Comparing students' engineering and science aspirations from age 10-16: Investigating the role of gender, ethnicity, cultural capital and attitudinal factors

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Abstract

Background Women (along with minority ethnic and low-income communities) remain underrepresented in engineering, despite a thirty-year history of research and equality legislation. Compared to the US and other EU countries, this underrepresentation is particularly pronounced in the UK. While existing literature gives insights into factors shaping retention and progression in university engineering students, comparatively less is known about the development of school students' engineering aspirations.

Purpose This paper contrasts science and engineering analyses to explore how relationships between background and attitudinal factors and aspirations change across primary and secondary school. We examine the relative influence of gender on aspirations in both science and engineering.

Design/Method We draw on survey data with over 20,000 English students from the [project name] project. A multilevel regression approach is implemented to test for the effects of gender, ethnicity, and cultural capital on science and engineering aspirations.

Results Gender is the main factor related to engineering aspirations while science aspirations are influenced by a broader range of factors. School-level factors become increasingly important for engineering aspirations. We also report evidence of the early distinctiveness of young women who aspire to engineering, in terms of their relatively high self-concept and motivations.

Conclusions The association of engineering with masculinity is evident in aspirations from age 10 and students aspiring to engineering are distinctive in several respects. Efforts aimed at improving participation in engineering might more usefully focus on challenging the elitist culture and practices, which may influence student perceptions, rather than focusing on changing student aspirations directly.

Keywords gender, aspirations, science

Introduction

Increasing and diversifying participation in engineering remains a key topic of global concern, with governments and industry issuing stark warnings about the economic and social consequences of the current and future predicted shortfall in qualified engineers (Ro & Knight, 2016; UK Resource Centre for Women in Science, Engineering and Technology, 2009). The profile of engineering students and professionals also remains worryingly narrow and resistant to change, as in most Western societies a typical graduate continues to be male, white, and middle-class (U.S. Department of Education, 2015). These trends persist, despite a thirty-year history of equality legislation and numerous initiatives and interventions designed to recruit and retain a diverse workforce (Beddoes & Borrego, 2011). Compared to other European Union (EU) countries (30%) and the Unites States (14%), the United Kingdom (UK; consisting England, Scotland, Wales and Northern Ireland) has a particularly low percentage (11%) of professional women engineers (Catalyst, 2017; Women's Engineering Society, 2018), a trend also mirrored at undergraduate level (National Science Board, 2014), meaning that there is an urgent need to find ways to diversify participation in post-compulsory engineering (Godwin, Potvin, Hazari, & Lock, 2016a; Raelin et al., 2014).

Compared to the field of science education, the education literature in engineering on understanding women's (under)participation is comparatively small (e.g., Hill, Corbett, Rose, 2010). The literature does provide some useful and robust understandings of factors shaping women's participation (and attrition) from university-level engineering. However, much less is known about how and why different girls and younger women come to view engineering as "for me", or not (Archer et al., 2012, p.885).

The majority of work focusing on younger age groups is United States (US) focused (e.g. Blanchard et al., 2015). Moreover, a number of studies explore school students' Science, Technology, Engineering, Mathematics (STEM) aspirations (e.g. Mann, Legewie, & DiPrete, 2015; Ozis, Pektas, Akca, & Devoss, 2018), although the collapsing of engineering aspirations within STEM aspirations makes it difficult to assess the extent to which factors may be common or different for engineering, compared to other STEM areas. Whereas in the US work is being done to ascertain the impact of the introduction of engineering design as a standard in the Next Generation Science Standards for students and teachers at the K-12 level (ages 5-18) (e.g. Judson, Ernzen, Krause, Middleton, & Culberton, 2016), there is no comparable standard or body of work in the UK.

The present paper aims to help fill this research gap by contributing a new understanding of the differences between what shapes the engineering and science aspirations of young people aged 10-16 in English schools. We explore whether there are similar or different patterns between science and engineering in terms of the key factors explaining young people's aspirations and how/whether these relationships change, or not, between the ages of 10-16.

Background

Women's participation in Engineering

Women represent only 15.1% of engineering and technology undergraduates in the UK, and a mere 11% of the UK engineering workforce are women (Women's Engineering Society, 2018). Indeed, England lags far behind the rest of Europe, with Latvia, Bulgaria and Cyprus recording almost 30% women engineers (WISE, 2017). There is a relatively small, but high quality, existing engineering education literature on the experiences of women engineers in higher education. These studies identify a common key problem for women's retention and progression, namely that the dominant culture of engineering is highly masculinised and makes it hard for women to 'fit in' (Benedict, Verdín, Baker, Godwin, & Thielmeyer, 2018, p.1), pushing even committed women out of the field (Godwin & Potvin, 2017; Male, Gardner, Figueroa, & Bennett, 2018). Indeed, women engineering students and professionals report prevalent experiences of sexism and discrimination (e.g. Steele, James, & Barnett, 2002). While comparisons are not often made across the different literatures, similar issues and experiences have been documented within the body of work on gender and physics higher education (Danielsson, 2009; Gonsalves, 2014).

Within the engineering education literature, attention has been drawn to a range of factors that relate to student participation in engineering – such as self-efficacy, performance/ competence and confidence beliefs - identifying the ways in which these factors may play out differently for women and men. For instance, it has been noted that, compared to men, women engineering freshmen report lower confidence in their engineering knowledge and abilities (Cech, Rubineau, Silbey, & Seron, 2011). However, the evidence suggests that often the relationship between these factors and studying engineering is not straightforward and may be mediated by other factors. For instance, Marra, Rodgers, Shen and Bogue (2009) found that while gendered differences in self-efficacy beliefs explain attrition from engineering majors (that is, women who are less confident in their abilities are more likely to drop out), these differences do not necessarily explain retention (i.e., women who persist and complete engineering degrees). Moreover, students' beliefs about their performance/competence on their own are not significant predictors of engineering "but are mediated by interest and recognition from others." (Godwin et al., 2016a, p. 312).

Extending previous work, Godwin et al., (2016a) highlight the particular importance of both identity and agency beliefs (views of the world towards achieving equity and purpose) and how these differ by gender, helping to explain differential patterns of engineering participation stating that "student identities and agency beliefs are significant predictors of engineering choice" (Godwin et al., 2016a, p. 312). However, while identity was a significant factor for both men and women, "seeing themselves as the type of person who do physics or math was less predictive of the choice of engineering for women than for men” (Godwin et al., 2016a, p. 328), which Godwin and colleagues suggest may be due to women identifying less with physics and maths than men because they “do not have the sources of recognition and interest to develop those identities as much as men do” (Godwin et al., 2016a, p. 328). Agency beliefs were also found to have an important and significant relationship with engineering career choice – a relationship that “was stronger for women than for men”, indeed, “for women the path between their agency beliefs and engineering career choice was stronger than the paths between both math and physics identities to engineering career choice.” (Godwin et al., 2016a, p. 328).

As a result, it has been suggested that school and college educators can support student identities and agency toward engineering by “recognizing their students as the kind of people that can do STEM”, a key aspect of which involves “valuing the background knowledge and lived experiences that students bring with them into classrooms” (Godwin et al., 2016a, p. 330), an approach that is widely advocated for supporting students from communities that are traditionally under-represented in STEM, including girls and students from low income and minoritized communities.

Limited Understanding of Young Students’ Aspirations

We know comparatively less about girls and young women’s engineering perceptions and aspirations at earlier ages. Some studies have however, focused on explicating school students’ gendered perceptions of engineers (e.g. Capobianco, Diefes-Dux, Mena, & Weller, 2011; Capobianco, French, & Diefes-Dux, 2012). Most existing work relies on retrospective analyses – that is, asking women higher education engineering students to reflect back to identify key issues and factors and/or conducting statistical analyses using prior data from women engineers (e.g. Godwin et al., 2016a). This body of work provides some important insights, yet it is limited in that it focuses on those distinctive women who have made it to degree level engineering.

There is a body of work that gives useful insights into why students do not continue with engineering and drop out at various points, for example during undergraduate study (e.g. Marra et al., 2009) and upon degree completion (e.g. Lichtenstein et al., 2009). Our understanding is also growing regarding pre-university educational settings and young peoples' decision-making processes surrounding the pursuit of an engineering education (Cass, Hazari, Cribbs, Sadler, & Sonnert, 2011; Godwin, Sonnert, & Sadler, 2016b; Tai et al., 2017).

Studies conducted with school students have identified several key factors shaping young women's aspirations, but this work has largely tended to group together (and not differentiate engineering from) wider STEM aspirations. For instance, Aschbacher, Li, and Roth (2010) found that family encouragement and supportive communities of practice were important for facilitating and supporting young women's STEM aspirations. Similarly, Archer and colleagues (2012) explore the interplay between family habitus and capital and the development of science-specific aspirations. But it is unclear to what extent these factors were similar or different between young women who aspired to engineering rather than science and/or medicine. Given that patterns of gendered participation in undergraduate engineering tend to be very different to those in medicine and the biological sciences, it may be useful to be able to study variations in gendered factors between different disciplinary areas among school students more closely.

The majority of engineering-focused research that has been conducted with school-age girls and young women has investigated the effects of in- and out-of-school interventions that are aimed at diversifying engineering participation. For instance, studies have been conducted on the effects on young people's aspirations and attitudes to engineering as a result of exposure to engineering design-based science instruction (e.g., Capobianco, Deemer, & Lin, 2017), hands on workshops (e.g., Weinberg, Pettibone, Thomas, Stephen, & Stein, 2007) and mentoring programmes (e.g., Hammack & High, 2014). There has also been highly valuable research conducted on how to better support elementary teachers to teach engineering in inclusive, equitable, and engaging ways (e.g., Calabrese Barton & Upadhyay, 2010) and the potential for engaging diverse urban youth through after-school makerspace programmes in ways that support their critical STEM agency (e.g., Calabrese Barton, Tan, & Greenberg, 2017). However, there is still a gap in our understanding of how young people develop engineering aspirations over time and in our knowledge of the extent to which factors shaping young women's engineering aspirations may be similar, or different, to those shaping wider science aspirations.

Theoretical Framework and Research Questions

Many young students' positive attitudes towards science are not translating into aspirations to pursue further study or careers in science and engineering, suggesting the view that STEM is "important, but not for me" (Jenkins & Nelson, 2005; Archer et al., 2013, p.176; Capobiano et al., 2011; Capobianco et al., 2012). While aspirations do not perfectly predict future life outcomes, research suggests that they are strongly related. For instance, Tai et al.'s (2006) analysis of National Assessment of Educational Progress data between 1988 and 2000 revealed that a student who expressed STEM career aspirations at the age of 14 was approximately 3.4 times more likely to complete a university degree in the physical sciences or engineering.

We propose that analysis of young people's aspirations can provide a useful tool for understanding STEM participation. We take a sociological perspective, which understands aspirations as socially constructed phenomena produced at the intersection of structure and agency (Archer & Yamashita, 2003; Archer, Halsall & Hollingworth, 2007), both shaped by, and revealing of, social positions. That is, a young person's aspirations are shaped by identities and inequalities, such as gender, social class, and ethnicity, which open up or constrain the opportunities for young people to engage and identify with STEM and the extent to which STEM is perceived as being possible and desirable ("for me"), or not (Archer et al, 2012, p.885). In our previous research (e.g., Archer & DeWitt, 2015) we found that applying this framework to young people's aspirations helped develop new understandings of student science participation. Godwin and colleagues (2016a) developed the concept of Critical Engineering Agency (CEA) in their study of engineering education. CEA incorporates both "multiple subject-related identities along with students' agency beliefs" and has been found to "predict students' engineering career choice" (Godwin et al., 2016a, p.314). Considering the parallels of our own theoretical framework to Godwin at al.'s (2016a) CEA theory, we explore what such an approach might extend to our understanding of young people's engineering aspirations.

We thus understand that aspirations are not solely determined by structural relations, but are shaped by both inequalities and personal agency. Lent and Brown's (1996) social cognitive career theory was also used to guide variable selection for these analyses and as a result, analyses focus particularly on the relationships between science and engineering aspirations and gender, race/ethnicity, self-concept, and attitudinal (e.g., motivational) factors. Self-concept supports the understanding of one's identity (Leary & Tangney, 2012; Ross, Capobianco & Godwin, 2017) and has, not surprisingly, been shown to be related to aspirations and educational choices (e.g. DeWitt, Archer & Osborne, 2014). We define science self-concept as students' global perceptions of their abilities in science (not what they believe they can do with these skills and abilities (i.e. self-efficacy, see Bong & Skaalvik, 2003). While measures of self-concept are often used in psychological research, we adopt a sociological conceptualisation (e.g. Bourdieu, 1977), which understands self-concept as produced through the interplay of agency and structure, in that an individual's perception of how good they are at science is both structured by their social positioning and experiences and, in turn, will structure how they perceive their options, choices and what is possible and/or desirable.

Building on the literature discussed above, the present paper seeks to contribute a new understanding of what shapes the engineering aspirations of young people in England aged 10-16, teasing out the extent to which these factors are similar, or different, from science aspirations. In particular, we ask:

- How do science and engineering aspirations change over time (from primary to secondary school) among different groups of students?
- To what extent are there are similarities or differences between the key (background and attitudinal) factors relating to young people's science and engineering aspirations?
- How do these patterns change, or not, over time between the ages of 10-16?

Methods

The overall project employs a mixed-methods approach to tap into both the breadth and depth of participants' aspirations. The quantitative component consists of an online repeated cross-sectional survey administered to one cohort of students at four time points: in the last year of primary school (Year 6, age 10-11), and in the second (Year 8, age 12-13), third (Year 9, age 13-14), and fifth (Year 11, age 15-16) years of secondary school in England. The current paper focuses on data from the fourth survey, comparing it with data collected in the first survey, when children were still in primary school. At the age of 15/16 (Year 11) students take national examinations, GCSEs (General Certificate of Secondary

Education), where they generally choose three or four subjects to specialize in (beyond the core Math, English language, and Science subjects). Students then have the option to study multiple routes including; A level (Advanced Levels; considered the prestigious route to university entrance), AS level (Advanced Subsidiary levels; previously an independent qualification encompassing the content of the first year of an A Level), BTEC qualifications (from the Business and Technology Education Council; a more applied training route) and International Baccalaureate. After the age of 16 students in the England (and indeed across the UK) are required to remain in education or formal training until the age of 18. In this paper we compare data gathered in Years 6 and 11 because we were interested in maximizing the timeframe of our analysis, in order to give us the broadest perspective possible on what factors may influence aspirations in science and engineering.

Survey Instruments

The surveys were developed through an iterative process involving drawing on existing instruments, an extensive body of qualitative literature (particularly concerning cultural capital and identity), and data gathered from discussion groups with students (Archer et al., 2010). All constructs used in the surveys have well-established empirical and theoretical bases, contributing to the validity of the instrument. To further support validity, existing instruments including the Simpson-Troost Attitude Questionnaire-Revised (Owen et al., 2008) and the *Is Science Me?* survey (Gilmartin, Li, & Aschbacher, 2006) were also drawn upon when creating items for the questionnaire.

The surveys began with a series of multiple-choice questions to obtain background information (e.g., gender, ethnicity, parental occupation) and contained Likert-type items covering a range of topics such as: aspirations; subject preferences; science self-concept; participation in science activities in and out of school; parental and peer attitudes towards school and science. Response options were on a five-point scale from *strongly agree* to *strongly disagree* with *neither agree nor disagree* used as a midpoint. The surveys administered in Years 6 and 11 were very similar, to allow for comparison between age groups, although we added additional items to the latter survey to reflect educational changes (e.g., questions about science teachers, separate science subjects, and post-16 plans).

The initial versions of the surveys were piloted with 298 students aged 10/11 and 200 students aged 15/16 before being administered to the larger cohort and principle components analyses and measures of internal consistency were conducted on the pilot data to establish psychometric validity and refine the items and scales. To check the reliability of the survey responses we used exploratory factor analyses (direct oblimin rotation) and Cronbach's alpha to determine internal consistency and unidimensionality of scales. The factor analyses revealed 12 resolvable components overall (e.g., attitudes towards science, positive views of scientists, negative views of scientists, science in my future) which related to previous reported analyses for the measures used, with Cronbach's alphas ranging from .66 to .93 in Year 11 and .62 to .90 in Year 6. As this paper focuses on the aspirations in science and engineering and science self-concept components, the relevant factor loadings and items for these are provided in Table 1, with other loadings omitted for space limitations. Further details of these analyses, the development of the instrument, as well as a thorough discussion of the validity of the instruments have been described elsewhere (see DeWitt et al., 2011; DeWitt & Archer, 2015).

[Insert Table 1 about here]

The surveys also contained a measure of cultural capital (conceptualized by Bourdieu, 1977) as a common proxy measure for social class, given the established difficulty of obtaining meaningful and useable data from large samples of children based on measures of parental occupation. The measure of cultural capital comprises, for example, credentials/qualifications and cultural knowledge and resources) with a scale of -4 through 9, calculated based on responses to items about parental education, approximate number of books in the home, and frequency of museum visitation (see Table 2). For simplicity and ease of interpretation, we grouped the scores into categories, indicating very low (-4 through -1.5) to very high (6.5 – 9) levels of cultural capital (see DeWitt & Archer, 2015 for justification of this scoring methodology).

[Insert Table 2 about here]

Sample

The survey was completed by 9,319 Year 6 students from 279 schools (Autumn 2009) and 13,421 Year 11 students from 340 schools (Autumn 2014). The Year 11 sample was larger as more resource was available at that point in the project for recruitment and in part due to the fact that secondary schools are larger, meaning that fewer schools needed to be recruited in order to obtain sample numbers. Alongside the cross-sectional data, we had a longitudinally tracked sample (*n*=477) who completed both the Year 6 and Year 11 surveys. The analyses reported in this paper were repeated with this tracked sample of students. Similar group differences were found (e.g. male students and students with higher cultural capital reported higher engineering aspirations) between the tracked and cross-sectional data. Therefore, this paper focuses on data from the larger cross-sectional samples.

Schools participating were roughly proportional to the overall distribution of schools in England in terms of geographical region ($\chi^2(5,4337)=8.09$, $p=.42$). The sample contains relatively more students in the highest attainment (based on national standardized test scores) category ($\chi^2(5,4337)=32.04$, $p<.001$) and relatively more students ($\chi^2(5,4337)=48.09$, $p<.001$) from schools with the lowest proportion of students eligible for free school meals (a commonly used proxy for socio-economic status). The gender profiles of the sample were roughly proportional to national figures (e.g., 53.3% females in sample vs 48.8% nationally in Year 11).

We are aware that we are oversimplifying gender and that it is not a binary construction. However, going into the level of detail that reflects the complexity of gender was beyond the scope of our survey. In addition, an extremely small proportion (*n*=9, 0.1%) declined to respond to the question. Thus, for the sake of parsimony, we decided to use a simplified construction of gender – focusing on students identifying as either males or females.

As the study focuses in part on the impact of race/ethnicity on students' aspirations, schools with higher populations of ethnic minority students were deliberately over-recruited to ensure sufficient numbers for analysis. Consequently, for example, there are fewer White students in the sample than in all primary and secondary schools in England. Table 3 below shows a summary of the demographics for the two samples.

[Insert Table 3 about here]

Analyses

In order to explore differences in science and engineering aspirations we conducted a series of *t*-tests and one-way ANOVAs. As sample sizes across groups varied, we used Gabriel's procedure, as this test has greater power than both Turkey honestly significant difference (HSD) test and Bonferroni (Field & Hole, 2003). The Games-Howell procedure was also run due to the uncertainty of equivalent population variances (Field, 2013). We also conducted a series of chi-squared tests for independence with adjusted residual analyses (García-Pérez & Núñez-Antón, 2003).

We then conducted two-stage multilevel modelling (MLM) analyses using MLwiN to investigate background factors (gender, race/ethnicity, and cultural capital) related to students' aspirations in science and engineering (Schagen & Elliot, 2004). The key advantage of multilevel models is that they recognise that students' responses are contained in a set that comes from a common source (each of their schools). MLM analyses therefore provide a more accurate measure of standard error compared with standard regression analysis. Consequently, it is less likely that non-significant independent variables are included in the final model (Type 1 errors are less likely), increasing the accuracy of the model (or the accuracy our picture of variables associated with aspirations).

In the first stage of the MLM analyses, we constructed an unconditional or base model, which included no independent variables, for the outcome variables. This model gave a measure of the variance at the pupil and school level for the outcome variable (i.e., aspirations in science). For these analyses, dummy variables for the specific groups within the categorical variables were created, using male, White, and the medium level of cultural capital as bases for comparison. For all variables, if a pupil was missing the data, a dummy variable for *missing* was entered into the model.

Second, we entered all the variables (gender, race/ethnicity, and cultural capital) into the analysis, and successively removed from the model variables that did not contribute significantly to a reduction in the pupil-level variance. At the end of this process, the only independent (predictor) variables remaining in the model were those whose relationship with the outcome measure was statistically significant at the p=.05 level. Finally, we calculated effect sizes for these variables (Schagen & Elliot, 2004), to determine the relative strength of the relationships between the independent variables and the outcome variable.

Through using the same set of independent variables (gender, race/ethnicity, and cultural capital), our analyses allowed us to make direct comparisons between the models for science and engineering aspirations (research question two) and between the Year 6 and Year 11 models (research question three). As the analyses reported in this study involved conducting a series of multiple tests, conservative Bonferroni adjusted alpha levels were adopted. We additionally focused on the interpretation of effect sizes rather than *p* values to reduce the risk of Type 1 errors and provide insight into the practical implications of the magnitude of any reported differences (Sun, Pan, & Wang, 2010; Wasserstein & Lazar, 2016). Cohen's *d* statistic accompanied any *t*-tests, partial eta squared ($\eta\rho^2$) values represented effect sizes for ANOVAs, and Cramer's V for chi-squared tests. For details on effect size calculations and interpretations for these tests see Pallant (2010).

Results

Addressing the first research question, regarding changes in science and engineering aspirations from primary to secondary school, an independent samples *t*-test (equal variances not assumed) revealed that students' low levels of science aspirations remained unchanged from Year 6 to Year 11. Similar tests for engineering aspirations revealed significant decreasing trends; however, the effect size was small. Together these results suggest that Year 11 students continue to report low aspirations in science and engineering, particularly relative to the positive attitudes towards science they held at primary (DeWitt et al., 2014). Table 4 below shows the means and standard deviations for science and engineering aspirations across the two surveys and within each of the background factors studied.

[Insert Table 4 about here]

Who aspires for science and engineering? The role of background factors

To address the remaining element of the first research question (exploring changes among different groups of students) and explore the data before presenting the MLM results addressing the second and third research questions (investigating factors related to science and engineering aspirations and how they change over time), this section draws on preliminary *t*-tests and ANOVAs (Table 4).

Gender. While male students in Year 6 had significantly higher aspirations in science than their female peers, the gender differences were relatively small (*d*=.20). Similar results were found in Year 11 with male students reporting significantly higher science aspirations than females, with Cohen's *d* (.16) indicating an even smaller effect size.

As gender had a small effect for science in Year 11, we conducted further analyses to disaggregate the sciences. In line with previous findings (e.g., Smith, 2011), in response to the qualitative survey question "What would you like to be as an adult?" relatively more students aspiring for biology-related careers were female (67.8% female, 32.2% male) while more males aspired for physics-related careers (66.0% male, 34.0% female) with Cramer's V (.235) indicating a large effect (χ^2 (2, 1,084)=59.719, p <.001). Analyses of the adjusted residuals showed that physics was contributing most strongly to the overall significant result.

In addition, relatively fewer (Year 11) females reported physics as the most interesting science (11.4% females vs 21.2% males, χ^2 (1, 13,420)=887.526, p <.001, Cramer's V=.257) and their best science (12.5% females vs 19.6% males, χ^2 (1, 13,420)=530.214, p <.001, Cramer's V=.199), and females were more likely to report physics as most difficult (30.3% females vs 17% males, χ^2 (1, 13,420)=553.533, p <.001, Cramer's V=.203). Female students were also relatively less likely to report intentions to pursue post-compulsory physics (8.2% females vs 15.1% males, χ^2 (1, 9,206)=588.083, p <.001, Cramer's V=.253), in line with previous research highlighting more pronounced gender patterns in the physical sciences (e.g. Blickenstaff, 2005).

In contrast to the findings for science aspirations, *t*-tests for Year 6 engineering aspirations revealed large effect sizes for gender, with males reporting significantly higher engineering aspirations than females (*d*=.77). Even larger effect sizes were found (*d*=.89) among the Year 11 cohort.

Race/Ethnicity. There was a statistically significant difference in science aspirations for different ethnicities at Year 6. Despite reaching statistical significance, the actual difference in mean scores between the groups was quite small ($\eta\rho^2$ =.022) and post-hoc comparisons indicated that the mean score for White students was lower than for the other ethnic groups. For Year 11, similar differences were reported with $\eta\rho^2$=.024 indicating a small effect.

For engineering aspirations, significant group differences were reported at both Year 6 ($\eta\rho^2$=.011) and Year 11 ($\eta\rho^2$=.012). Post hoc comparisons indicated that White students had significantly lower scores than all other ethnicities. When comparing the effect sizes of ethnicity for aspirations in science and engineering, they were larger for science aspirations, suggesting that ethnicity contributes more strongly to explaining variation in science aspirations.

Cultural Capital. There was a statistically significant difference in science aspirations by cultural capital in the Year 6 sample, with $\eta\rho^2$=.044. Post-hoc comparisons indicated that the mean score for students with very high cultural capital was higher than all other groups. In Year 11, similar group differences were found with $\eta\rho^2$=.061.

For engineering aspirations, we found significant differences at Year 6 ($\eta\rho^2$=.014) and Year 11 ($\eta\rho^2$=.016), with very high cultural capital students reporting higher aspirations. Comparing the effect sizes for science and engineering analyses, cultural capital had a stronger relationship to supporting or impeding science aspirations compared to engineering aspirations.

Comparing Years 6 and 11 Multilevel Models

Table 5 below shows the coefficients and standard errors for the MLM analyses conducted to explore the relationships between the background factors studied and engineering and science aspirations over time (the second and third research questions), taking into account the nested structure of the data (i.e., students clustered within schools).

[Insert Table 5 about here]

Looking at the relationships with the largest effect sizes in the Year 6 science aspirations model, Indian, Bangladeshi and other South Asian students and those with very high cultural capital tended to have higher aspirations. The gender effect reported in this model was small (.22) compared to the effect sizes for the other independent variables. This model accounted for 9.9% of the variance in science aspirations. Of this variance, 45.4% was due to school-level variance and 54.6% was due to student-level variance. The Year 11 science aspirations model produced similar results and explained 10.0% of the variance, with 41.5% of this variance due to school-level variance and 58.5% due to student-level variance. These results suggest that as students progress through primary to secondary school, school-level factors may become less important in forming science aspirations.

The Year 6 model of engineering aspirations explained 15.3% of the variance in the outcome variable. Of this variance, 6.8% was due to school-level variance and 93.2% was due to student-level variance. The Year 11 model explained 20.1% of the variance. Interestingly, 12.8% of this variance was due to school-level variance and 87.2% was due to student-level variance. These results suggest that as students transition through primary to secondary school, school-level factors may become more important in forming engineering aspirations.

Comparing the two sets of models, the background factors seem to explain more variance in engineering aspirations compared to science aspirations. Considering the Analysis of Variance (ANOVA) and MLM results together, it seems possible that the gender effect for engineering is contributing to this pattern. Gender consistently had the largest effect in the engineering models but quite a small effect compared to most ethnicities and cultural capital in the science aspiration models. It is also worth highlighting that the student-level factors are more important for engineering aspirations compared to science.

Differences in Science-Self Concept and Attitudinal Factors

In exploring attitudinal factors connected to aspirations within our theoretical model described above (again addressing the second research question), we conducted a series of *t*-tests investigating gender differences in science self-concept. Although science self-concept would not be expected to be as closely linked to engineering aspirations and identity as engineering self-concept, we explore the relationship as it may provide useful insight into influences on aspirations.

When looking at the whole Year 11 sample, males (M=30.56, SD=6.94) had higher science self-concept than females (M=27.80, SD=6.98; t(13,361)=22.892, p <.001, Cohen's d=.40). We also found significant gender differences when only looking at students who *strongly agreed* they wanted to work in science, with females reporting lower science self-concept (M=34.21, SD=5.81) than males (M=36.74, SD=5.74, t(1,856)=9.373, p <.001, d=.44). When these tests were repeated with students who *strongly agreed* they wanted to work in engineering, no significant differences in science self-concept were found (t(1,478)=1.460, p=.145, d=.076). In fact, the means were reversed, with females aspiring for engineering showing slightly higher science self-concept (*M*=32.48, *SD*=6.71) than males (*M*=31.78, *SD*=7.20).

Also addressing the second research question relating to attitudinal factors, chi square tests for independence were conducted to look at the association between engineering aspirations and students' motivations for future careers. Relatively more students strongly agreeing that they want to be an engineer reported that earning a lot of money was very important (53.2%) compared to students not holding engineering aspirations (45.2%) ($\chi^2(3)=40.150$, $p<.001$, Cramer's V=.055). We saw similar results with students wanting 'to make a difference in the world'; with 36.8% of engineering students strongly agreeing vs 33.7% of other students ($\chi^2(3)=13.229$, $p<.01$, Cramer's V=.031). We also found a significant association between the motivating factor 'to create things' and students engineering aspirations, with students strongly agreeing that they want to be an engineer significantly more likely (35.4%) to report creating things as an important motivating factor than their peers not aspiring for engineering (18.9%), with Cramer's V=.136 indicating a medium effect for a large table ($\chi^2(3)=280.844$, $p<.001$).

When we repeated these tests for 'to help other people', relatively fewer students aspiring for engineering (38.7%) compared to their non-engineering aspiring peers (43.5%) reported this as a reason ($\chi^2(3)=41.792$, $p<.001$, Cramer's V=.056). In addition, relatively fewer females aspiring for engineering (47.5%) compared to other female students (51.1%) reported helping others as very important ($\chi^2(3)=19.046$, $p<.001$, Cramer's V=.052).

Discussion

This paper contributes new insights into understanding the aspirations of young people regarding participating in science and engineering. In particular, it augments understandings of the complex and multifaceted nature of student aspirations in STEM

(Brotman & Moore, 2008), showing how science and engineering aspirations remain relatively low and stable between ages 10 and 16. This work also identifies similarities and differences in the factors related to science and engineering aspirations and highlights some key distinctive features of students (but particularly young women) who aspire to be engineers.

For instance, at age 10 and age 16, students reporting engineering and science aspirations were relatively less likely to be White and comparatively more likely to have high cultural capital, although this effect was stronger in each case for science than engineering. Yet we also found that student-level factors have a stronger relationship with engineering aspirations compared to science aspirations and identified how gender has a particularly strong relationship with engineering aspirations. The findings showed that, even from age 10, girls were notably less likely than boys to aspire to engineering careers.

Our analyses also enabled us to directly compare how key background factors (like gender) varied between the science and engineering models. These comparisons suggest that while some similar factors are at play overall, engineering students are also distinctive. For instance, we found that, compared to their peers, students who aspire to do engineering are more likely to be motivated to earn a lot of money, make a difference in the world and to create things. Moreover, our findings highlighted the distinctive profile of young women who aspire to do engineering, showing how these students differ not just from other young women in general (in that they are more likely to express a very high science self-concept). These students also differed from young men who aspired to engineering, in that aspiring female engineers were relatively less likely to be motivated by a desire to help other people through their future careers. We now consider what implications these key findings may have for the field, but notably for intervention work aimed at increasing and diversifying participation in engineering.

Should engineering interventions start earlier?

In England and the rest of the UK, most engineering interventions are aimed at the 14-19 age period (Royal Academy of Engineering, 2017). While our finding - that in England school-level factors increased from Year 6 to Year 11 for engineering aspirations - may provide partial support for these interventions, we also reported relatively little change in students' engineering aspirations between ages 10-16. Of course, we do not know what engineering aspirations look like before age 10, nor which students, if any, in our sample had been exposed to engineering interventions, or not, so cannot comment on the effectiveness, or otherwise, of these. However, as a general point, we might extrapolate that our data suggests that there is currently little detectable evidence of an impact of 14-19 engineering interventions on the aspirations of our sample – although further investigation is needed. Our finding that there is little change in engineering aspirations age 10-16 also raises two further questions: at what age do patterns in engineering aspirations first begin to emerge? Might early intervention help disrupt later patterns of aspiration? We suggest these questions deserve further research attention.

Challenging and changing the elite culture of engineering

We interpret our finding, regarding the tendency for those aspiring to science and engineering to possess high levels of cultural capital, as suggesting that the two fields still share a common alignment with social advantage and eliteness. Our work thus lends further support to existing calls that more still needs to be done to challenge the elite culture of engineering (e.g., Godfrey & Parker, 2010). Our data indicate that current participation patterns look set to continue, given the lack of change in the profile of young people who are currently aspiring to go into science or engineering.

Our finding, that young women who aspire to do engineering report a relatively high science self-concept, might be interpreted as inferring support for the idea that the majority of young women do not aspire to be engineers because they lack confidence in their science and/or math abilities. Indeed, this is the premise of a variety of existing interventions. Considering the strong links between engineering, maths, and physics content and identities (Godwin, Potvin, Hanzari, & Lock, 2013; Li et al. 2009), these findings are further supported by our result showing that female students were relatively more likely to report physics as the most difficult science and comparatively less likely to report physics-related career and study intentions. However, drawing on our previous research on the culture of physics (Archer, Moote, Francis, DeWitt, & Yeomans, 2017), we would suggest that, rather than adopting a deficit approach that seeks to change the supposedly faulty individual, it is more productive and socially just to focus on changing the culture of the discipline in question, to make it more inclusive, to help broaden participation beyond the "exceptional" few young women for whom engineering aspirations are possible and desirable (Archer et al. 2017, p.88).

'Re-branding' engineering?

Our finding, that students who aspire to do engineering are more likely to be motivated to create something, might be read as chiming with current initiatives that aim to increase the visibility of engineering as a creative science (e.g., Haag, Hubele, Gracia, & McBeather, 2007). However, we also note that the desire to create something was not as strong a motivator among students who do not aspire to be engineers, which might indicate a certain inherent limited impact of this form of branding exercise. However, we suggest that an emphasis on creativity may help to challenge the traditional association of engineering with masculinity, given that femininity is popularly aligned with creative expression and is dominantly placed in opposition to notions of rationality, science, and masculinity (e.g., Archer, 2000). Moreover, we interpret the finding that students who aspired to engineering exhibited some distinctive characteristics as suggesting that there may be a need for engineering-specific interventions and not just generic STEM initiatives.

In an endeavor to broaden the appeal of engineering, efforts have been made to promote engineering careers as socially responsible, interesting, and “helpful” to society (e.g., National Academy of Engineering, 2008, pp.168). However, our findings suggest that while many young people may share a motivation to *make a difference in the world* (and thus may potentially be attracted by messaging that promotes engineering as a career that enables one), students who aspired to engineering were notably less likely than their peers to want to help others. This leads us to wonder about the extent to which recent social responsibility initiatives may have limited success, in that they are unlikely to contain messaging that resonates with most aspirant engineers – and by extension, may not reflect the sentiments of many of those already within the profession.

Introducing engineering into the mainstream school curriculum in England?

We also found that student-level factors were relatively more important in the engineering aspiration multilevel models, compared to the science aspiration models conducted. We hypothesize that one reason for this finding could possibly be because in England the majority of school students have little, to no, direct experience with engineering practice and have limited understandings of what engineers do in their daily lives (Royal Academy of Engineering, 2017). The lack of exposure to engineering in the mainstream curriculum may potentially make the choice of an engineering degree more difficult than other STEM disciplines (Marra et al., 2009; Pierrakos, Beam, Constantz, Johri, & Anderson, 2009), and could account for differences between the findings of this study and studies conducted in the US following the incorporation of engineering design into the curriculum.

Considering previous research suggesting that curricular emphasis is the most distinguishing factor related to engineering major choice between genders (e.g. Zafar, 2009), we extend a suggestion that England might consider the potential merits of finding ways to integrate aspects of engineering education into the mainstream curriculum. Integrating engineering into the school curriculum – similar to the way in which coding has been introduced into schools in the UK and US (e.g. INSPIRE, 2016) – may provide further opportunities to support students in authoring their potential identities in engineering (Godwin et al., 2016a). However, such experiences would need to be provided through equitable and social justice pedagogical approaches, which have the potential to engage diverse young people with the subject (Bybee, 2014; Calabrese Barton & Upadhyay, 2010).

The distinctive profile of young women who aspire to do engineering

We found that within the sample as a whole (and among students aspiring for science), young men expressed a higher science self-concept than young women, yet there were no significant gender differences among students aspiring for engineering. Our work thus adds to existing findings, discussed earlier, showing that female engineering higher education students report high levels of math self-confidence. We suggest that this finding also has relevance given that many existing initiatives aimed at supporting young women into engineering pathways focus on enhancing their self-confidence through mentoring – yet our research suggests that, at least up until the age of 16, most of the young women who aspire to do engineering already have exceptionally high math and science self-concepts.

We also found that young women who aspired to engineering were less likely than their male counterparts to be motivated to help others through their career. This pattern aligns with findings from wider work, showing that most female engineering students and practicing engineers do not rank altruism highly as a career choice motivation (e.g., Slim & Crosse, 2014), and are more often drawn to the career by the challenge it presents (e.g., McIlwee & Robinson, 1992).

Efforts have been made to acknowledge and deconstruct the masculine image of science and engineering and the gender roles it perpetuates (e.g., National Academy of Engineering, 2008). However, we interpret our findings as suggesting that there may be an added challenge/complexity to this endeavour, because those young women who aspire to do engineering appear to be distinctive from their wider peers. That is, would these young women still be as equally attracted to a profession with a more feminised image?

Remaining questions

Our findings raise a number of questions for engineering education. For instance, should the sector focus on marketing an image of engineering that aligns closely with the interests of those who are already attracted to it, despite the apparent limited size and profile of this pool of potential applicants? Will efforts to broaden the appeal of engineering potentially discourage those who currently aspire to become engineers?

Our findings lend support to wider calls to challenge the elite culture of engineering, but what might this look like in practice? Drawing on wider research, we suggest that one potential policy lever is to open up degree entry routes. For example in England, where our study is based, most engineering degrees currently require advanced level mathematics and physics – yet entry to advanced level physics is highly restricted (Murphy & Whitelegg, 2006), and this tight gatekeeping helps narrow the size and the demographic profile of the potential pool of engineering applicants. We suggest it may therefore be useful for engineering to consider ways that such entry routes might be broadened. Indeed, in North America and the UK, some engineering degree programs that have removed the requirement for advanced level physics (e.g., University of British Columbia and University College London) have reported increased and diversified participation (Bonfield, 2015).

Limitations and Future Research

Due to being based on self-report measures, the research presented here is limited by issues of both internal validity (e.g., response bias, control of the sample and/or spurious responses) and external validity. While the results presented can arguably be generalized to students in England, the year groups were oversampled for minority ethnic groups due to the nature of the study. The differences in demographics presented need to be remembered when interpreting the results and any wider cultural comparisons need to be made cautiously. Further research replicating these results in other countries would help to build confidence in the generalizability of the findings presented.

The paper presents results from multiple samples (Year 6 and Year 11), several with non-repeated data, and any conclusions need to be made cautiously. As this study compares data gathered in Years 6 and 11 in order to provide a broad perspective, we are also aware that more nuanced changes, which may provide a more complete picture, are not provided. We therefore suggest that future studies use repeated-measures and run three-level models (e.g. with time, nested within students, clustered within schools) to be able to draw stronger conclusions.

The alpha values for engineering aspirations approached the lower limit of what is acceptable (.70). This is not uncommon for components with relatively few items, however, it is possible the low alpha values were due to students' lack of awareness of what an engineer does. We also appreciate that relating an engineer's work to that of an inventor is an oversimplification. However, the results from the factor analyses conducted suggest that the inventor item loaded more strongly with engineering than science providing support for the component structure. We also acknowledge that the lack of significant gender differences in science self-concept among engineering aspirations may be due to the domain specificity of this measure (relating to science more so than engineering).

Finally, due to the fact that the effect sizes were small in the models for the other background factors, it can be assumed that cultural capital and race/ethnicity have an indirect effect on engineering career aspirations, possibly mediated by gender. Future stepwise logistic regression analyses are planned to help identify any mediation paths of other factors to provide further insight.

Conclusions

Low and unequal participation in engineering remains a persistent issue for the sector. The work presented in this paper aims to add to understanding of the complex issues driving and maintaining these inequalities. Our analysis of survey data from a cohort of over 20,000 students at age 10 and 16 in England revealed that gendered differences in engineering aspirations are evident by age 10. We also unpicked similarities and differences in factors associated with science and engineering aspirations. In particular, the analyses highlighted the distinctive profile of young women who aspire to become engineers. We interpret the findings as raising questions and challenges for intervention work aimed at improving (increasing and widening) participation in engineering, arguing that existing efforts might be improved through a stronger focus on changing the elitist culture and practices associated with engineering which can influence students' perceptions of engineering, rather than trying to change individual student aspirations.

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Table 1
Cronbach's alphas (α) *and sample items for the Year 6 (*n*=9,319) and Year 11 (*n*=13,421) survey components.*

Component	*n*	Items	Y6 α	Y11 α	range
Science Aspirations	5	I would like to: study more science in the future, become a scientist, have a job that uses science, work in science; I think I could be a good scientist one day	.90	.93	5-25
Engineering aspirations	2	I would like to: work in engineering, be an inventor	.67	.66	2-10
Science self-concept	9	I am good at science, I learn things quickly in science lessons*, I get good marks on science tests, I understand everything in my science lessons, I am just not good at science (rev), I find science difficult (rev), I feel helpless in science lessons (rev)	___	.90	9-45

Note. Mean inter-item correlations for all three scales are between .2 and .4, which is acceptable according to Briggs and Cheek (1986). Ranges presented are for the summed (unstandardized) scale items (rated on a five-point Likert scale with endpoints of strongly disagree and strongly agree). *This item was repeated for the three separate sciences.

Table 2
A summary of cultural capital survey items.

Item	Response Options
Did either of your parents/carers go to university	Yes No Don't Know
Did either of your parents/carers leave school before the age of 16	Yes No Don't Know
How many books (including eBooks) are there in your home?*	None Very few (less than 50 books) One shelf filled with books (50 books) One bookcase filled with books (200 books) More than one bookcase filled with books (more than 200 books)
How often do you go to a museum when you are NOT in school (in your spare time)?*	At least once a week At least once a month At least once a term At least once a year Never

Note. *Items refer to *all* books in the home and *any* museum visitation, as this is a measure of cultural capital, not a science-specific measure.

Table 3

A summary of the gender, race/ethnicity, school type, and cultural capital profiles for the Year 6 and 11 samples.

Gender	**Year 6 sample (%)**	**Year 11 sample (%)**
Male	50.6	46.7
Female	49.3	53.3
Race/Ethnicity		
White	74.9	75.9
Asian	8.9	9.7
Black	6.9	3.7
Chinese or East Asian	1.4	1.5
Middle Eastern	.3	.9
Mixed or Other	7.5	4.8
School type		
Private school	9.1	11.1
State school	90.9	88.9
Cultural Capital		
Very low	2.0	5.8
Low	23.4	32.2
Medium	34.1	28.3
High	20.2	17.8
Very high	20.3	15.9
Total Sample *N*	9,319	13,421

Note. In Year 11, 3.4% of students responded ‘prefer not to say’ to the ethnicity question and were coded as missing for the purposes of the analyses.

Table 4

*A summary of group differences in science and engineering aspirations across Year 6 (*n*=9,319) and Year 11 (*n*=13,421).*

	Science Aspirations		**Engineering Aspirations**	
	Year 6 *Mean (SD)*	**Year 11** *Mean (SD)*	**Year 6** *Mean (SD)*	**Year 11** *Mean (SD)*
	13.68 (5.16)	13.81 (5.45)	13.26 (5.74)	12.99 (5.58)
	$t(21,295)=-1.768$, $p=.075$, $d=.025$		$t(20,266)=3.573$, $p<.001$, $d=.048$	
Gender				
Female	13.15 (4.94)	13.41 (5.52)	11.25 (4.75)	10.86 (4.86)
Male	14.17 (5.25)	14.26 (5.34)	15.28 (5.73)	15.43 (5.35)
	$t(9300)=9.669$, $p<.001$, $d=.20$	$t(13108)=8.925$, $p<.001$, $d=.16$	$t(9081)=36.977$, $p<.001$, $d=.77$	$t(12625)=51.259$, $p<.001$, $d=.89$
Ethnicity				
White	13.29 (4.99)	13.44 (5.36)	13.02 (5.55)	12.66 (5.49)
Black	14.38 (5.35)	14.47 (5.81)	13.63 (5.97)	13.82 (5.72)
Asian	15.80 (5.20)	16.11 (5.17)	14.84 (5.93)	14.47 (5.56)
Chinese or East Asian	15.08 (4.96)	15.57 (5.23)	15.31 (5.12)	14.00 (5.42)
Middle Eastern	13.50 (5.49)	14.03 (6.03)	12.73 (5.65)	14.08 (6.10)
Mixed or Other	13.92 (5.33)	14.14 (5.81)	13.47 (5.65)	13.42 (5.71)
	$F(5,9313)=41.975$, $p<.001$, $\eta\rho^2=.022$	$F(5,12808)=62.984$, $p<.001$, $\eta\rho^2=.024$	$F(5,9313)=19.958$, $p<.001$, $\eta\rho^2=.011$	$F(5,12830)=30.584$, $p<.001$, $\eta\rho^2=.012$
Cultural Capital				
Very Low	11.50 (5.20)	11.18 (4.90)	12.16 (5.78)	11.67 (5.76)
Low	12.67 (4.83)	12.47 (5.02)	12.33 (5.51)	12.33 (5.53)
Medium	13.55 (4.99)	14.08 (5.38)	13.22 (5.62)	12.98 (5.52)
High	13.98 (5.14)	14.93 (5.50)	13.66 (5.67)	13.69 (5.56)
Very high	15.36 (5.09)	15.70 (5.49)	14.22 (5.63)	14.10 (5.47)
	$F(4,9314)=107.343$, $p<.001$, $\eta\rho^2=.044$	$F(4,13266)=213.591$, $p<.001$, $\eta\rho^2=.061$	$F(4,9314)=37.102$, $p<.001$, $\eta\rho^2=.014$	$F(4,13297)=53.647$, $p<.001$, $\eta\rho^2=.016$

Note. The science aspiration composite included five items, rated on a five-point Likert scale (with endpoints of strongly disagree and strongly agree). The engineering aspiration composite included two items and was rescaled to match the range for the science aspiration composite (5-25). Cohen's (1988) guidelines indicate that $d \geq .20$ indicates a small effect, $d \geq .50$ medium, and $d \geq .80$ large, Similarly, $\eta\rho^2 \geq .01$ indicates a small effect, $\eta\rho^2 \geq .06$ medium effect, and $\eta\rho^2 \geq .14$ large effect.

Table 5

Multilevel model *coefficients, standard error and effect sizes of background variables on science and engineering aspirations in Year 6 (*n=*9,319) and Year 11 (*n=*13,421).*

	Science Aspirations			Engineering Aspirations		
	Y6 Coefficient (Y11)	Y6 *SE* (Y11)	Y6 Effect Size (Y11)	Y6 Coefficient (Y11)	Y6 *SE* (Y11)	Y6 Effect Size (Y11)
Intercept (constant)	13.98 (14.62)	.12 (.13)		6.08 (6.21)	.048 (.048)	
Gender (female)	-1.11 (-1.16)	.10 (.098)	-.22 (-.21)	-1.63 (-1.97)	.043 (.037)	.72 (-.88)
Ethnicity – Black African	NA (1.30)	NA (.31)	NA (.24)	NA (.53)	NA (.12)	NA (.24)
Ethnicity - Indian	1.96 (2.42)	.27 (.28)	.38 (.44)	.57 (.75)	.11 (.10)	.23 (.33)
Ethnicity – Bangladeshi	2.34 (1.79)	.41 (.44)	.46 (.33)	.82 (.75)	.17 (.17)	.36 (.34)
Ethnicity-Pakistani	1.69 (1.98)	.35 (.28)	.33 (.37)	.50 (.54)	.15 (.11)	.22 (.24)
Ethnicity-Asian Other	3.00 (3.10)	.77 (.36)	.59 (.56)	.81 (.85)	.33 (.14)	.36 (.38)
Ethnicity-Chinese	1.72 (2.10)	.65 (.45)	.34 (.38)	1.12 (NA)	.27 (NA)	.49 (NA)
Ethnicity- Asian & White	1.56 (.93)	.47 (.38)	.30 (.17)	NA (.34)	NA (.15)	NA (.15)
Ethnicity-Mixed Other	-.62 (NA)	.28 (NA)	-.12 (NA)	NA (NA)	NA (NA)	NA (NA)
Cultural capital – very low	-2.07 (-2.87)	.37 (.21)	-.41 (-.53)	-.50 (-.51)	.16 (.050)	-.22 (-.28)
Cultural capital - low	-1.31 (-1.57)	.14 (.17)	-.26 (-.29)	-.43 (-.22)	.058 (.045)	-.19 (-.13)
Cultural capital –high	.35 (.79)	.14 (.14)	.067 (.15)	.11 (.21)	.061 (.052)	.046 (.11)
Cultural capital – very high	1.69 (1.61)	.15 (.15)	.33 (.30)	.35 (.38)	.063 (.057)	.16 (.20)

Note. Year 11 coefficients, SEs and effect sizes are shown in parentheses. 'N/A' is used to indicate when a variable did not form part of a particular model (Year 6 or Year 11). All independent (predictor) variables remaining in the model were those whose relationship with the outcome measure was statistically significant at the *p*=.05 level.