Journal of Research in Science Teaching

Volume 51, Issue 1
January 2014
Pages 1–30

Research Article

Adolescent boys' science aspirations: Masculinity, capital, and power

Louise Archer , Jennifer DeWitt, Beatrice Willis

First published:
21 October 2013 Full publication history

DOI:
10.1002/tea.21122 View/save citation

Abstract

There is widespread international concern about post-16 participation rates in science, with women's under-representation constituting a particular issue. This paper contributes to these debates through a novel, critical examination of the role of masculinity within boys' negotiations of science aspirations. Drawing on a UK longitudinal study of children's science and career aspirations from age 10 to 14 (including a survey of over 9,000 (Year 6, age 10/11) and 5,600 (Year 8, age 12/13) pupils in England and repeat individual interviews with 92 children (at age 10/11) and 85 (age 12/13), the paper focuses in-depth on repeat interviews with 37 boys. We identify five discursive performances of masculinity, which are related to the boys' (science) aspirations: two are associated with science/related aspirations (termed “young professors” and “cool/footballer scientists”) and three characterize boys who aspire otherwise (“behaving/achieving” boys; “popular masculinity” boys and “laddish” boys). Classed patterns across these five discourses are then explored through two cross-cutting phenomena, (1) popular constructions of science as "brainy"/"smart" and (2) the uneven social distribution of "science capital," explaining how each of these are implicated facilitating middle-class boys' identifications from/with science and dissuading working-class boys' aspirations. We argue that these analyses illuminate an *orthodoxy* of science careers which maps closely on to current patterns of participation in post-16 science and which impacts powerfully on who can/not conceive of a career in science as being "for me." J Res Sci Teach 51: 1–30, 2014

Enhanced Article Feedback

There is widespread international concern about how not only to increase, but also to widen, post-16 participation in Science, Technology, Engineering, and Mathematics (STEM). In western developed nations, participation in post-16 science varies considerably by gender, ethnic background and social class, with those most likely to pursue degrees in the physical sciences being White (and Indian and Chinese heritage) men from middle-class backgrounds—a pattern which has persisted over many years (e.g., AAUW, 2010 ; Smith, 2010a, 2010b, 2011). A key concern for those wishing to improve (widen and/or increase) participation in post-16 science is, therefore, to understand how and why social axes, such as gender, social class, and ethnicity, influence students' attitudes to science and their post-16 choices.

Research has identified persistent and entrenched gender inequalities in students' attitudes to science (Haste, 2004 ; Scantlebury & Baker, 2007 ; Schreiner, 2006 ; Schreiner & Sjoberg, 2004 ; Sjoberg & Schreiner, 2005). Studies also reveal how children tend to imagine scientists as male (Baker & Leary, 1995 ; Buck, Plano Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2008 ; Fadigan & Hammrich, 2004) and view science (particularly physical science) as being "for boys" (Adamuti-Trache & Andres, 2008 ; Baker & Leary, 1995 ; Breakwell, Vignoles, & Robertson, 2003 ; Calabrese Barton & Tan, 2009 ; Caleon & Subramaniam, 2008 ; Carlone, 2003 ; Farenga & Joyce, 1999 ; Francis, 2000 ; Jones, Howe, & Rua, 2000 ; Hughes, 2001 ; Greenfield, 1996, 1997 ; Mendick, 2005 ; Fennema & Peterson, 1985). Feminist academics have also highlighted the strength and prevalence of societal discourses that align science (e.g., Haraway, 1988 ; Harding, 1998) and mathematics (Burton, 1990 ; Walkerdine, 1990) with masculinity. Despite numerous initiatives aimed at improving the situation, gendered participation rates in post-16 science remain little changed (Smith, 2011), albeit with some gradual improvement in particular fields (AAUW, 2010 ; Harding, 1998). Moreover, despite liking science as much, if not more, than boys, girls aged 10–13 are much less likely than boys to aspire to careers in science (Archer et al., 2012b). And yet—despite the close association between science and masculinity—there are clear and persistent trends which show that some groups of men (notably working-class men and those from particular minority ethnic backgrounds) are *also* particularly unlikely to study science post-16 and enter science-related careers.

Indeed, science participation varies considerably by social class and ethnicity. Gorard and See (2009) show how participation and attainment in science are stratified by socio-economic status: students from poorer families are less likely to study sciences post-16 than many other subjects, and those who do are less likely to obtain grades high enough to encourage further study of the subject. Findings from our own study also point to social class differences in science aspirations, with middle-class children aged 10–13 being far more likely to aspire to careers in and from science than their working-class peers (Archer, Dewitt, & Wong, 2013). Analysis by Elias et al. (2006) and Jones and Elias (2005) also show that among those eligible to study Physics at degree level (i.e., those with sufficient and appropriate grade points to be eligible for entry to a physics degree program), British students from Black Caribbean, Black African, Pakistani, and Bangladeshi backgrounds were heavily underrepresented, whereas British Chinese and Indian students were proportionally overrepresented.

A small number of foundational studies have explored the intersection of identity, class, ethnicity and gender in relation to science. For instance, Calabrese Barton and Tan (2010) explored how low income urban youth can assert themselves as community science experts in an out-of-school science club project and Brickhouse et al. (2000), analyzed how some African American girls from poor or working-class backgrounds are able to perform scientific identities in the classroom. Brickhouse et al. highlight how ethnicity, class and gender interact to shape not only the strategies that are available to students to perform scientific identities, but also how these students are seen by others, which can affect the likelihood of being able to achieve “success” in school science.

In this paper, we seek to address a key gap in current understandings about how gender and other social axes influence attitudes, aspirations and participation in science—by focusing on the role of masculinity (*cf* . Archer, DeWitt, et al., 2010 ; Carlone, Webb, & Taylor, 2011 ; Letts, 2001) and its interaction with social class. We suggest that examining masculinity (and the ways in which boys' gendered and classed identities are implicated in their ability to conceive of science as a possible/desirable post-16 route) can provide insights into inequalities in science attitudes, aspirations and post-16 participation. That is, statistics tell us that some boys are more likely than others to participate in post-16 science than others—here we seek to shed light on some of the reasons why. Moreover, if we treat gender as a relational concept (Butler, 1990 ; Francis, 2000), it is important to be able to contextualize the existing body of research on gender and science participation, which predominately focuses on girls/women, with an understanding of how boys also negotiate science aspirations and participation. Not only does this enable us to identify parallels or points of difference, but may help shed light on any interrelationships between boys' and girls' identifications with science.

We focus in particular on 10–14 year olds' (science) aspirations, and how intersections of identities and inequalities shape these aspirations. Although youth aspirations do not accurately predict future outcomes and participation, they can give a good indication of the types of career that a young person in likely to end up in later life (Croll, 2008). An overwhelming body of accumulated evidence points to interests in science being formed by age 14 (Lindahl, 2007 ; Murphy & Beggs, 2005 ; Ormerod & Duckworth, 1975 ; The Royal Society, 2006). Moreover, an analysis conducted by Tai, Qi Liu, Maltese, and Fan (2006) of data collected for the 1988 US National Educational Longitudinal Study, shows that by age 14, students with expectations of science-related careers were 3.4 times more likely to earn a physical science and engineering degree than students without similar expectations. In other words, science aspirations are useful in that they can give a probable indication of future participation. As we discuss elsewhere (Archer, Dewitt, et al., 2013), aspirations are also sociologically interesting and can provide a focus for examining interplays of identities and inequalities within young people's lives.

We locate our work within the feminist critique of the international policy and media obsession with boys' underachievement (e.g., Epstein et al., 1998 ; Skelton & Francis, 2009). This body of work questions broad brush treatments of gender (notably the idea that "all" boys or girls are "failing" or "succeeding"), seeking instead to highlight interactions of class and ethnicity within gender. Similar to the research by Brickhouse et al. (2000), we take the position that gender is cross-cut by other social axes (notably social class and ethnicity), such that it is insufficient to look at how gender alone affects science aspirations, attitudes and participation. Rather, in our study we wish to better understand *which* boys (and which girls) do, or do not, see science as "for me," and the reasons why. Moreover, given that, as the wider feminist literature points out, science is aligned with masculinity, in this paper we seek to explore why many of the boys in our surveys and interview samples not consider science careers as being "for me"?

The present paper focuses only on the boys in our sample, in order to enable a detailed analysis of how performances of masculinity interact, are implicated in, boys' orientations to science and, particularly, post-16 science aspirations and participation. We see this focus on boys and masculinity as worthwhile given the dearth of existing research on this topic. Yet it does not mean that we do not recognize the ongoing equity issues around girls' participation. Rather, we hope that our analysis of the role of masculinity can complement wider understandings of girls' STEM participation. Although this focus on masculinity is inevitably both conceptually and methodologically limiting, we attempt to contextualize findings at various points through comparison with data from the girls in our sample. Indeed, the paper is intended as a sister piece to two recent articles from the same study (Archer et al., 2012b ; Archer, Dewitt, Osborne, Dillon, & Wong, 2013) in which we explored how and why different girls from the same study sample constructed science and science aspirations as "thinkable" or "not for me," showing that girls who see themselves as "girly" (highly feminine) are particularly unlikely to view a career in science as being "for me" (Archer, Dewitt, Osborne, et al., 2013) and that those girls who hold science aspirations tend to be highly academic and describe themselves as "not girly" (Archer et al., 2012b).

This paper seeks to open up boys' science aspirations for analysis. Specifically, we seek to investigate the relationship between masculinity, science identity and aspirations, asking why is it easier for some boys to imagine a future for themselves within STEM? We show how an interplay of performances of masculinity, cultural/familial discourses and classed resources ("science capital") mean that some boys, but particularly those from White and South Asian middle-class backgrounds, experience an easier "fit" between their sense of self and an imagined future in science.

Theoretical Approach

For our "theoretical tool kit" we draw on two bodies of work, namely feminist post-structuralist theorizations of gender and Bourdieu's theorization of social reproduction. Feminist poststructuralist theorizations of identity provide us with a conceptual framework for understanding children's identifications with science and how they reconcile their science aspirations with gendered identity performances. This approach includes Butler's (Butler, 1990, 1993) theorizations of gender as "performance" and integrates it with a conceptualization of gender as intersecting with, and mediated by, other social axes, such as "race"/ethnicity and social class (Archer & Francis, 2007 ; Calabrese Barton & Brickhouse, 2006). Hence we understand identity as non-essentialized, fluid, contested and produced through discourse (Anthias, 2001 ; Burman & Parker, 1993 ; Gee, 1996). Identities are "always in process" (Hall, 1990 , p. 222), being constituted within and through discourse and relations of power (Foucault, 1978 ; Weeks, 1981). Social structures (e.g., of gender, class, "race") play an important role in shaping the identities, choices and aspirations that people perceive as possible and desirable ("for me").

Extending the notion of identity to our focus on aspirations and participation in science, we also draw on the concept of "science identity," for which we use Carlone and Johnson's (2007) explication, in which science identity refers to both an individual's sense of self (as interested in and/or competent at science) and the extent to which they are recognized (as being talented/having potential in science) by others. In other words, science identity captures the extent to which a person sees themselves, and is recognized by others as being, a viable science subject. As research has shown, tensions between student and institutional and/or disciplinary identities (Brickhouse, Lowery, & Schultz, 2000 ; Carlone, 2004) can impact on students' ability to successfully learn science and successful participation in school science "can be better facilitated when students have a science-related identity they can fall back on" (Calabrese Barton & Tan 2010 , p. 194).

Our understanding of gender identity draws on Butler's (Butler, 1990) conceptualization of gender as relational (that is, masculinity and femininity do not independently "exist" but only as relational to one another) and performative. Gender is not the "result" of a person's sex and does not emanate "naturally" from particular (sexed, racialized, classed) bodies. Rather, gender is a socially constructed performances that is produced through discursive and bodily "acts": gender is not something you "are" or "have" but rather is something that you "do" (perform) and continually re-do. It is a (powerful) "illusion" (Butler, 1990 , p. 185/6), created through constant verbal and bodily performances ("doing boy"/"doing girl"). Hence in this paper we explore the plurality of boys' performances of masculinity (Francis, 2007), relating these performances to boys' (science) aspirations.

We see masculinity as a socially constructed performance that is enacted by men. Some theorists, such as Halberstam (1998), have argued that gendered performances (of masculinity or femininity) are not necessarily tied to particular biologically sexed bodies. That is, women can perform masculinity and men can perform femininity. However, we follow Connell (2008), Francis (2012) and others (e.g., Paechter, 2006) who argue that the biologically sexed body *does* profoundly shape the extent to which gender performances can be realized and recognized. Our understanding of masculinity is also informed by Connell's (1987 , 1995) theorization of hegemonic masculinity, which denotes "those dominant and dominating modes of masculinity which claim the highest status and exercise the greatest influence and authority" (Skelton 2001 , p. 50). A common feature of hegemonic masculinity is its discursive organization around the subordination of others, notably women and gay men (Connell, 1989). Although as Francis notes, masculinity and femininity can be understood as relationally organized around a core conceptual dichotomy (e.g., active/passive; mind/body), the ways in which performances of masculinity are enacted can be structured by other social axes, such as social class. Drawing on Connell's work, research has highlighted how popular, contemporary hegemonic performances of masculinity among school boys tend to be organized around notions of “laddishness” (Francis, 1999 ; Jackson, 2006). “Laddishness” draws on Willis' (1977) classic study of “the lads” (a group of working-class boys), and encapsulates displays of “hardness,” having a “laugh,” sporting prowess, objectification of women, disruptive behavior and behaviors aimed at conveying the impression of not engaging in, or expending effort on, school work. Likewise, researchers have identified how performances of “muscular intellect” (confident/arrogant displays of intellect) and a privileging of “calm, rational” masculinity may be prevalent among some high-achieving middle-class boys (see Francis, Skelton, & Read, 2010 ; Mac An Ghaill, 1994 ; Mac an Ghaill & Redman, 1997). Hence some performances of masculinity may be more dominant (hegemonic) than others, but they are not uncontested or absolute in their hegemony. Drawing on Bakhtin's (1981) theorization of monoglossia and heteroglossia in language, Francis (2012) applies these concepts to gender to explain the tension between hegemonic and “other” performances of masculinity (or femininity):

> [Monoglossia refers to] dominant forms of language, representing the world-view/interests of dominant social groups, which are positioned or imposed as unitary and total […] While at the macro-linguistic level there may appear to be stability (monoglossia), at the micro level there is plasticity, contradiction and resistance: heteroglossia. (Francis, 2012 , pp. 3–4)

Thus, Francis (ibid.) continues, a “monoglossic, binary account of gender operates to mask and pathologize heteroglossia; yet heteroglossia nevertheless exists in all productions of gender.” Different boys will engage in different discursive (verbal and/or embodied) performances of masculinity at different moments and in different contexts. Some of these performances will carry more patriarchal power, status or authority than others, yet all are ways of “doing boy,” that is, contributing to the production of the social actor in question as a masculine, gendered subject.

Our second lens derives from Bourdieu's theory of practice (e.g., Bourdieu, 1984, 2001 ; Bourdieu & Passeron, 1977), which addresses the reproduction of social inequalities in society, proposing that relations of privilege and domination are produced through the interaction of habitus (an inner matrix of dispositions that shape how the individual operates in the social world) with capital (resources—which can be economic, cultural, social and symbolic) and field (social contexts). In this paper we utilize particularly his concepts of (science) capital, doxa/orthodoxy and sociodicy.

We utilize “science capital” as a conceptual tool for understanding the production of classed patterns in the formation and production of children's science aspirations. We propose that “science capital” is not a separate “type” of capital but rather a conceptual device for collating various types of economic, social and cultural capital that specifically relate to science—notably those which have the potential to generate use or exchange value for individuals or groups to support and enhance their attainment, engagement and/or participation in science. In this paper, our usage of the term primarily refers to science-related forms of social capital (e.g., contacts, social networks, knowing people who work in STEM or who possess valued forms of science capital) and cultural capital (qualifications, enduring habits/dispositions, scientific literacy; rules of the game). Economic capital might be deployed to increase science capital, for example, through purchase of resources, opportunities to increase or acquire science capital (e.g., science kits, tutoring, visits to science centers). Following Bourdieu's theorization of social reproduction, we see the value of different forms of capital as derived from their deployment by specific, socially located individuals or groups. That is, the nature of science capital and the extent to which it can be possessed or realized will be shaped by the identities of the social actors in question (their habitus, structural location and embodied identity) and by field (the social contexts within which it is operationalized). In other words, the meaning and value of a particular form of science capital will vary depending on who is possessing/deploying it and in what context (field).

Sociodicy refers to the rationale that dominant groups in society provide for their privilege, their “theoretical justification of the fact that they are privileged” (Bourdieu, 2010 , p. 119). Doxa refers to a form of symbolic power that is embedded in recognized societal institutions. It comprises a “set of fundamental beliefs which does not even need to be asserted in the form of an explicit, self-conscious dogma” (Bourdieu, 1977 , p. 16). It differs from orthodox or heterodox belief in that doxa does not recognize “the possibility of different or antagonistic beliefs” (Bourdieu, 1977 , p. 164). Doxa presents the immediate social world as self-evident and undisputed and hides the workings of power by ensuring that particular dominant values, practices and ideals are misrecognized as legitimate and meritocratic. In comparison, orthodoxy represents the “official way of speaking and thinking the world” (Bourdieu, 1977 , p. 169), denying competing views (as heresy).

In this paper, we use data from our study to explore the interaction of performances of masculinity, science capital and the orthodoxy (or doxa) of science, as constructed within the narratives of 12/13 year olds boys. We ask, what are some of the fundamental beliefs that these boys hold about science careers (and who such careers are “for”)? We show that science careers are largely seen as only leading to a narrow set of careers (e.g., “scientist”) and as only for the “brainy”—which, within dominant discourse, is aligned with middle-class masculinity. This, we argue, results in science aspirations and participation being experienced as a “natural fit” for many middle-class, academic boys but as “unthinkable” for many working-class boys. The paper therefore aims to provide a new angle on the perpetuation of unequal (classed, racialized and gendered) participation in science and the reasons why some pupils do (and others do not) aspire to post-16 science.

The Study

The ASPIRES project is funded by the UK's Economic and Social Research Council as part of its Targeted Initiative on Science and Mathematics Education. It is a 5-year, longitudinal survey exploring science aspirations and engagement among 10–14 year olds. It comprises a quantitative online survey of the cohort and repeat (longitudinal) interviews with a selected subsample of students and their parents. The survey and interviews are conducted at three time points: Phase 1 was administered at the end of primary school (age 10/11, Year 6) and phases 2 and 3 were administered in the second and third years of secondary school (age 12/13, Year 8 and age 13/14, Year 9). This paper presents data from the first two phases—as phase three data was still being collected at the time of writing. We focus in particular on the phase 2 qualitative dataset (the second round of interviews with pupils when they are in Y8, age 12/13). At points throughout the paper contextual information is provided from the phase 2 survey as a means for framing the qualitative data analysis, although full details of the survey and its methods, analyses and findings are discussed in separate publications (DeWitt et al., 2011, 2012).

The survey collected a range of demographic data (including measures of cultural capital[1]) and covered topics such as: aspirations in science; attitudes toward school science; self-concept in science; perceptions of own and others' gender identity; images of scientists; participation in science-related activities outside of school; parental expectations; parental school involvement; parental attitudes toward science; and peer attitudes toward school and toward school science. The development and validation of the survey instrument and findings from the first survey have been described elsewhere (DeWitt et al., 2011, 2012), which provide further detail on the reliability and validity of the survey instrument, as well as the specific items. The majority of questions used a Likert scale to elicit attitudinal responses.

Each of the surveys focuses largely on the same key topic areas, in order to allow for data comparison, although a few questions were added or adjusted between phase 1 and 2, to reflect changes in the organization of learning in primary and secondary school. In particular, the second survey added items about students' perceptions of their science teachers (because science in secondary school is taught by specialist teachers), about the usefulness of studying science and anticipated reasons for selecting subjects to continue studying when the time comes for them to make those choices (i.e., around age 16).

In the interviews, topic areas broadly mirrored the survey areas in order to explore students' meanings and understandings in more depth but also sought to explore students' experiences and identities more broadly. Topic areas include: constructions of self (in and out of school, interests, learner identity, self-efficacy); experiences of school, experiences of and views on school science, teachers and other subjects, aspirations and the future, formation of aspirations, influences on choices, processes of decision-making, imagined future subject choices; gendered constructions of self and others; extra-curricula activities; images of scientists; achievement and popularity; usefulness of science). Questions were added in phase two to explore the transition to secondary school and comparisons, especially concerning science, between primary and in secondary school. Aspirations, subject choices and post-16 plans were also explored more deeply. Interviewers probed responses to encourage participants to explain their views and to reflect on the potential sources or influences on their views. Interviewers also recorded brief fieldnotes after each interview, to convey additional detail about the interviewee (e.g., appearance, demeanor) and the interview context (e.g., where and when the interview took place). Questions explored what participants understand as being “science” both in and out of school and probed (changes in) interests in different areas of science and related subjects. A complete copy of the survey is available from the authors, as are the interview questions, but sample items can be found in the Appendix.

The first phase of the research was conducted with pupils when they were in Y6 (age 10/11 years). This included a survey, completed by 9,319 students in England, who were recruited from 279 primary schools (248 state schools and 31 independent). This sample represented all regions of the country and was roughly proportional to the overall national distribution of schools in England by attainment and proportion of students eligible for free school meals. Of the students who completed the survey there were: 51% boys, 49% girls; 91% attended state funded schools; and 75% White, 9% Asian, 8% Black, 8% Other and mixed ethnicity. The second phase of the survey was conducted two years later (2011/2012), when participants were in Year 8 (age 12/13 years). 5,634 Year 8 students from 69 secondary schools (58 maintained and 11 independent schools) completed the phase 2 questionnaire between September and December 2011. Again, these schools represented all nine Government Office Regions in England and comprised a range of attainments at Key Stage 3 science (from 2008) and a range of free school meal (FSM) eligibility. In addition, the sample was roughly proportional to the overall distribution of schools in England in terms of attainment (though with fewer in the middle band and more in the second lowest band) and proportion of students eligible for FSM. There were 40% boys, 60% girls, 93% attended state schools; and 711 had also completed Survey 1. Both phases of the survey covered topics such as: aspirations in science; attitudes toward school science; self-concept in science; images of scientists; participation in science-related activities outside of school; parental expectations; parental school involvement; parental attitudes toward science; and peer attitudes toward school and toward school science.

In the first phase of the research 170 interviews were conducted with 78 parents and 92 children age 10/11 (Year 6). Participants were drawn from 11 schools in England (9 state and 2 independent schools). Potential schools were purposively sampled from the list of 279 schools who responded to the phase 1 survey as part of the wider study (see also DeWitt et al., 2011, 2012) to represent a range of geographic and social/economic contexts, including multiethnic urban, suburban and rural schools. Schools were provided with information letters about the project and consent forms to distribute to all parents in the year group. All those who agreed to take part were interviewed. Students came from a broad range of socioeconomic classes and ethnic backgrounds. For phase 2, we managed to follow-up 85 of these pupils when they were in Year 8 (37 boys and 48 girls). These students now attended 41 secondary schools in 9 areas of England and Wales.

Interviews were conducted by the paper authors and a PhD student (Billy Wong), with the majority of the interviews being conducted by the second author. Of the interviewers, three are White middle-class women (with English, American and French national backgrounds) and one was a British-Chinese male. Interviewees were invited to choose their own pseudonyms, hence the majority of pseudonyms cited in this paper reflect the personal choices of interviewees.

All interviews were digitally audio-recorded and transcribed. In line with the study's conceptual approach outlined earlier, data were analyzed using a discourse analytic approach (Burman & Parker, 1993) that is informed by feminist post-structuralism which, as Alldred & Burman (2005) discuss, distinguishes it from more general approaches to discourse analysis (Wilkinson & Kitzinger, 1985). This form of analysis does not attempt a close, “micro” textual analysis but rather focuses on looking for patterned talk (discourses) within the data, attending in particular to the organization of power within the talk and the social implications of particular constructions (e.g., What is the talk “doing”? What is being normalized or defended? Where is the locus on power within a particular construction—whose interests are being asserted? Who or what is being Othered? What is normalized or closed down?). This approach differs from “grounded” approaches in that it is strongly theoretically guided (by the theoretical position outlined earlier).

Initial coding and sorting of the data (on key topic areas, themes and by responses to particular questions—e.g., “gendered constructions of self”; “aspirations”) was undertaken by Authors 1 and 3 using the NVivo software package, with the lead author providing a check on reliability of coded extracts in relation to the specified codes. The lead author then searched the coded extracts to identify discursive gendered performances and patterns of aspirations/relationships with science, which were then tested and refined through successive phases of coding and analysis, iteratively testing out emergent themes across the data set to establish “strength” and prevalence (Miles & Huberman, 1994). These coded themes were then subjected to a more theoretically informed analysis (in line with the stated conceptual framework) to identify interplays of power and practices of power and gendered, classed, and racialized discourses within respondents' talk. For example, initial coding was used to collate all instances where boys talked about their own (and others') identities as boys (e.g., how they see themselves as similar or different to other boys in any respect) and any talk about science which alluded to gendered (or racialized or classed) themes (e.g., defenses or challenges to the idea of science as a “male” pursuit; talk about who tends to like science at school or pursue science careers; references to family or community liking for or engagement with science).

Analysis then explored these data through the lens of feminist poststructuralist theorizations of masculinity—identifying how and where particular tropes of masculinity are being reproduced or resisted (e.g., discourses of hegemonic masculinity as active, independent, strong) and how these intersect with classed discourses (e.g., performances of “laddishness” versus performances of “muscular intellect”). The brief fieldnotes on interviewees that were written by interviewers were also included in this analysis—e.g., where notes had been made of a student's physical appearance and/or their behavior at interview—in order to provide additional background information for the analyses of boys' performances of masculinity (e.g., their performances of style/fashion or “geekiness”). However, in line with the theoretical framework, we understand “performances” as being both verbal and physical (i.e., we primarily looked for boys' verbal performances in their talk—not just at their physical appearances).

By moving back and forth between the data and the theoretical literature on masculinity and once engagement with science was overlaid on to performances of masculinity, this analysis produced five clusters, which between them included all the boys in the study—two which reflected boys who like science and who aspire to continue with it post-16 (“young professors” and “cool” footballer scientists) and three who do hold science aspirations but who have varying degrees of interest in or engagement with science (“behaving/achieving” boys, “popular masculinity” boys and “laddish” boys). In line with the Bourdieusian lens, analysis also focused in particular on boys' negotiations of “cleverness” (and the extent to which this was embraced or resisted, and how it was constructed as relating to “being good at science”) and the extent to which they possessed science-related capital.

Views of Science and Science Aspirations

Our approach understands aspirations as complex, multiple and sometimes contradictory social phenomena (Archer, Hollingworth, & Mendick, 2010). We see aspirations as worthwhile phenomena for analysis due to being socially indicative phenomena (as ways of probing relations of agency and structure within people's lives) and, in some cases, providing probabilistic indications of children's future paths (see Croll, 2008 ; Tai et al., 2006).

Our interest in this paper is the role that identities and inequalities, notably masculinity, can play in shaping children's (science) aspirations. There are many factors that can influence aspirations, and much previous research has focused on children's liking, or dislike, of school science (e.g., Murphy &

Beggs, 2005 ; Ormerod & Duckworth, 1975 ; Osborne, Simon & Collins, 2003). However, we found that in both the Y6 and Y8 surveys, the majority of children reported enjoying their science lessons and gave favorable reports of their science teachers.

It was beyond the scope of our study to collect data from direct observations of participants' science lessons—although existing research provides valuable insights into such experiences are integral to the development of students' science identities (e.g., Carlone, Haun-Frank, & Webb, 2011). But students' self-reported experiences via the survey showed that most students reported positive experiences, with over 70% of students in both the Y6 and Y8 surveys agreeing that they learn interesting things in science. Around 80% of Y8 students also agreed that they have enthusiastic science teachers and that their teachers care if pupils understand the lessons and expect them to do well. Y8 students rated science as their fourth most popular subject (behind Design and Technology, English and Mathematics). Similarly, 68% of Y8 students like their science teacher and 82% believe if they study hard they will do well in science (with 69% of students feeling that they do well in the subject). Only 19% say that they find science difficult. Interviews with Y8 students also confirmed this view—with most students saying they enjoy science classes in secondary school as much as, or more than, in primary school. We also found that in Y8 (as in Y6) children seem to have positive views of careers in science, with 79% believing that scientists do valuable work and the majority agreeing that scientists are respected by society (62%) and make a lot of money (63%).

We did not find any gender differences in terms of boys' and girls' overall self-reported liking for science in either the Y6 or Y8 surveys. In terms of aspirations in science there were also no significant differences in the proportions of boys and girls in the Y8 survey who were classified as “uninterested in science,” that is, disagreed with all aspirations in science items (5.5% of girls and 5.5% of boys) and as “science keen,” that is, agreeing with all items (1.9% girls, 2.6% of boys).[2] More specifically, the survey contained five items which, together, were identified statistically as forming a component (or latent variable) which we termed “aspirations in science.” These items were: When I grow up I would like to work in science; I would like to study more science in the future; I would like to have a job that uses science; I would like to become a scientist; and I think I could become a good scientist one day. Multilevel modeling, a form of regression analysis that takes into account the nesting of students within schools, was also used to explore the aspirations in science latent variable in more detail. These analyses reflected that in the Year 6 survey, being female was associated with lower scores on the aspirations in science latent variable, but only marginally (with just a small effect size of 0.13). In the Year 8 survey, being female continues to be associated with lower scores on this latent variable, but the effect size is still small, at 0.17.

Overall, survey data reflected that pupils in both primary (Y6) and secondary (Y8) schools appear to like science and hold largely positive views of scientists. And yet we also found that science careers are not popular aspirations among boys or girls. Less than 17% of Y6 pupils agreed that they would like to become a scientist in the future. This percentage remained low in the Y8 survey (14.5%), although other STEM careers are more popular, such as inventor and engineer. Moreover, this lack of enthusiasm seems to be quite specific to the idea of “becoming a scientist,” as students are more interested in “having a job that uses some science” (28.5% in Y6, 32.4% in Y8), and studying “more science in the future” (40.0% in Y6, 42.9% in Y8). That is, it would seem that students are quite specifically resistant to “being a scientist,” rather than science per se. Indeed, “scientist” was one of the least popular aspirations among pupils. As detailed in Figure 1, when asked to rate a sample spread of future career options, business appeared to be the most popular aspiration among Y8 pupils, with 62% agreeing they would like this future job (*cf* . Sports 39%; Performing arts 53%; Doctor 35%; Inventor 26%; Engineering 25%; Scientist 15%). Sports, inventor, engineer and scientist were also strongly gendered, with much high proportions of boys aspiring to these professions. Higher proportions of girls than boys aspired to arts careers. Moreover, despite Y6 and Y8 boys and girls appearing to express a similar liking for science, a gender difference emerged in terms of boys' and girls' STEM (and non-STEM) aspirations, with boys more likely than girls to aspire to careers in science and engineering. Indeed, science careers were associated with masculinity by over 50% of interviewed parents (see Archer et al., **2012b** , Archer, Dewitt, Osborne, et al., **2012b**).

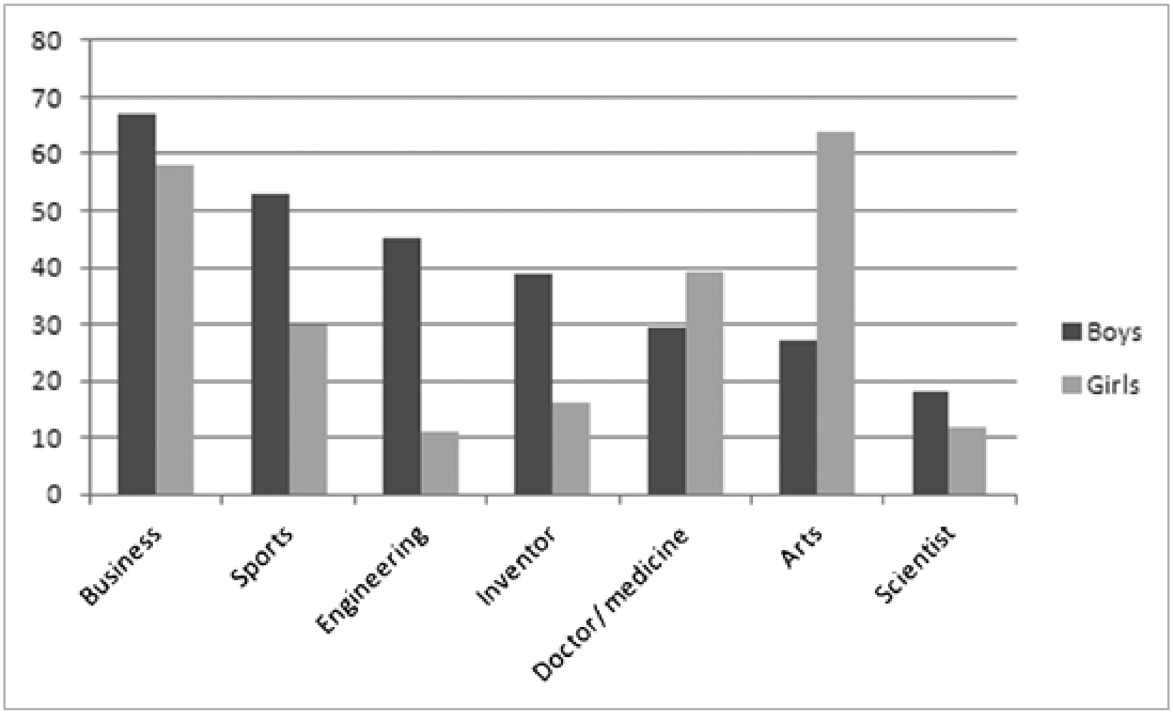

Figure 1.

Open in figure viewer

Aspirations of children aged 12/13. Percentage of boys and girls agreeing that they would like to do this job in the future.

In other words, our data indicates that despite liking school science, expressing generally positive views about science careers and reporting that their parents also value science, relatively few of the children in our sample aspired to careers in science, with science careers rating far lower than many other types of aspiration. Moreover, despite little or no gender differences in terms of children's liking of science, boys appear more likely than girls to aspire to STEM careers. In this paper we attempt to explore boys' science aspirations further through the Y8 interview data, seeking to understand the interplay of identities and inequalities that renders STEM aspirations more “thinkable” for some boys than others.

Y8 Interviewee Boys' (Science/Related) Aspirations and Performances of Masculinity

To understand differential patterns in aspirations better, we categorized the stated aspirations of our Y8 interviewee boys into sports (*n* = 8), Arts (8), other professional (7), medicine (6), business (5), armed forces/security (5), engineer (4), science (5), skilled manual trade (3), IT (2). These were mapped on to their accounts of engagement with/liking for science, see Table 1.

Table 1. Categorization of interviewed boys' aspirations and masculinity discourses

	Number of boys	Class/ethnicity	Main masculinity discourses
Boys with science aspirations (boys who expressed aspirations for careers *in* science)	6	1 South Asian; 5 White; 2 upper/middle-class, 3 lower middle-class	“Young professors” (2)
		1 Working class	“Cool/footballer scientists” (4)
Boys with science-related aspirations	7	3 South Asian; 1 mixed Asian/White; 1 Black African, 2 White	“Young professors” (3)
		4 upper middle-class; 2 lower middle-class; 1 working class	“Cool/footballer scientists” (4)
“Interested but …” boys (i.e., boys who are interested in science but do not hold science/related aspirations	21	17 White, 3 black African, 1 South Asian boy	“Normal” boys (9)
		6 Upper middle-class; 2 middle-class, 3 lower middle-class, 9 working class, 1 d/k	“Good boys” (8)
			“Laddish” boys (4)
“Anti-science” boys (boys who express a dislike of science and/or science aspirations)	3	1 Black African, 1 Portuguese, 1 Polish All working class	“Laddish” boys (3)

The boys' performances of masculinity were analyzed, classified and mapped these on to the above orientations to science aspirations. Although there are obviously slippages, overlaps and inconsistencies within and between these performances—they are not proposed as discrete “types”—our analysis generated five discursive performances, or constellations, with particular characteristics, which are denoted in the right hand column, termed: “young professors,” “cool footballer scientists,” “popular masculinity boys,” “behaving/achieving boys' and “laddish boys.” These are now discussed in turn, beginning with those who expressed science and science-related aspirations. We identified two main identity discourses/performances of masculinity among those with science/related aspirations: “Young professors” (*n* = 5) and “Cool/Footballer Scientists” (*n* = 7). We then move on to discuss those boys who did not hold science aspirations, the “interested but.” and “anti-science” categories, whom we identified as performing either “popular masculinity” (*n* = 9), “behaving/achieving” (*n* = 8) or “laddish” (*n* = 7) masculinity.

Young Professors

There were five boys (Bob, Neb, Robert M, Tom4, and Victor2) who we categorized as performing “young professor” identities. The “young professor” label is used to try to convey the intellectual and academic nature of these boys' identity performances, which were characterized by a pride in, and a foregrounding of high academic achievement and a comparative lack of interest in popular culture. Of the five, Bob was mixed White/South Asian, Tom4 South Asian and the others White British. Four were from upper middle-class, professional families and one, Victor 2, from a lower middle-class family. Two aspired to careers in science: Neb wanted to be a quantum physicist or astronomer and Victor2 wanted to be a science teacher. The other three boys aspired to science-related careers, with Tom4 aspiring to medicine, Robert M aeronautical engineering and Bob electronic engineering. All these boys strongly identified themselves as high-achieving, “clever” students. For instance, Tom4 drew attention to his “gifted and talented” status in both his Y6 and Y8 interviews and Victor2 was proud of the school's recognition of his academic achievement, saying “I don't mean to boast, but I won Male Student of the Year.” These boys performed a highly academic, “boffin” (Francis et al., **2010**) version of masculinity that was characterized by frequent displays of knowledge and superior intellect, particularly in relation to science and mathematics. These performances privileged rationality and constructed an alignment between their own academic interests and values and those of the school/education system. The young professors described themselves as always abiding by school rules. They also commonly positioned themselves as “mature,” on account of their academic interests, which they contrasted with the “immature,” “anti-education” attitudes of their “laddish” peers. They also differentiated themselves through their self-confessed “geeky,” “nerdy,” less fashionable or “eccentric” styles of hair and clothing.

It was notable that four out of the five boys were from upper middle-class backgrounds. Neb, Tom4, and Robert M performed aspects of “muscular intellect,” confident/arrogant displays of intellect (Francis et al., **2010** ; Mac An Ghaill, **1994** ; Mac an Ghaill & Redman, **1997**), conveying a confident self-assurance and pride in their abilities. They had ambitious aspirations, for instance, Neb aspired to become a quantum physicist and Tom4 wanted to study maths or medicine at Cambridge, and they were entirely confident that they would be able to achieve these dreams. In contrast, Victor2 and Bob presented themselves more as quiet, sometimes “geeky,” high-achieving boys. For instance, Bob, who aspired to be an electronics engineer, was painfully shy and monosyllabic in his interviews. Victor2 recognized that his identity performances are different from other boys at his school, saying “I sort of act different to them because. I don't like getting in trouble […] I've been called a geek quite a … and a goody two shoes quite a lot.” His mother concurred that “he's … quite a sensitive boy, sort of a bit scared of getting told off and that kind of thing.”

As Bourdieu argues, each field has its own logic of practice and these boys move within the science education field "as a fish in water" (Bourdieu & Wacquant, 1992). They enjoyed a close fit between their performances of masculinity and their visions of careers in/from science. This congruence was exemplified particularly well by Neb—who presents himself as both highly academic and as slightly eccentric, with hair that is long and "wild" on top, saying "I think my hair would suit the job as a mad scientist!" Upper middle-class boys were disproportionately represented among the young professors, with habitus and capital interacting (Archer et al., 2012a) to promote science aspirations. Their families tended to possess ample science capital and provided resources and capital in projects of concerted cultivation (Lareau, 2003) to help boys see science as interesting and valuable and to help them develop practical competencies in science through a range of social contacts and extra-curricular activities (Vincent & Ball, 2007). These boys also described how "everyday" family conversations were often geared toward "strategizing" for their futures.

Victor2 was the only boy in this grouping not from an upper middle-class background. He came instead from a lower middle-class family and neither of his parents held degrees. He was also different in that he aspired to become a science teacher, rather than a more socially prestigious "scientist." He explained that this marked a change from his previous Y6 interview, when he admitted "I wanted to be a scientist." For Victor2, becoming a science teacher felt more achievable, reflecting, "so I'm thinking if I become a Science teacher, I can teach what I know." His words convey a trace of a lack of confidence, especially compared to the confident predictions of his upper middle-class peers, such as Tom4 who is quoted above, reflecting on the safer route of sticking to the "known." As discussed by Archer et al. (2010), other research has identified similar instances of working-class and minority ethnic young people and their families discussing their aspirations by advocating sticking to "safe routes" as a means for managing risks generated by social inequalities. Victor2 also notes that his parents are "neutral" about his science aspiration—whereas the other young professors recounted notable parent support for their science aspirations. Given that Mujtaba & Reiss (2012) identify the importance of at least one key adult in sustaining progression into post-16 science, this could indicate a precariousness to Victor2's progression, which he is minimizing through pragmatic reformulation of his science aspirations.

"Cool"/Footballer Scientists

Eight boys (Ali, Colin, Gerrard, Indiana, Josh, Kaka, Football Master, and Yogi) were categorized as performing "cool"/footballer scientist identities. The term "cool/footballer scientist" attempts to convey how these boys simultaneously balanced science aspirations with performances of popular masculinity. In terms of ethnicity and social class, three boys, Josh, Indiana, and Football Master, are White British, Gerrard is White Eastern European, and three boys, Kaka, Yogi, and Colin, are South Asian. One boy, Ali, is Black African. They represented a range of class backgrounds, from Yogi's middle-class professional background to those like Ali, who came from working-class, acutely economically disadvantaged backgrounds. Four boys expressed science aspirations: Gerrard and Kaka aspired to become scientists, Indiana wanted a job that was "something to do with science" and Josh aspired to become a marine biologist. The other four boys aspired to science-related careers: with Yogi and Ali aspiring to become engineers, Colin wanted to become a doctor and Football Master aspired to become a vet.

These boys' identity performances were characterized by a "balancing" of their science/related aspirations (and the concomitant "good boy," academically achieving identity integral to these) with performances of popular, heterosexual masculinity (Francis, 2000; Francis et al., 2010). The boys went to some length to emphasize how their science interests are balanced by an interest/competence in sports, especially football, and/or other markers of "cool," popular masculinity, such as being trendy/fashionable and "having a laugh" (Francis, 2000). They tended to cite the same interests as those who were classified as performing "popular masculinity," who are discussed below, as namely liking sports/football and video games—but the cool/footballer scientists also fore-grounded their love of science. They were able to draw on particular markers/signifiers of popular hetero-masculinity in order to counter any potential allegations of "geekiness" that might be leveled at their science interests. For instance, Gerrard was a physically tall, well-built boy who was good at sports, notably football. He explained:

> No one could say I'm a geek because when they look at my size then […] yeah and that [being good at football] really helps me, yeah … yeah cos otherwise if I was no good at sport then people would think I'm a geek, yeah. (Gerrard, Y8 interview)

However, the limits of such performances were also noted when, during the interview, Gerrard was observed to become uncomfortable and "clammed up" when another, popular student came into room. This silencing suggests the precarious, contextual nature and limits of being able to resist a "science geek" positioning. That is, Gerrard still needs to be careful not to make his love of science *too* explicit to his popular peers.

As Francis et al. (2010) explain, high-achieving popular pupils tend to be able to draw on particular embodied, gendered resources, such as good-looks and being fashionable/good at sport, to balance their "feminized" academic achievement with social popularity (see Skelton & Francis (2005) for full discussion on the "feminization" of education). These students tended to present themselves at interview as assertive and sociable individuals who were confident in their social interactions with adults and classmates and were particularly confident in their own high academic abilities. High achieving popular middle-class boys tend not to be seen as "macho" but rather perform assured, "rational" versions of calm/mature masculinity. As Francis et al. (2010) point out, this echoes other research which identified how some middle-class boys perform masculinity through "muscular intellect (Mac An Ghaill, 1994; Mac an Ghaill & Redman, 1997), with confident/arrogant displays of intellect.

Josh explained how he balanced his academic interest in science with "having a laugh," a key performative aspect of "laddishness." Although crucially, as noted by Francis et al. (2010), high-achieving popular pupils, like our science-aspirant boys, do not perform laddishness excessively nor in ways that challenge teacher authority:

> I like to have a laugh, cos although I'm sensible, I'm not like completely sensible or … I have a joke every once in a while. (Josh, Y8 interview)

Despite performing similar "cool" scientist identities, social class clearly structured the boys' abilities to capitalize on and realize their aspirations. For instance, Yogi, a South Asian, middle-class boy, balanced his engagement with science and academic achievement through a confident performance of being “trendy,” which was facilitated in no small part by his social class and the economic and social capital invested in him by his family. Yogi discussed at length his involvement in music producing and DJing, with tales of meeting music producers and DJs, all facilitated by his father's extensive social capital. He also proudly described his fashionable taste in clothes, which was aided by his mother's career, and his “cool” masculine leisure activities, such as skateboarding (“I'm really into science but I'm also into skateboarding and stuff like that”), which he also undertook with his “cool” dad, whom Yogi described touchingly as his “best friend.” He was clearly driven by a desire for success, admitting “I want to be good at everything and if I'm not the best, I always try harder to be the best.” But he also recognized his own class privilege to some extent, reflecting “I think I'm really lucky for what I have, yeah.”

In contrast, Ali, a Black African working-class boy, aspired to be a “car engineer,” designing car engines. He felt supported by his family, saying “My mum wants me to be an engineer and my dad wants me to be a doctor or an engineer,” and he enjoyed science at school. Yet his family, who were refugees from Somalia, possessed no real science capital. Ali's class location appeared to mediate his relationship with science and the future in that, like other disadvantaged urban pupils (Archer, Hollingworth, et al., **2010**), he held only provisional aspirations and was unsure whether he would continue with science post-16, regarding participation as dependent on his academic achievement. Ali also pondered whether he would be able to choose to study science as part of his optional subjects choices, made usually when students are in Y9, for the General Certificate of Secondary Education (GCSE) national examinations at age 16, saying “If I get good grades in Science I might choose it for my like GCSEs.” As this extract illustrates, Ali lacked science capital and was seemingly unaware that it is mandatory for all students in England to study science at GCSE—although there are different options available regarding how much and what form that science will take.

The “Behaving/Achieving” Boys

These eight boys (Bill, Bobster, Cheeky Monkey, Clay, Dave, Finch Raza, Tom3) all fell within the “interested, but …” category. The term “behaving/achieving boys' attempts to convey how these boys all performed identities that are academically and behaviorally aligned with the values of school and the education system in general—they perform “good” student identities, as defined within dominant educational discourse. They tended to perform “quiet” and “restrained,” academic masculinity that were often “artistic” rather than traditionally hegemonic. In terms of social class, the boys were classified as 4 upper middle-class; 1 middle-class; 1 lower middle-class; and 2 working-class. All categorized themselves as White British, although Finch's father was of mixed White/Asian heritage. Their identity performances were characterized by self-descriptions as being “good,” well behaved and academically achieving, quiet boys at school. They tended to express a strong interest in science and talked about the importance of science for knowledgeable citizenship—indeed, these boys often described engaging in science-related activities in their spare time and half of them had substantial science capital within their families, with parents employed in scientific jobs. Raza, an Indian, upper middle-class boy, provides a particularly clear example of this performance of “quiet, behaving/achieving boy” masculinity. Raza is a pleasant, thoughtful boy who describes himself as different to many of the boys at school because “I like to do quiet sort of activities.” He achieves well academically and is well behaved at school. Although science bears no direct relationship to his ambition to be an author, he likes science and plans to take the prestigious “triple science” qualification at GCSE. Triple Science refers to the study of three separate science subject qualifications taken in national examinations at age 16. As the most substantial and high status science GCSE option available it tends to be a route that is only open to the most academically successful students, with many schools making the choice as to which students are allowed to study Triple Science, or not. Raza explains that he aspires to study Triple Science at GCSE and plans to take at least one science post-16, at A Level:

> I think it will be useful because [then] I'll have a better understanding of the world and how things work. Because, obviously I don't want to be caveman who doesn't know how fire works … I want to know more, it's nothing to do with my career, it's just I want to have more knowledge of the world.

While they may not aspire to careers in science, and in this respect could potentially be classified as “lost potential” from a science pipeline perspective, these boys are highly engaged with science and, we would predict, appear set to attain good levels of scientific literacy and science capital. In this respect, we would suggest that they are “successes” for science education, rather than policy “problems.” Yet it is still interesting to note that despite being highly engaged with science and espousing what ostensibly might be called “science identities”—valuing science, seeing themselves as good at science and planning to study science post-16—they aspire to other areas. That is, these boys appear to complicate the relationship between science identity and science aspirations, as their identification with science and their plans to study science post-16 do not translate into science aspirations. There appear to be two reasons for this. First, there may be a question of identity and perceived aptitude, for instance, several of the boys had “artistic”/creative aspirations: Clay aspired to become an artist, Raza and Bill wanted to become writers, Finch aspired to be a professional classical musician and Tom3 aspired to a job as a cricket player or commentator. All boys were also able to point to evidence of personally excelling in these areas. Second, it was notable that the other three boys, Bobster, Cheeky Monkey, and Dave, aspired to careers for which they had considerable family social capital, that is, family members or family friends already working in these jobs in architecture, the armed forces; and business, respectively. We return later in the paper to the importance of capital, but as we discuss elsewhere (Archer, Dewitt, et al., 2013), family capital was the single most important source of influence on aspirations within the sample.

“Popular Masculinity” Boys

These nine boys (Alan, Buddy, David, Gus, Hedgehog, Indiana, Mactavish, Roger, Wayne) all fell within the “interested, but …” category. The term “popular masculinity” is used to convey how these boys' identity performances are strongly orientated to producing normative, hegemonic, but not extreme, versions of masculinity that emphasize engagement with popular “masculine” leisure pursuits. In terms of social class, they were classified as two upper middle-class; one middle-class; two lower middle-class; three working-class; and one boy was un-assignable due to lack of data. Eight were White British and Alan was of mixed (White/Black) heritage.

They shared a propensity to portray themselves as "normal" boys, emphasizing their similarity to their peers, as typified by a near universal identification with liking "football and computer games." They tended to exhibit "respectable" but not necessarily excessive academic achievement and they tended to like science, but did not want to "be a scientist." These boys are well exemplified by David, a white British, lower middle-class boy, who describes himself as similar to other boys "they're the same as me "cos they all like football and games consoles and that." David has aspirations in business or sports and describes himself as a good student, saying "I just get on with work and do it." Like the other boys in this group, David generally likes science at school but has no interest in following a career in science, saying "it doesn't really appeal to me." Like others in this category, David links a career in science to "being a scientist," which as Buddy explains, is not appealing: "I like science but I don't particularly appetise (sic) myself with the thought of becoming a scientist." In this sense, they differed markedly from the "behaving/achieving" boys, discussed above, who were more likely to proffer a discourse of "science for citizenship."

"Laddish" Boys

These seven boys (Cristiano, Jack, Jake, Ghost, Michael, Tom2, Tom[3]) were classified as performing "laddishness" to some extent. As Francis (**1999** , p. 357) explains, the notion of the lad/laddishness evokes "a young, exclusively male group and the hedonistic practices popularly associated with such groups … for example, "having a laugh" […] disruptive behaviour, objectifying women and an interest in pastimes and subjects constructed as masculine" (e.g., football). Within schools, laddishness has been associated with disruptive classroom behaviors and a lack of interest in learning and visible displays of "not working" (Jackson, **2006**). The term has also been extended to girls, termed "ladettes," who perform aspects of laddishness, notably hard drinking, swearing and displays of not engaging with academic work (ibid.) but is used here in its original, masculine configuration. The boys identified in the present study as performing laddishness were all from working-class backgrounds and four were Black African, one White British, and two White European.

There was variation within this small group of boys in terms of the extent of their performances of laddishness and academic achievement, some being milder or more extreme than others, with the "anti-science" boys describing the most problematic relationships with education and school. But they all held in common performances of "laddish" masculinity in terms of downplaying academic effort/attainment and "messing about" in class. This group of boys were the most likely to describe school or particular lessons as "boring," tended to report mid to low achievement and many described being disruptive in class. For instance, Jack, a Black, North African working-class boy, admitted "I can't say I'm a good student" on account of his mid to low achievement and frequently being asked to leave lessons due to being disruptive. Tom2, a Black African working-class boy, describes school as "boring," explaining "I get in trouble a lot … I've been excluded a couple of times …for getting into fights." Similarly, Tom doesn't like science, which he describes as "basically every lesson is boring," and admits to messing about in class, saying "it's boring, what's the point of doing science GCSE?"

Michael was the only boy in our Y6 sample to say that not only did he find school science "boring" but even at one point claimed to "hate it." His views had changed little by his Y8 interview, when he reiterated “I don't really like school, cos I don't like learning.” Ghost, as in his Y6 interview, in Y8 he says that he still likes “chilling” and being “lazy” and getting into trouble at school: “I like messing about … I think it's funny how they [teachers] just go mad at you and you don't care … I have a lot of issues with teachers in this school.” In line with existing literature on laddishness, which describes how many laddish boys report hiding their work “secretly,” working “undercover” (e.g., Frosh, Phoenix, & Pattman, **2002**), Ghost admits “like I know stuff but I hide it.” He does have some interest and engagement with science, but largely only in terms of a “laddish” form of engagement, such as doing the popular “Coke and mentos” explosive experiment.[4] As Ghost explains, “I like blowing stuff up.”

There was a notable over-representation of minority ethnic and working-class boys among those performing “laddish” masculinity. In line with existing academic work, minority ethnic boys, but especially those from Black backgrounds, tend to experience particularly problematic relationships and sustained inequalities within the education system and attention has been drawn to how their performances of masculinity are often “demonized” within mainstream educational discourse (e.g., Archer, **2008** ; Gillborn, **2001** ; Youdell, **2003**), with the source of problematic behavior/attainment being located within the individual or “culture,” rather wider social structures. Such boys also tend to be placed in lower ability sets at school, which research has associated with providing a less interesting and challenging curriculum, lower teacher expectations, and as more likely to be taught by less experienced teachers and/or teachers with lesser subject expertise (e.g., Boaler, Wiliam, & Brown, **2000** ; Slavin, **1990**). In this respect, it is perhaps unsurprising that these students are less likely to report being engaged by school science. Yet as our analyses suggest, the boys' performances of macho, laddish masculinity—which of course may be in part both a product of and response to their experiences of being in the lowest sets—also meant that their identities sit in binary opposition to dominant associations of science and science careers, which are aligned with middle-class, academic (“boffin”) masculinity.

Several of these boys also articulated future aspirations that epitomized elements of hegemonic masculinity, such as strength, bravery and machismo, for instance becoming a footballer, dreams of “getting rich,” or jobs that involved notions of danger and violence. For instance, Ghost aspired to join the army or RAF, saying “I just like guns … I like shooting people … I'd drive a tank in the war just to like blow someone's head off.” In both his Y6 and Y8 interviews, Michael aspired to “violent” careers as either a bouncer (Y6) or a security guard (Y8), because as he explained, “I like getting involved in fights.”

They described varying degrees of interest in science generally, but were all uninterested in following a career in science. For instance, Tom2 was adamant “I don't want to be a scientist, it's boring being a scientist.” They largely perceived science as having little relevance to their future careers. For instance, Michael reflected “Science won't really help me, nothing that I need for a job.” Science was also not seen as cool or a viable form of masculinity among these boys. For instance, Michael suggested “I don't know no people that are into Science” and Ghost described people who are really into science as “nerds.”

The final step in our analysis sought to identify discourses that might illuminate how science/careers are being constructed and which might help explain some of the patterns in terms of who can/not see a career in science as “for me.” Our analysis identified two key, cross-cutting elements (1) popular constructions of science as “brainy”/“smart” and (2) the uneven social distribution of “science capital.”

Science as “Brainy”

We found that science careers are strongly associated with cleverness, with over 80% of children in both surveys agreeing that scientists are “brainy.” We also found in our interview sample that many girls and boys who aspired to science careers tended to see themselves (and were described by their parents) as “clever.” Students who liked science but who did not consider it a career “for me” were more likely to self-describe and/or be described by their parents as “normal” or “middling” students. In other words, most children seem to see careers in science as only for the exceptional (“brainy”) few. Of course, this is not an arbitrary association, but is reinforced and perpetuated by institutional structures —for instance many schools in the UK do not allow students to take advanced level (A level) science qualifications unless they have achieved the top grades in GCSE examinations at age 16. Yet this is not the case in many other non-science subjects, in which students are more likely to be allowed to progress to advanced study having achieved lower pass grades at GCSE (DfE, **2012**).

As discussed above, it was notable in our interview sample that among those boys who aspired to science/related careers (exemplified particularly clearly among the “Young professors”), academic prowess was fore-grounded within their performances of masculinity. That is, they performed explicitly “intellectual” identities in which their sense of self is bound up with high academic performance. In parallel to this, 12 of the 25 boys without science/related aspirations actually articulated the view that those who are into science tend to be “clever” or “smart” (e.g., “smart people is good at science,” Tom) and felt that this was at odds with their own learner identities (as either “normal” or “not the smartest”). For instance, Hedgehog explained “I'm not the baddest and I'm not the goodest […] I'm not like the not smartest.” Mactavish talked about how “my family aren't to be honest all top of the block, smart” and Jack simply said “I'm not brainy.” As Alan put it, “most people who like science are really good at everything, like them subjects. I just don't really talk to them.” In comparison to their peers, these boys were more likely to describe people who are “into science” as: “They're clever and they know a lot about it” (Tom2); “they'll be clever … and they will be dressing like nerds” (Michael); and “I try to use this in the softest way possible, I don't mean it in the really insulted way, but a smarty pants or know-it-all” (Buddy).

Considerable academic attention has been drawn to how cleverness is a gendered (e.g., Francis & Skelton, **2005**) and/or classed discourse (Bourdieu, **2010** , p. 119). As Bourdieu asserts, notions of competence lie at the heart of the current educational sociodicy and form part of the structure of class distinction and preservation of privilege between the elite and the mass. He suggests that alongside the more long standing distinction within sociodicy between the deserving and undeserving poor, is a new, contemporary, intellectual justification:

> The poor are not just immoral, alcoholic and degenerate, they are stupid, they lack intelligence. A large part of social suffering stems from the poverty of people's relationship to the educational system, which not only shapes social destinies but also the image they have of their destiny. (Bourdieu, **2010** , p. 119. Emphasis added)

In other words, hidden injuries of class (Sennett & Cobb, 1977), as inflicted within the education system, appear to be integral to conceptions of these boys who are coming to see science as not part of their futures. Moreover, we suggest that from a Bourdieusian perspective, the dominant, prevalent association between science and "cleverness" might be read as a form of orthodoxy (if not a doxa) in that it represents a hegemonic view of science that is prevalent and widely reproduced—indeed, the association between science and cleverness almost "goes without saying." Conversely, boys performing "young professor," "cool/footballer scientist;" and "behaving/achieving boy" versions of masculinity all experienced relatively unproblematic relationships to achievement and concomitantly experienced a continuity or "fit" between their identities and potential future science careers. In other words, for these boys science careers are "thinkable" and possible, even if their personal interests and preferences lie elsewhere. We suggest, therefore, that there is a prevalent, popular association (supported and perpetuated by institutional structures) between science careers and "cleverness" which leaves little room for "average" or "middling" students to imagine a future for themselves within a science/related career and consequently renders science aspirations the preserve of the "academic elite."

Science Capital

In a previous paper (Archer et al., 2012a), we explored interactions of family habitus and capital among the Y6 parents and children in our sample, examining the implications of these interactions for the development of children's science aspirations. This analysis showed how the possession of science capital, but particularly where it interacts with middle-class family habitus that promotes the concerted cultivation (Lareau, 2003) of children, greatly facilitates the development of 10/11 year old children's science aspirations.[5] Here we extend this work further, with evidence that to indicate that a notion of "science capital" may also be useful for helping to explain patterns in children's science aspirations over time. As detailed earlier, we define "science capital" as science-related qualifications, knowledge/understanding, interest, literacy and social contacts. It is a symbolic form of capital with an exchange value in the labor market due in no small part to it being a high status qualification that acts as a signifier of academic ability and competence. Science capital also conveys symbolic value as a marker of "knowledgeable citizenship."

Building on our earlier analysis, we suggest that the analysis of the development of boys' aspirations over the 10–13 age period shows that a "lack" of science capital (especially where augmented by wider inequalities in capital and a disconnect between habitus and field) increases the challenge for children to sustain and persevere (and achieve) science aspirations, as it positions these families at a considerable disadvantage within the educational field.

> A field is a structured social space, a field of forces, a force field. It contains people who dominate and others who are dominated. Constant, permanent relationships of inequality operate inside this space, which at the same time becomes a space in which the various actors struggle for the transformation or preservation of the field. All the individuals in this universe bring to the competition all the (relative) power at their disposal. It is this power that defines their position in their field and, as a result, their strategies. (Bourdieu, 2010,

p. 37)

Although we found generally low levels of science capital across the families in our study at age 10/11, the more recent, detailed analysis presented in this paper indicates that it was particularly acute among the "popular masculinity" and "laddish" boys—with anti-science boys possessing little or no familial science capital. One of the consequences of this is that many children and their families do not recognize the transferable nature of science (as a qualification with a high exchange value in the labor market). Within the field, they do not have the same capital and strategies as those who possess high amounts of science capital. For instance, as Buddy repeated at several points during his interview, he would not choose to study science post-16 as "what would I do with science?" Alan also concurred, reflecting "there's no point doing [studying] Science and then getting a job that doesn't use Science." They had little awareness of the diversity of potential careers from science (science qualifications were largely seen as only leading to careers of scientist, science teacher or doctor), unlike families with high amounts of science capital, who were able to deploy their knowledge and resources more strategically (see Archer et al., 2012a). Indeed, despite liking school science, only 43% of children in the Y8 survey agreed that they would like to study more science in the future. When asked to identify the most important reasons for choosing subjects to study in the future, over three quarters (76%) identified the usefulness of a subject for their future careers as being the first or second most important factor. Only a fifth thought that "how well I do in the subject" would be the most important consideration when making subject choices, with less than 15% citing liking/enjoyment of the subject as the key reason.

Discussion

In this paper we have sought to contribute to existing debates around STEM participation through a relatively novel examination of the role of masculinity within boys' negotiations of science aspirations. We have explored interactions of gender and social class within a sample of Y8 boys' aspirations and relationships to science, identifying how their performances of masculinity interact with capital and other factors to produce particular, predictable patterns in terms of which boys see science careers as potentially (not) "for me."

We suggest that our analyses add to understandings of gender and science education by showing how the equation of science and masculinity, while strong, is cross-cut by social class. In other words, it is not simply that the association of science with masculinity dissuades many girls from seeing science as a possible or desirable future career path, but that the close association between science and middle-class, "academic" masculinity also dissuades working-class boys (and is particularly alienating for working-class girls, Archer, Dewitt, Osborne, et al., 2013). We suggest that our findings show that—irrespective of their "liking" of science—boys' performances of masculinity may facilitate or constrain their engagement with science and the extent to which science can be envisaged as a possible or desirable future career path and that this is patterned along class lines. That is, boys who perform "geekier," highly academic masculinity are more likely to experience science as desirable and congruent with their sense of self and are, accordingly, more likely to express science aspirations (the "young professors") or plan to study science post-16 because they value it for informed citizenship, irrespective of their aspirations (the “behaving/achieving” boys).

In contrast, while many boys who perform “popular masculinity” may like science, they do not see it as a desirable or conceivable career aspiration. Laddish boys are particularly unlikely to report enjoying science and we suggest that the dichotomy between popular, hegemonic working-class masculinity and “brainy,” middle-class masculinity (which is associated with science) renders science aspirations particularly “unthinkable” for these boys. For working-class boys in general, the uneven distribution of “science capital” along class lines also contributes to narrow views about the potential value of science qualifications (e.g., their transferability in the labor market) and a further reinforcement of the notion that science is “not for me.”

Our analyses of the “behaving/achieving” boys' accounts also complicate, to some extent, any assumed simplistic relationship between science identity and science aspirations. That is, for these boys, being highly engaged with science and aspiring to study post-16 science does not translate into science-related aspirations. For these boys,” competing personal preferences and aptitudes in other areas can take precedence. Of course this is only a “problem,” as a potential “waste” of talent, from a pipeline perspective—from a scientific literacy perspective, these boys' strong valuing and practice of science for citizenship could be read as a “success” for society. Yet their accounts also underline the importance of family science capital in both facilitating and enabling science identities—whether for science aspirations or citizenship—and in the formation of aspirations more generally.

Of course, inequalities in science capital and the “brainy” image of science are issues which render science aspirations less conceivable and achievable among working-class students in general—that is, they affect both boys and girls. And as our analyses here and in our “sister” papers have shown, both girls and boys who express science aspirations tend to be middle-class and perform highly academic identities. However, our data hint at a further potential gender difference: we found (Archer et al., 2012b) that among girls that in Y6, “bluestocking” (non-girly, highly academic) performances of femininity far outnumbered those of “science femininity (girls who sought to “balance” their scholarliness and interest in science with performances of popular “girly” femininity), by 16:6. But by Y8, there was only one girl who still held expressed science aspirations and who was performing popular femininity (the remainder of those who still held science aspirations were performing “bluestocking” femininity). In contrast, as reported in this paper, Y8 boys who expressed science aspirations were more evenly balanced between “young professor” and “cool/footballer” scientist performances (by 5:8). Because of the small numbers involved, this comparison inevitably needs to be treated with extreme care—however, it does raise the possibility that science aspirations may be more prevalent and sustainable among boys because the alignment of science with masculinity affords a greater range of potential “ways of being” for boys (e.g., “geeky” versus “cool”), but which becomes increasingly constrained for girls (due to a tension between popular femininity and the masculine-ness of science which amplifies during adolescence).

But why do science aspirations actually matter? It may be contestable as to how many future scientists the economy needs (Lowell, Salzman, Bernstein, & Henderson, 2009 ; Xie & Killewald, 2012), but we would suggest that there is a strong equity argument for the imperative to widen participation in STEM, not least given predictions of a growing STEM skills gap (CBI, 2010) and that one of the main areas of growth and demand in the UK economy will be for STEM professionals (HM Treasury, 2011 ; UKCES, 2012). Our position is not that children need to be encouraged to make “different” (or the "right") choices (i.e., those valued by the dominant groups in society). Rather, we feel that there are important equity issues at stake. Widening participation in STEM is not only beneficial for the STEM "pipeline" (the supply of professionals to work within STEM fields of employment) and the UK economy, but also for increasing the scientific literacy of the general UK population. Both are desirable because we view scientific literacy as an important form of symbolic capital. Bourdieu suggests that:

> The goal of education is to offer the means of becoming a good citizen, of putting individuals in a position to understand the law, to understand and defend their own rights, to set up unions … We must work to universalize the conditions of access to the universal. (Bourdieu, **2010**, p. 60)

To this we would add that in the current technological age, especially in western developed nations such as Britain, which seek to establish themselves as knowledge-intensive economies, "science" is attributed a particular symbolic weight/value. Not only can scientifically literate individuals access favorable (high pay and status) jobs (Greenwood, Harrison, & Vignoles, **2011**) but there is an added imperative for citizens to be able to understand, participate in and shape, scientific developments in society. Yet science is not currently open "to all" as an identity option. Not everyone will want to choose to study science post-16 or pursue a science career—but everyone should be equally able to make these choices. This is an important equity point because science is a key form of symbolic capital which can facilitate agency and the re/production of privilege. As August Compte argued "science leads to foresight and foresight leads to action" (cited by Bourdieu, **2010**, p. 50). As we have discussed in this paper, seeing science and science careers as "for me" is not simply the result of personal preferences or aptitudes—it is profoundly inflected by social class inequalities and nuances in performances of gender, which shape the extent to which an individual can/not conceive of science as potentially being "for me." In this respect, the inequalities we have charted in relation to science are likely to contribute to and exacerbate wider societal inequalities. Resolving these inequalities is not just a matter for science—it is a concern for all of us.

Our findings indicate, however, that the barriers to widening participation in science are substantial and entrenched. We interpret our findings as indicating a prevailing doxa in which science careers are constructed as not only male, middle-class and predominantly White/South Asian, but also only for the "clever" (the exceptional few). To imagine a future for themselves within science, students need to self-identify as "brainy"—an identity which is structurally more difficult for working-class and minority ethnic pupils to occupy due to the sociodicy of dominant societal groups which aligns privilege with academic achievement achieved through "natural intelligence" (see also Archer, **2008**). Moreover, as feminist theorists highlight, occupying "clever" identities may also be a challenge for girls, given issues around gendered constructions of "intelligence" (which associates masculinity with effortless brilliance and femininity with "plodding achievement"—and which, as Carlone's (**2004**) research shows, may be particularly amplified within the highly gendered context of advanced physics classes).

Lucey, Melody, and Walkerdine (**2003**) argue that there are no structural reasons why working-class girls should succeed—indeed, their research shows how successful working-class girls support themselves despite, not because of, their social contexts. Likewise, we would argue that working-class boys and girls will require disproportionate resilience if they are to pursue careers in/from science (see Johnson, Brown, Carlone, & Cuevas, 2011 for a useful discussion on resilience as arising from struggles against oppression). However, the alignment between masculinity and science (but especially the physical sciences) may be more beneficial to fostering and sustaining boys' science aspirations and/or engagement and this may be an important reason why boys continue to outnumber girls in post-compulsory science courses and careers.

Such issues are also complexly played out across "race"/ethnicity. While being mindful of the small numbers involved in our study, it was notable that all the South Asian boys interviewed seemed to experience an alignment between their performances of masculinity and the field of science/careers. The South Asian boys often enjoyed relatively high levels of science capital and academic achievement and either held science/related aspirations or articulated a valuing of science for knowledgeable citizenship. Conversely, Black boys were disproportionately likely to experience lower levels of achievement, a lack of science capital and were unlikely to see science careers as being "for me." This suggests that cultural discourses and racialized and classed inequalities may be playing a role in producing patterns of differential identification with science (see also Wong, 2012).

Science educators may be encouraged that so few Y8 boys in our sample expressed "anti-science" views—and that those who did so seemed to be generally disengaged from school, rather than specifically turned off by science. At one level, the alignment of masculinity with the orthodoxy/doxa of science does seem to open it up as a potential form of capital to many boys, yet we would caution that there are still entrenched inequalities within science that operate to exclude working-class and some minority ethnic boys from being able to conceive of it as "for me." Moreover, the alignment of masculinity and science could indicate that inequalities in terms of girls' and women's participation look likely to remain intractable and resistant to intervention—and that more radical approaches to disrupt gender hegemony may be required to effect more substantial changes in participation patterns. Indeed, our analyses suggest that terms of the debate may need to be shifted, in order to emphasize that there is not only a pressing issue regarding widening participation for "girls into science" but also inequalities of social class and ethnicity (in relation to girls and boys)—there is still no commonly accepted vision of science as being "for all."

Our recommendations are based on a belief that science can constitute an important form of symbolic capital that, we would argue, needs to be democratized and shared more equally across society. While the field retains its elite and exclusive status, it is unlikely to be able to achieve improved (that is diversified, not just increased) participation. One practical avenue would be to increase the range of available post-16 science qualifications (beyond the current "gold standard" A level route) to help open up notions of what post-compulsory science "is" and who it is "for." We also recommend the development of mechanisms for increasing family science capital and integrating STEM careers awareness into mainstream teaching throughout primary and secondary school.

Bourdieu (1977 , p. 169) writes that "crisis is a necessary condition for a questioning of doxa but is not in itself a sufficient condition for the production of a critical discourse." We argue that the "crisis" in STEM participation (in terms of the need for improved, not merely increased, participation) provides an impetus for identifying and interrogating existing doxa/orthodoxies (such as the association of science with "cleverness")—but that this may require challenging dominant discourses (such as the association between science and cleverness) which contribute to the "elite" and privileged status of science in society. As Bourdieu writes:

> The dominated classes have an interest in pushing back the limits of doxa and exposing the arbitrariness of the taken for granted; the dominant classes have an interest in defending the integrity of doxa, or short of this, of establishing in its place the necessarily imperfect substitute, orthodoxy. (Bourdieu, **1977** , p. 169)

This paper has sought to contribute to a critical discourse pertaining to science participation, with a view to the production of a useful heterodoxy, in which questions of equality and participation are fore-grounded. In short, our analyses point to the need for a more radical dismantling of the privileged "identity" associated with science careers, in order to effect a more democratic vision of science as "for all."

In practice, our study indicates that "one size fits all" approaches to increasing science participation (whether generally or for "girls" or "boys") are unlikely to have much effect on improving post-16 participation. Approaches that are sensitive to young people's gendered *and* classed identities would seem more appropriate for delivering STEM enrichment and/or interventions aimed at increasing participation. Our findings also indicate that campaigns to broaden popular images of science and/or scientists need to not only challenge the association of science with masculinity but should also specifically engage with the classed dimension, notably science's association with middle-class "brainy" masculinity. Indeed, we believe that there is an urgent need to develop ways to disrupt the link between science and "braininess" which, as our work shows, excludes and alienates many young people, but particularly boys and girls from working-class backgrounds, from science and science careers. Yet this is not merely an issue of the symbolic representation of science—it raises profound challenges for the structure and organization of post-16 science in the UK and elsewhere, which tends to privilege a narrow range of post-16 routes. We suggest that there is a case to be made for expanding post-16 science provision beyond the current "gold standard" academic model (e.g., A levels in the UK) which tend to be configured on a "pipeline" model (as routes to higher education and careers in science). Challenging the elite academic association of science with "braininess," will require a broader range of possible post-16 science pathways and types of qualification that are open to students with a range of attainment, and which are accorded a good status with educators and employers. This widening provision would be key to creating the structural environment within which to enact a vision of "science for all" and could help reinforce the importance of science not just for the supply of future STEM professionals, but also for informed, active citizenship.

Finding ways to engage those young people who are currently most disengaged from science (e.g., "laddish" boys) may also require not only changing how science and science careers are presented, but also building "science capital," for example, conveying the value and transferability of science qualifications in the labor market. Our work points to the importance of finding new ways to build and develop science capital among under-represented groups. But to enable more working-class students to attain the relevant qualification to enable the pursuit of careers in and from science, structural changes may also be required to ensure that working-class students are not disproportionately disadvantaged by their location in the most under-resourced and low status science classes and schools.

Currently, many gender-based STEM participation interventions focus on providing role models and/or "positive images" of science (e.g., ensuring images of STEM professionals represent a diversity of gender and/or ethnic backgrounds). Drawing on feminist literature, we suggest that a more fruitful future approach might focus on supporting teachers and students to deconstruct gender stereotypes and messages. Such an approach seeks to equip students with the conceptual understanding and tools to dismantle popular stereotypical associations (e.g., science as masculine), which could be applied to a range of associations (e.g., science as "brainy"). Such approaches have reported success in helping young children deconstruct gendered stereotypes in literary texts (Davies, 2002) and working with boys to challenge sexism and violence (Salisbury & Jackson, 1996).

In sum, our findings point to the need to develop a more sophisticated science education policy approach to improving participation—prioritizing social class alongside gender inequalities. This also implies a shifting of the current (UK) policy discourse, away from a focus on increasing interest in science (as a way to increase participation) toward a commitment to challenging multiple inequalities which impact on students' engagement with science and their ability to imagine and achieve a future for themselves within, and through, science.

Appendix

Sample items with Cronbach's alphas for survey components

Component	**Cronbach's alpha**
Aspirations in science and medicine (6 items) (Items: I would like to study more science in the future; I would like to become a scientist; I would like to have a job that uses science; I would like to work in science; I think I could be a good scientist one day; I would like to be a doctor or work in medicine)	0.895
Aspirations in science (5 items) (This component was used in analyses for the sake of comparison with the Year 6 survey. Items are the same as the above, except for the item about medicine)	0.909
Stereotypically 'male' jobs (4 items) (Items: I would like to work in engineering; I would like to be an inventor; I would like to work in sports or be a professional athlete; I would like to run or work in a business)	0.619
Attitudes toward school science (7 items) (Sample items: We learn interesting things in science lessons; I look forward to my science lessons; Science lessons are exciting; Studying science is useful for getting a good job in the future; My science teacher is enthusiastic about science)	0.896
Self-concept in science (9 items) (Sample items: I do well in science; I find science difficult; I am just not good at science; I learn things quickly in my science lessons)	0.876
Parental attitudes to science (3 items) (Items: My parents think science is interesting; My parents would be happy if I became a scientist when I grow up; My parents think it is important for me to learn science)	0.754
Parental aspiration/ambition (4 items) (Sample items: My parents want me to go to university; My	0.698

parents want me to make a lot of money when I grow up)	
Parental involvement (4 items) (Sample items: They know how well I'm doing in school; They always attend parents' evenings at school)	0.636
Participation in science-related activities (5 items) (Sample items: Outside of school, how often do you: Read a book or magazine about science? Visit web sites about science? Watch a TV program about science or nature?)	0.768
Peer orientation to school (4 items) (Sample items: How many of your classmates care about their marks in school? Encourage you to do well in school?)	0.750
Peer attitudes to science (2 items) (Items: How many of your classmates like science? Think science is cool?)	0.795
Positive images of scientists (7 items) (Sample items: Scientists and people who work in science can make a difference in the world; Have exciting jobs; Make a lot of money; Are brainy)	0.817
Stereotypical images of scientists (3 items) (Sample items: Scientists and people who work in science are odd; Don't have other interests)	0.717
Future job—making/creating (4 items) (Sample items: For my future job it is important to me to make, design or invent things; To build or repair things using my hands)	0.677
Future job—social/more to life than work (6 items) (Sample items: For my future job it is important to me work with others instead of by myself; To have time for a family)	0.714
Future job—raw ambition (3 items) (Sample items: For my future job it is important to me to earn a lot of money; To become famous)	0.655

Notes

[1] Cultural capital was determined by responses to items such as parental university attendance (and leaving school before age 16), approximate number of books in the home and frequency of museum visitation. These items were used to provide an overall indication of level of cultural capital. Students in our sample fell into the following categories: very low (2%), low, (23.3%), medium (34.1%), high (20.3%), and very high (20.3%).

[2] In the Y8 survey, there were only 122 students in the “science keen” category (2% of girls, 3% of boys). There were 311 in the “uninterested” group (plus 4 non-responses.) An equal proportion (5.5%) of girls and boys were in this category.

[3] Tom has been provisionally included in this category on the basis that he talked about messing about in class, finding many lessons boring and exhibiting low achievement and engagement. However, he was not fluent in English and this hindered him expressing himself clearly and hampered accurate coding of his transcripts.

[4] In which mint sweets are added to a bottle of fizzy cola to produce a spectacular eruption of foam (see http://en.wikipedia.org/wiki/Diet_Coke_and_Mentos_eruption).

[5]See also OECD (2004), PISA in Focus 18, which shows that students who experience more extracurricular science activities attain more highly and have more positive views of the subject.

References

Citing Literature