and science capital significantly supported and sustained her science identity and trajectory over a number of years, in the end these could not mitigate the powerful educational systems, structures and practices that maintain the elite status of science through restricted entry routes to science and through their action (through symbolic violence, as discussed below) on the habitus and their mitigation of Black capital that lead Vanessa to the painful conclusion that her 'love' for the subject is not enough.

From a Bourdieusian perspective, we understand the education system as fundamentally designed to support and enable the reproduction of privilege and relations of oppression and domination (Bourdieu & Passeron, 1977). That is, the education system is based on and designed to reproduce the interests, values and social positioning of the privileged, which means the system is designed to reproduce White, male, middle-class privilege and supremacy. We can see this underlying impetus play out in various ways in Vanessa's case.

First, we interpret Vanessa's experiences of urban schooling as an example of how the education system in England is differentially resourced and distributed, a process that has been termed the 'rationing' of education along class and ethnic lines (Gillborn & Youdell, 1999). As a working-class, Black student, Vanessa is not unusual in experiencing under-resourced, disruptive classrooms with high science teacher turnover and an under-supply of specialist science teachers (Manning, 2017) and unequal provision of careers education support (Moote & Archer, 2018) – a point that Robbie highlights as exemplifying the "myth of colonialism" (in which

the educational vision that has been "sold" is restricted to the privileged and not shared with the colonised).

Second, we note that one of the conditions of possibility for many young women to identify with and pursue science trajectories is a negotiation of femininity and the performance of 'different', but specifically 'non-girly' femininity (see also Francis et al., 2017; Gonsalves, 2014), which we interpret as highlighting the continued alignment of science with masculinity and the reproduction of gender privilege.

Third, we suggest that while Vanessa's Black habitus and Black capital were valuable and transformative in that they challenged dominant power relations to produce and sustain her science identity and trajectory, the normative and socially reproductive dominant power of the field (to value and leverage dominant forms of capital) still remained, as exemplified by the ways in which Vanessa was disadvantaged at various points in her trajectory by not having specific forms of dominant cultural knowledge and resources to support her decision-making (as exemplified by her and Robbie's "regret" and poignant reflection "I wish I'd known").

Fourth, we note the powerful ways in which educational gatekeeping (e.g., requirements to access to high status science qualification routes and advanced level science courses) is designed to 'keep out' particular students in order to reproduce the elite status of the subject (Archer et al., 2017). As we have discussed elsewhere, we interpret the popular and pervasive construction of science as 'hard' and 'only for the clever' as reproductive of racialized, gendered and classed science participation, through constructions of 'cleverness' as aligned with White, male, middle-class identity, in which the educational attainment of Others tends to get explained away (e.g., as due to hard work, rather than intelligence or aptitude, see Archer, 2008; Archer & Francis, 2007; Bourdieu & Passeron, 1977). Hence, we see how dominant associations of science with cleverness mitigated Vanessa's relationship with science, as her good grades in science were deemed insufficient by a system that restricts entry to exceptional/best grades only. We see such practices as part of how the field undertakes social reproduction – reproducing the elite status of science and maintaining unjust patterns of participation – albeit at the cost of the aspiring individuals who are excluded and to the detriment of the field itself, which misses out on the talents of young Black women, such as Vanessa.

Finally, using our Bourdieusian lens, we identify the ways in which these practices of distinction operate to a considerable extent through symbolic violence, as exemplified by Robbie and Vanessa 'blaming' themselves (rather than systemic and structural injustices) for Vanessa's 'failure' to maintain a science identity and trajectory. We see this, for instance, in Robbie's concern that he is "not doing enough" to support his daughter and Vanessa's statement that her love for science was "not enough" and her "personal" decision to withdraw from Biology A level on the basis that it is "too hard" (see also Robbie's own regrets at "not climbing on education-wise"). As Bourdieu explains, symbolic violence is a powerful technology of oppression that works through intersectional injustices. While Vanessa's decision to drop Biology is arguably a logical and strategic response to injustices within the *field* (to maximise her chances of academic success within a subject that disadvantages her), we suggest that it highlights how practices of distinction in science

(whereby science subjects achieve status through their demands for higher levels of attainment than other subjects) are both arbitrary and play a role in reproducing unjust patterns of participation. Finally, we note the pain that these experiences inflict on Vanessa and the identity work that she must now, as exemplified by her account of how she now watches *CSI: Miami* in a different way, not focusing on the science aspects and in her description of how she does not like how she now feels about science.

We also note that Vanessa's account notably does not mention the presence or role of caring and kind teachers, and particularly caring teachers of colour, factors that have been noted as important in various studies of successful Black STEM students (e.g., Brown, 2002; Mensah, 2019; Mensah & Jackson, 2018; Nasir et al., 2019; Russell & Atwater, 2005). We also note the absence of any specific educational support programmes within Vanessa's trajectory – which, again, have been identified as important facilitators of Black STEM students' trajectories, such as advanced school preparation programmes (Rosa & Mensah, 2016) and college preparation and support programmes (Brown, 2002; Maton et al., 2000; Russell & Atwater, 2005), particularly those aimed at supporting minoritized students on to STEM degree programmes. Notably, a number of these studies also identify the crucial role of financial assistance for students to undertake specific programmes – which again, Vanessa did not benefit from. While we cannot speculate as to whether the presence of these factors would have resulted in Vanessa completed advanced level science qualifications and entering her desired forensic science degree, we suggest that their absence arguably increased her vulnerability and that had such support been in place, it would have likely offered valuable additional resilience and support to her science identity and trajectory.

2.6.3 The Science Debt?

Our analysis of Vanessa's case has highlighted intersectional injuries and injustices within the lives of Black, working-class young women and the ways in which these injustices are 'hidden' by symbolic violence, such that the 'blame' and cause of injustices in STEM participation become located within Black individuals (e.g., as a lack of attainment) rather than being attributed to unjust educational practices and systems. Importantly, Vanessa's case shows how Black families' habitus and capital are important and valuable resources that can support a young person's science identity and trajectory – providing an important counterbalance to popular policy assumptions (e.g., Commission on Race and Ethnic Disparities, 2021).

We propose that the disjuncture identified by our quantitative and qualitative analyses, in which Black school students tend to express high aspirations for science and high levels of science self-concept yet record comparatively lower rates of science participation and high attrition, can be conceptualised as an example of the 'science debt'. The notion of science debt borrows directly from Gloria Ladson Billing's (2006) foundational notion of the 'education debt', in which she

powerfully reconceptualised educational 'gaps' in attainment (between Black and White students) as a debt that is accumulated over time, through relations of injustice and experiences of both overt racisms and repeated micro-aggressions, and that is consequently 'owed' by the system to racialized communities. We suggest that Vanessa's case powerfully exemplifies the 'science debt', underlining how, despite possessing considerable family science capital and a habitus orientated towards science, social and educational inequalities worked to exclude, demoralise and persuade her away from science, denying her 'love' of the subject and rendering her science identity and aspirations 'impossible'.

2.6.4 Thinking Otherwise: Changing the Field of School Science

So how might the field of school science better support young people like Vanessa's science identity and participation? Bourdieu proposes that field determines the value accorded to students' capital, setting the 'rules of the game' regarding what and who gets valued within a given space. From this perspective, we understand that supporting the science identities and trajectories of students requires changing power relations and inequities within the field of science education (see Archer et al., 2017; Godec et al., 2017), rather than seeking to change the student. This approach contrasts considerably with many existing interventions in the UK that are aimed at diversifying participation in STEM, which tend to adopt a deficit approach that are premised upon addressing a 'lack' of interest, motivation, knowledge and/or skills within the young people in question.

Instead, our call to change the field focuses on transforming unjust power relations and practices of privilege/oppression and distinction, changing educational systems and practices, for instance, drawing on justice-orientated, culturally relevant (Ladson-Billings, 1995; Mensah, 2011) and assets-based pedagogies within teaching, learning and outreach work that challenge dominant binaries (e.g., Jammula & Mensah, 2020) and develop relations of trust and care between teachers and young people (Nasir et al., 2019). Changing the field also needs to happen not just in the classroom but through the entire education system and particularly at the level of national education policy, as education policy produces the conditions that require schools to enact unjust practices and is a key way in which the continued 'science debt' is produced and sustained and which results in the symbolic violence and exclusion experienced by young women like Vanessa.

Finally, returning to Vanessa's opening quote, we suggest that love also constitutes a valuable and important resource in the reimaging of science education policy and practice. Love is a long-standing principle and practice within the civil rights movements and many contemporary movements, enabling dialogue and connection and supporting educators to recognise and understand the hurt and oppression experienced by Black students (Hooks, 1994). As Freire (1970) argued, a politics and

practice of love can enable the breaking down of unequal power relations between teachers and as hooks explains, "emphasizes the importance of service to others" (Hooks, 1994). Hence, we suggest that in addition to recognising, valuing and supporting a students' love for science, educators can also centre love in their pedagogy, "softening the power differential between students and teachers in support of greater relational equity in the space" (DiGiacomo & Gutiérrez, 2016) and using love as a means for supporting students' science identities and trajectories (e.g., Morrell, 2015).

2.7 Conclusion

In this chapter we have argued that 'problem' of Black students' under-representation in science is created by the operation of societal and systemic injustices that are enacted through everyday science teaching, learning and education policy. Contrary to deficit assumptions that are evident in many popular policy texts and outreach initiatives, which assume that Black families and students 'lack' information, motivation and/or aspiration towards science, our survey analysis found significantly higher science aspirations among Black students compared to White students and our qualitative analysis identified how Vanessa's home and family habitus and capital, particularly her family's deployment of Black African science capital, were important and valuable to fostering and sustaining her science identity and trajectory. Yet, education system was closely implicated in closing down and denying Vanessa's science identity and trajectory, ultimately leading her to decide that science was not for her. This exclusion not only negatively impacts Vanessa, but speaks to the wider exclusion of Black students from science – an injustice that is to the detriment of science and society and requires urgent change. To conclude, we argue that productive ways forward should focus on changing the field, rather than young people, to challenge injustices in STEM education policy and practice and to support and embed culturally responsive pedagogies of love within school science teaching.

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