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Social class inequalities in attitudes towards mathematics and achievement in mathematics cross generations: a quantitative Bourdieusian analysis

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Abstract
Drawing on Bourdieu's theory of social and cultural reproduction, this article utilizes the conceptual tools of habitus and cultural capital to examine intergenerational inequalities in attitudes towards mathematics and mathematics learning in three secondary schools in England. Data from 1079 students aged 14–16 included mathematics achievement, survey measures of attitudes towards mathematics, perceived parental attitudes towards mathematics, newly developed scales for cultural capital and habitus, and social class. There was a very strong relationship between student's attitudes towards mathematics and students' perceptions of their parents' attitudes towards mathematics. Middle-class students reported more positive attitudes towards mathematics, more positive perceived parental attitudes towards mathematics, and had higher mathematics achievement than working-class students. Cultural capital had a significant positive effect on students' attitudes towards mathematics but a minor effect on their achievement in mathematics. However, cultural capital's effect on students' attitudes and achievement in mathematics faded when habitus was included in the model. We suggest that habitus may play a more central role than cultural capital in the reproduction of mathematics inequalities. School quality had a modest but significant impact on mathematics outcomes in this study, so we argue that challenges to mathematics inequalities will require changes both within and outside of mathematics classrooms.

Keywords Attitudes towards mathematics · Social class · Habitus · Cultural capital · Bourdieu · England

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1 Introduction

The COVID-19 pandemic has highlighted the challenges that education systems face to ensure equitable opportunities for students to achieve good educational outcomes. The long-established link between parents' socioeconomic status and students' attainment has now been put under renewed scrutiny. The prevailing disparities in educational outcomes are based on a complex mix of factors such as the level of parental support for students' learning, availability of resources, and familial perception of education and its importance, alongside implicit and explicit racism, sexism, and other forms of identity discrimination (DiMaggio, 1982; Bourdieu & Wacquant, 1992; Fan & Chen, 2001). Recently in England, the Office for Standards in Education, Children's Services and Skills (OFSTED) has introduced a new inspection framework which puts at the centre the role of curriculum and, for the first time, states explicitly the need for schools to develop students' cultural capital (Ofsted, 2019). This policy shift draws on a plethora of research that has established the link between cultural capital and academic achievement (Graaf et al., 2000; Quaye, 2015; Waithaka, 2014). Bourdieu's theory of social and cultural reproduction offers us a mechanism to understand how inequality is reproduced and the way in which social class accounts for differences in students' outcomes (Bourdieu, 2006).

At the secondary level, mathematics is a "core" subject; students "cannot ignore the powerful 'exchange value' of mathematics qualifications, or indeed the market value placed on high-level mathematical skills needed for certain commercial, technological and scientific roles" (Noyes, 2016, p. 25). Nonetheless, students bring to their learning traces of their histories, which are reflected in their attitudes towards mathematics. Attitudes towards mathematics may be influenced by students' home environment (Jacobbe et al., 2012; Lopez & Donovan, 2009; Evans & Field, 2020), teachers' attitudes (Marchis, 2011; Noyes, 2012), teacher instruction in the classroom (Hodges & Kim, 2013), parental aspirations (Fan & Chen, 2001), and parents' self-efficacy in mathematics (Ingram et al., 2007). Bourdieu's ideas have had a profound impact on educational research (Lareau, 2003; Reay, 2015), in part because they accommodate a "dialectical relationship between structure and agency" (Mahar et al., 1990, p. 1). Bourdieu viewed the educational field (schools) as a "mechanism for consolidating social separation" (Grenfell, 2008, p. 29) and a "cultural site of socialisation that … was often more likely to reproduce, rather than challenge social inequality in the state" (Dillabough, 2004, p. 490). Bourdieu argued that the educational system rewards students from middle-class backgrounds due to the cultural capital they possess. Some prior studies have applied Bourdieu's approach to mathematics education (Noyes, 2016; Noyes, 2006; Jorgensen et al., 2011; Williams & Choudry, 2016; Kleanthous & Williams, 2013); however, none focuses explicitly on the role that cultural capital and habitus play in the intergenerational reproduction of attitudes towards and achievement in mathematics. This article draws on Bourdieu's conceptual tools of habitus and cultural capital to offer a nuanced explanation of social class, ethnic and gender differences in students' attitudes towards and achievement in mathematics. The primary aim of this study is to establish empirical findings about social class differences in students' attitudes towards mathematics and achievement in mathematics. The article also makes a substantive methodological contribution consisting of two original instruments that can be used to investigate cultural capital and habitus.

2 Cultural capital and the functioning of habitus

Cultural capital can be described as "a long-lasting disposition of the mind and body in the form of cultural goods" (Bourdieu, 2011, p. 84). Cultural capital has three forms: the embodied state (accumulation from childhood which involves pedagogic action and parental investment), the objective state (such as paintings and instruments), and the institutionalised state (such as educational credentials, degrees from prestigious universities) (Reay et al., 2005). Embodied cultural capital is the most widely used form in educational research and most relevant to the current study (Lareau & Weininger, 2003; Quaye, 2014). Embodied cultural capital relates to "dispositions of the mind and body" (Bourdieu, 1986, p. 243) and is gained through an accumulation of labour of familial investment to be used in the educational field. Students use this embodied cultural capital to secure privileges and improve academic achievement. Middle-class students possess the cultural capital which enables them to be "naturally distinguished from those who are obliged to strive for distinction" (Bourdieu, 1990, p. 11). On the other hand, the working class is "discursively constituted as an unknowing, uncritical, tasteless mass from which the middle class draw their distinction" (Reay, 2001, p. 335). Educational systems recognise the cultural capital that students bring to the educational field and which allows them to meet institutional expectations (Laurea & Weininger, 2003). Scholarship over the last decade has pioneered the exploration of forms of capital specific to particular academic disciplines, for example, science capital (Turnbull et al., 2019) and mathematical capital (Jorgensen, 2018).

Bourdieu (1986, p. 48) stated that "this embodied capital, external wealth [is] converted into an integral part of the person, into a habitus". Habitus represents the disposition of a socialised individual, and it is expressed through ways of "standing, speaking, walking, and thereby feeling and thinking" (Bourdieu, 1990b, p. 70). One of the reasons for using habitus in this study is that habitus provides a method for simultaneously analysing "the experience of social agents and ... the objective structures which make this experience possible" (Bourdieu, 1988, p. 782). There have been many critiques of Bourdieu's concept of habitus because it is viewed as deterministic and lacks room for consciousness and agency (DiMaggio, 1982). Nonetheless, Bourdieu and Wacquant (1992) countered the charge of determinism by suggesting that habitus allows individuals to escape "both the objectivism of action understood as mechanical reaction 'without an agent' and the subjectivism which portrays actions as the deliberate pursuit of conscious intentions" (p. 121). Habitus is in fact ingrained in the history of a person (Bourdieu, 1992), but "may be changed by history, that is by new experiences, education, or training" (Bourdieu, 2002, p. 29).

Additionally, the prominence of habitus was well articulated by Bourdieu as "the basis of perception and appreciation of subsequent experience" (Bourdieu, 1977b, p. 78). Therefore, to make an authentic claim about the impact of cultural capital on the achievement gaps in mathematics, it is vital to use habitus and cultural capital together. Dumais (2002) and McClelland (1990) both operationalised habitus as occupational aspirations for white-collar jobs. This study is more specific, operationalising habitus as an aspiration for mathematics-related careers.

In *Outline of a Theory of Practice*, Bourdieu (1977b) explains how the complex relations between field, capital, and habitus result in practice. Students' habitus comes initially from the family socialisation and secondly through their school experiences. Bourdieu pointed to the relational link between them using the following formula: [(habitus) (capital)] + field = practice (Bourdieu, 1984, p. 101). The habitus, which tends to orient a parent's view of the social world, manifests at the level of aspirations that a student will bring to the educational field and therefore, the attitudes that they show in their learning of mathematics are already ingrained in the student.

3 Attitudes towards mathematics

As students "produce practices by the schemes engendered by history", then the traces of their history will be reflected in attitudes towards mathematics—the feeling and behaviour about mathematics influenced practice (Bourdieu, 1984, p. 82). Despite a relatively long history of research into attitudes towards mathematics, it is "not possible to offer a definition of attitude towards mathematics that can be suitable for all situations, and even if one were agreed on, it would be too general to be useful" (Kulm, 1980, p. 358). The definition of attitude has evolved over the many decades since Allport (1935) with varying definitions given by researchers (Hannula, 2011). A widely cited definition is that attitude is an "affective response that involves positive or negative feelings of moderate intensity" (McLeod, 1992, p. 581). Zan et al. (2006) expanded on the work of McLeod (1992), using a grounded theory approach to affect and self-regulation. In summary, attitude remains an ambiguous construct with most research using working definitions, so it presents some difficulty in comparing research findings. For this study, we adopt the definition "the cumulative measure of engagement in mathematics learning influenced by individual habitus and cultural capital" (Quaye, 2014, p. 59).

The first of our four attitudes to mathematics subscales is self-confidence in learning mathematics which is sometimes researched under the term *self-concept* (Shavelson & Bolus, 1982). Kyriacou and Goulding (2006) suggested that boys have higher academic self-concepts than girls about mathematics. Girls, on the other hand, tend to have low confidence and mathematics-related anxiety, and, therefore, have an overall negative perception of mathematics (Hannula, 2002). The main reasons boys continue with mathematics learning is for a career or the usefulness of mathematics but girls mostly study mathematics because of enjoyment of the subject (Williamson, 2004). It is troubling to observe that even if females are successful in mathematics, confidence tends to remain low. This is evident because the females' lack of confidence reflects in lower participation in high-level mathematics courses (Chipman & Thomas, 1985). Beyond this, masculinity of mathematics is both historically rooted and active in contemporary culture (Mendick, 2006; Marquis, 2018; Jaremus et al., 2020). Self-confidence has been identified by many researchers as a good determinant of success in mathematics (Linn & Hyde, 1989; Pomeroy, 2016). The more confident students are in their learning of mathematics, the more likely they are to continue with mathematics at a higher level (Hackett, 1985; Mazenod et al., 2019).

3.1 Parents' attitudes towards mathematics

Parents have a significant impact on shaping the world view of their children, and their attitudes are "the single biggest factor in children's educational success" (Merttens, 1999, p. 79). Students are born into families who have different experiences of school and specifically their parents have diverse feelings and attitudes towards mathematics. Parents' attitudes towards mathematics may be positive or negative, and as students encounter the familial field through early socialisation, they acquire certain dispositions based on their family experiences

(Bourdieu, 1977a). Tocci and Engelhard (1991) argue that members of a student's family, in particular fathers, influence students' attitude formation. Additionally, parents' own biases are used to influence students' subject and career choices and their engagement in the learning of mathematics. Eccles (1993) argues that "parents form impressions of their child's interest and abilities in general based on their own biases. Parents communicate their beliefs and attitudes about mathematics and its utility through their individual practices" (p. 3). A range of qualitative studies has established a link between students' and parents' attitudes towards mathematics (Larkin & Jorgensen, 2015; Usher, 2009). Essentially, parents' attitudes have a significant impact on students' achievement and attitudes. It is therefore expected that the students' attitudes towards mathematics will subsequently impact their achievement in mathematics and students from middle-class families will have both higher achievement and more positive attitudes towards mathematics than those from working class families. In the current study, we therefore expected to observe a positive correlation between students' attitudes to mathematics and students' perceptions of their parents' attitudes to mathematics.

3.2 Students' attitudes towards mathematics and achievement in mathematics

For decades, researchers have reported reciprocal causal influence between achievement and attitudes (Hannula, 2002; Papanastasiou, 2002; Moyer et al., 2018). Tapia (1996) claimed that "a student's attitude is the most important factor in success" (p. 12). Since not all students have positive attitudes towards mathematics, the common reasons for their negative attitudes are due to the feeling of difficulty of mathematics and experiences of failure (Usher, 2009). On the contrary, students who receive support from their parents and teachers tend to have positive attitudes towards mathematics.

Several studies have found that positive affect declines over time as students progress through secondary schooling (Hannula, 2002; Kaczala, 1980) and argue that this decline is more pronounced in secondary school than middle school (Wilkins & Ma, 2003). For example, Hallam and Deathe (2002) reported a decline in mathematics self-concept between years 9 and 10 of secondary schooling. Some scholars attribute this decline to the fact that as students progress through school, the mathematics taught becomes more abstract and further away from their everyday experiences (Boling, 1991). Hyde et al. (1990) claimed that where differences did occur in attitudes towards mathematics between males and females, the females portrayed more negative attitudes, although more recent studies demonstrate that this gender effect is not present in all cultures (Sarouphim & Chartouny, 2017). Studies have highlighted gender differences in mathematics achievement across countries, although such differences are often marginal and sometimes absent (Else-Quest et al., 2010; Pomeroy, 2016; Sarouphim & Chartouny, 2017). Understanding the underlying causes of gender differences in mathematics achievement and attitudes is crucial in promoting the study of mathematics beyond compulsory secondary education. As students take different positions within the educational field, they "showed critical awareness that the images they held of mathematicians were clichés, and often both used them to distance themselves from them" (Mendick et al., 2008, p. 33). So "for both men and women, gender is increasingly taking the form of a self-conscious artifice which can be managed, strategically deployed and performed" (Adkins, 2004, p. 202). Due to the function of students' habitus within the educational field, students can improvise their relationship towards mathematics learning at any given time.

Although a quantitative study by Papanastasiou (2002) in a Cyprus middle school suggested that students' achievement could not be statistically predicted by their attitudes and beliefs, Hannula's (2002) ethnographic study of eighth-grade female students found that a high score in an exam due to an increase in understanding led to a positive attitude towards mathematics. In this case study, the emotional student expectation was reported to be more positive. The research reported that "attitudes sometimes can change dramatically, in a relatively short time" (Hannula, 2002, p. 42). In this study, it was suggested that "the negative attitude towards mathematics can be a successful defence strategy of a positive self-concept" (Hannula, 2002, p. 42). This finding confirms earlier studies by Tapia and Marsh (2001) of attitudes of 7th to 12th -grade students and they reported that "achievement levels influenced value, motivation, and enjoyment at all grade levels" (Tapia & Marsh, 2001, p. 14). Taken together, these studies highlight the complexity of attitudes towards mathematics, showing that parental attitudes, teaching practices, and prior attainment, can all influence students' attitudes. Before discussing the results, we describe the methodology applied in this study.

4 Methods

A mixed methods approach employing structured questionnaires, semi-structured interviews, and mathematics assessment data was utilised in the wider study on which this paper draws (Quaye, 2020). In this article, we report on questionnaire and assessment data. We recognise that much recent educational research drawing on Bourdieu's conceptual tools uses qualitative methods; however, we also note the prominence of survey methods and quantitative analysis in Bourdieu's (1984) early empirical work and in recent educational studies which operationalise concepts including habitus and capital using survey methods (Turnbull et al., 2019; Pomeroy, 2021).

4.1 Participants

There were 1079 respondents drawn from three co-educational, comprehensive secondary schools in England: 541 female and 538 male. The main ethnicities were White English (224), White British (291), Pakistani (107), Indian (150), Afghan (30), Mixed (48), Black African (66), Black Caribbean (13), and Other Asian (77). The proportion of students classified as working class based on self-report indicators was 76%, compared with 24% of students classified as middle-class. The proportion of students classified as middle class in this study is much lower than the wider UK proportion of 59%, or the OECD average of 61% (OECD, 2019). The research was conducted in three secondary schools (years 7–11 or grades 6–10) in the South-East of England: "Newton Academy" in a suburban area with 20% of students in receipt of free school meals and graded by OFSTED as "Outstanding"; "Ohms College" located in a major city with 25% of students in receipt of free school meals and graded by OFSTED as "Good"; and "Obama School" in a rural area with 13% of students receiving free school meals and graded by OFSTED as "Requires Improvement". For comparison, the percentage of students nationally receiving free school meals was 13.9%. The schools were selected for their heterogeneity in terms of location and quality category and for their relatively high level of socio-economic and ethnic diversity. School names are pseudonyms.

Respondents were aged 14 to 16 and had started their General Certificate Secondary Education (GCSE) mathematics course that leads to an examination at the end of compulsory secondary education at age 16 and which is an entry requirement for many educational and employment options. At the start of data collection, students without Key Stage 2 (end of year

6) mathematics data were excluded from the analysis because it would be impossible to measure progress without prior attainment data.

4.2 Instruments

The student surveys used for this study consisted of 85 items which included four student attitude subscales (*enjoyment*, *value of mathematics*, *motivation*, *and self-confidence*), perceived parental attitudes towards mathematics, cultural capital and habitus scales, and indicators of social class.

4.2.1 Student attitudes towards mathematics

For student attitudes towards mathematics (ATM), we used Tapia and Marsh's (2002) 40-item Attitudes Towards Mathematics Inventory (ATMI) which was first validated by Tapia (1996) and used a five-point Likert scale, 1=strongly agree and 5=strongly disagree. The *confidence in mathematics* subscale consists of 15 items that are linked to students' expectations of succeeding in learning mathematics. The statements include positively worded items (for example: "I can solve mathematics problems without too much difficulty" and "I believe I am good at solving mathematics problems") and negative reverse-coded items (for example: "Mathematics is one of my most dreaded subjects" and "Studying mathematics makes me feel nervous").

The second subscale was *motivation in mathematics*, designed to measure students' interest in and desire to study mathematics. Many approaches to capture the quality of an individual's motivation for learning mathematics have failed to provide sufficient detail (Hannula, 2006), because researchers have assumed students are motivated to seek knowledge and will communicate that when asked. The motivation subscale comprises five items, ranging from positive to negative statements (for example: "I am confident that I could learn advanced mathematics" and "I would like to avoid using mathematics in college").

The third subscale consists of 10 items and measures students' beliefs about the *usefulness of mathematics* in their life and for the future. In the UK, like many countries, the importance of mathematics cannot be overemphasized because "mathematics is crucial for economic development and technical progress" (ACME, 2011, p. 4). It is a widely held view that "mathematics is a critical skill for all, including to those who have not achieved a Grade 'C' at GCSE by age 16" (Hodgen & Marks, 2013, p. 1). This subscale assessed the extent to which such views are held by students themselves. Example items are "Mathematics is a very worthwhile and necessary subject" and "Mathematics helps develop the mind and teaches a person to think".

The final student attitude subscale was designed to measure the extent to which students *enjoy* working in mathematics lessons and solving mathematics problems, a dimension of learning which is important not only because students spend so much time in mathematics classes, but also because enjoyment has been shown to correlate positively with achievement (Ma, 1997). However, according to research by the Programme for International Student Assessment (PISA), there is a lack of enjoyment of mathematics generally (OECD, 2004). Furthermore, there is a difference in the way boys and girls experience enjoyment in the learning of mathematics and students' emotions about mathematics learning can change rapidly (DeBellis & Goldin, 2006). This scale consists of 10 items on which students reflect their enjoyment of mathematics, ranging from positive to negative statements (for example: "I get a great deal of satisfaction out of solving a mathematics problem" and "Mathematics is dull and boring").

Responses were added together to represent an overall student attitude score. The theoretical maximum score across the four student attitudinal subscales was 200 and the minimum 40. The Cronbach alpha reliabilities calculated from our analysis for the attitude subscales were as follows: *enjoyment* (.91), *value of mathematics* (.93), *motivation* (.73), *self-confidence* (.92), and overall students' *attitudes towards mathematics* (.86), indicating good internal consistency for all subscales and the attitude scale overall.

4.2.2 Perceived parental attitudes towards mathematics

For perceived parental attitudes, we used the Fennema-Sherman Mathematics Attitudes Scale (Fennema & Sherman, 1976). The scale was completed by students and was therefore operationalised using student perceptions of parental attitudes towards mathematics as a proxy for parental attitudes. This scale consists of twelve statements such as "My parents have strongly encouraged me to do well in mathematics" and "My mother or father hates to do mathematics" (reverse-coded) and used a five-point Likert scale, 1=strongly agree and 5=strongly disagree. The Cronbach alpha for the scale was .83, indicating good internal consistency.

4.2.3 Cultural capital scale

The first author constructed original habitus and cultural capital scales for the survey based on the literature available. These scales were piloted before the data collection. The nine indicators of cultural capital were "I attend dance classes"; "I attend art classes"; "I attend musical performances and concerts"; "I borrow books from my local library"; "I visit Museums and Art Galleries"; "I visit the theatre"; "I use social media sites"; "I watch sports"; and "I play sports" (Quaye, 2015). Students responded on a five-point Likert scale of never = 1, Rarely = 2, sometimes = 3, most of the time = 4, and always = 5, giving the cultural capital scale a theoretical minimum of 9 and theoretical maximum of 45. The Cronbach alpha for *cultural capital* (.62) indicated good internal consistency. If there are less than 10 items on a scale similar to the cultural capital scale, then it is difficult to get a high alpha value, so a common threshold is $\alpha > .5$ (Brownlow et al., 2004).

4.2.4 Habitus scale

Quantitative or mixed method studies that have operationalised habitus alongside cultural capital have been scant (Turnbull et al., 2019). Dumais (2002) operationalised habitus as students' expectation to have specific occupations by the age of 30, and McClelland (1990) used habitus as a representation of students' occupational aspirations to have an upper "white collar" job. We have considered the difficulties associated in operationalising habitus (Quaye, 2015) and opted to operationalise habitus as students' mathematics-related career aspirations. The habitus scale began with the instruction "This section measures your aspiration for a future career in a mathematics-related job." The careers listed were mathematician, statistician, engineer, meteorologist, mathematics teacher, insurance broker, accountant or banker, games designer, computer programmer, lawyer, and nurse or doctor. Students responded to each item on a three-point scale: yes = 3, maybe = 2, and no = 1, meaning the scale had a theoretical minimum of 11 and theoretical maximum of 33. The Cronbach alpha for *habitus* (.81) indicated good internal consistency.

4.2.5 Demographic variables

Social class was operationalised using a composite measure similar to the Great British Class Survey (GBCS) because the approach involves Bourdieu's concept of cultural capital, parental education, and occupation to categorise students' social class (Savage et al., 2013). Using a cultural capital score calculated for each student, parents' education (reported as university education for mother or father or both) and parents' occupation were used to allocate students to the corresponding social class groupings.

Ethnic data were generated from a single open-response survey item "What is your ethnicity? (e.g., White British, Black African, British Chinese, etc)" and responses were coded to ethnic categories used in England's Pupil Level Annual School Census (PLASC). Gender data were based on a single survey item "What is your gender?" with options "male", "female", and "other" (not selected by any student).

4.2.6 Achievement in mathematics

Mathematics achievement data in the form of GCSE style school internal assessment grades were collected from each school based on reported internal assessment information. The GCSE grades were A*-G and were converted to numerical equivalents for analysis.

4.3 Analysis

The survey data were analysed to gain insights into how perceived parental attitudes towards mathematics affect both students' attitudes towards mathematics and achievement in mathematics. We also examined how social class, habitus, and cultural capital affect attitudes towards mathematics. Descriptive statistics such as means, and standard deviations provide summaries of the main attitude and achievement outcomes and enable data visualisation. We also present social class comparisons of some key outcomes, presented visually in bar graphs and analysed using inferential statistics including *t*-tests. The confidence intervals for statistical significance were set at 95% and techniques including correlation matrix (Spearman's rank correlation), general linear modelling, and hierarchical multiple regression were utilised to further understand the strength and direction of the relationships between variables. Due to the rather high number of comparisons included in some analyses, we controlled for overall type I ("false positive") error inflation using the Bonferroni correction technique, which sets the alpha level lower than the conventional .05. For example, when calculating pairwise correlations between achievement in mathematics and five independent variables, we used a more stringent new *p*-value of .01 ($p<.05/5$) to determine whether correlations were statistically significant. The corresponding drawback of using Bonferroni correction is that it can lead to type II ("false negative") errors because the statistical power to detect the effect of interest whilst controlling the familywise error rate is greatly reduced (O'Keefe, 2003).

5 Results

Figure 1 shows a *social class* comparison of *perceived parental attitudes towards mathematics*. Middle-class students reported a higher mean score for *perceived parental attitudes towards mathematics* (M = 48.1, SD = 6.4) than working-class students (M = 45.3, SD = 7.7), $t(1077) = 5.4$, $p < .001$, $d = 0.40$. An effect size of 0.40 is in the small-medium range by generic guidelines; however, given the complex and self-reinforcing relationship between familial attitudes and achievement (Kleanthous & Williams, 2013), this result should be interpreted as not only statistically significant but also practically and sociologically significant.

Figure 2 shows the *social class* differences in mean scores for students' *attitudes towards mathematics*. Overall students' *attitudes towards mathematics* for middle-class students were positive with a total mean score of 144.1 ($SD = 24.5$), whereas working-class students reported a mean score of 136.7 ($SD = 25.8$), indicating a neutral *attitude towards mathematics*, $t(1077) = 4.1$, $p < .001$, $d = 0.29$. The direction and statistical significance of the social class difference in students' *attitudes to mathematics* were consistent across all four attitudinal sub-scales and within each of the three participating schools. These results suggest that the relationship between class privilege and positive *attitudes to mathematics*, observed in prior studies (Evans & Field, 2020), was present for students in the current study, and most likely for their parents. This result is consistent with extant literature which points to the strong impact of parents' *attitudes towards mathematics* on students' attitude formation and *attitudes towards mathematics* (Evans & Field, 2020; Tocci & Engelhard, 1991). However, this result does not conclusively imply that *parental attitudes to mathematics* influence their children's *attitudes to mathematics*. A plausible alternative (or parallel) explanation of the result would be that social class influences attitudes to mathematics for both parents and children. Furthermore, the result does not in itself suggest a mechanism for intergenerational transmission of attitudes to mathematics. We have suggested that *cultural capital* and *habitus* could shed further light on the relationship between students' attitudes to mathematics and those of their parents.

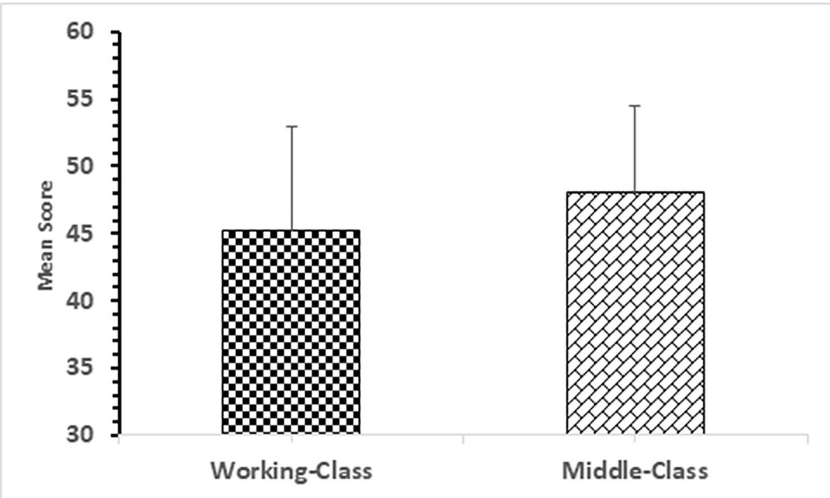

Fig. 1 Perceived parental attitudes towards mathematics mean scores by social class. Note: Number of working-class students = 832, number of middle-class students = 256, total N = 1079

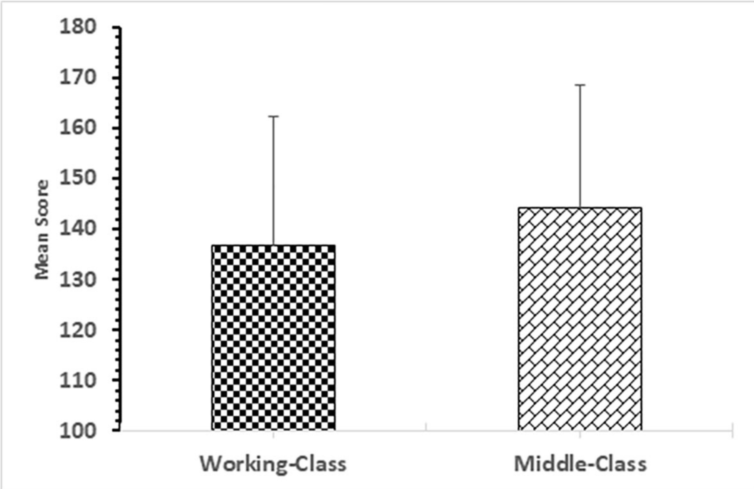

Fig. 2 Students' attitudes towards mathematics mean scores by social class. Note: The minimum score is 40 and the maximum is 200. Number of working-class students = 832, number of middle-class students = 256, total *N* = 1079

Figure 3 shows a *social class* comparison of cultural participation scores (*cultural capital* index). The mean scores for students' *cultural capital* participation according to social class groupings shows that middle-class students had a marginally higher *cultural capital* index ($M = 22.2$, $SD = 5.8$) than working-class students ($M = 21.6$, $SD = 6.1$), although this result did not reach statistical significance despite the large sample, $t(1077) = 1.4$, $p = .16$, $d = 0.10$. The most popular *cultural capital* activity was using Facebook, Twitter, Tumblr, or other social networking sites, for both middle-class students ($M = 4.1$, $SD = 1.2$) and working-class students ($M = 4.2$, $SD = 1.2$). Overall, middle-class students reported higher levels of participation in

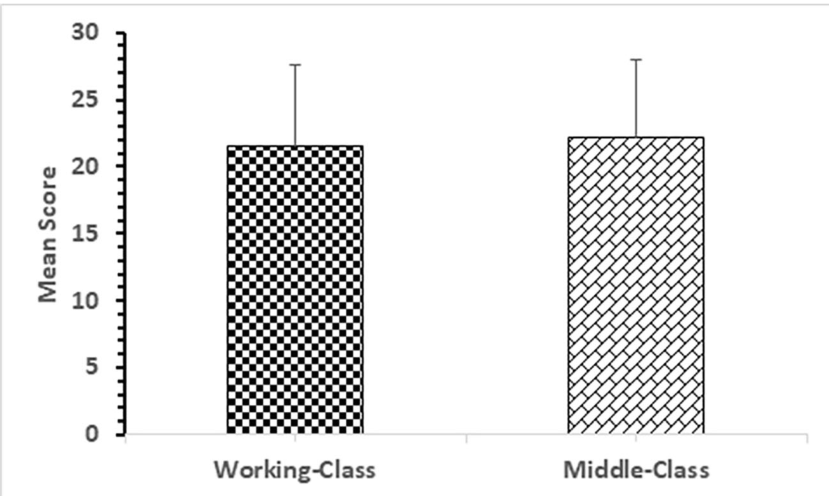

Fig. 3 Cultural capital indices mean scores by social class. Note: The minimum score is 9 and the maximum is 45. Number of working-class students = 832, number of middle-class students = 256, total *N* = 1079

cultural capital activities than working-class students across all ten activities, except for attendance at art classes and use of social media.

Figure 4 shows an item-by-item social class comparison of students' responses to the *habitus* scale. Across the eleven mathematics-related careers used to operationalise the *habitus* index, students' *habitus* varied across *social class*, *gender*, and *ethnicity*. The mean *habitus* index was lower for working-class students (M = 15.3, SD = 4.9) than middle-class students (M = 16.1, SD = 5.1), with a small but statistically significant effect $t(1077) = 2.44$, $p = .02$, $d = 0.17$, indicating that middle-class students are more likely than working-class students to imagine themselves in mathematical careers. This result was consistent across all career types except games designer, for which there was no significant social class difference. This finding is consistent with recent New Zealand research showing that middle-class 13-year-old students were more likely than their working-class peers to imagine themselves in stereotypically mathematical careers (Pomeroy, 2021). It is also consistent with the argument that working-class parents aspire for their children "to gain a basic education, stay out of trouble and survive the psychological injuries of school failure took precedence … [rather than] a more middle-class concern with academic performance" (Gillies, 2005, p. 845). The results show that the most likely mathematics-related career aspiration for working class-students is Nurse or Doctor with a *mean* score of 1.6 (SD = 0.8) compared to middle-class students for the same career reported *mean* score of 1.8 (SD = 0.9). The highest *mean habitus* index score for middle-class students' mathematics-related career is lawyer at 1.8 (SD = 0.9) compared with a working-class score of 1.7 (SD = 0.9).

Habitus also varied by *gender* and *ethnicity*. Males had a higher *habitus* index (M = 16.5, SD = 5.3) than females, with a moderate and strongly significant effect size (M = 14.4, SD = 4.3), $t(1077) = 7.3$, $p < .001$, $d = 0.43$. It was interesting to observe that this gender difference in mathematical career aspiration was consistent across both middle-class and working-class students. In addition, the career aspirations by *ethnicity* show "Afghan" students (M = 17.8, SD = 4.6) having the highest habitus index across the eleven *ethnicity* groups, followed by "Other White" students (M = 17.7, SD = 5.3). At the opposite end, the lowest *habitus* index score was reported by "Black Caribbean" students (M = 13.8, SD = 2.3) followed by "White British"

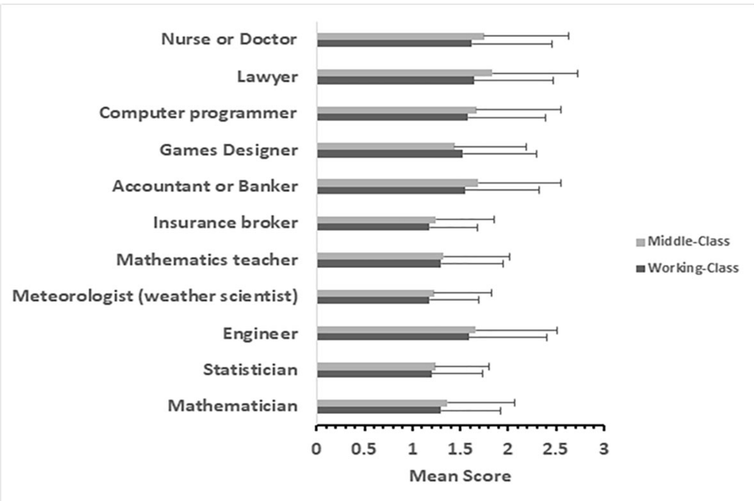

Fig. 4 Habitus indices mean scores by social class. Note: The maximum item score is 3

students (M = 14.8, SD = 3.9) which is a notable group reporting low aspirations to have a mathematics-related career.

Table 1 shows correlations between the key variables *Achievement in Mathematics* (*AIM*), students' *ATM*, *perceived parental ATM*, *cultural capital*, *social class*, and *habitus*. *AIM* has a significant, positive correlation with students' *ATM* (r_s = .21, N = 1078, p < .001) There is 4.2% of the shared variance between students' *achievement in mathematics* and students' *attitudes towards mathematics*. Although the correlation according to Cohen (1988) is small, there is overall a statistically significant positive correlation between students' *mathematical achievement* and all the *attitudes*' subscales. The highest positive correlation was recorded between *mathematical achievement* and student *self-confidence* (r_s = .24, N = 1011, p < .001), consistent with Pomeroy's (2016) study of New Zealand Year 9 students. Students' *perceived parental attitude towards mathematics* (r_s = .23, N = 1011, p < .001) also correlated as the next highest positive score with students' *mathematical achievement*. These results are consistent with previous studies that show that achievement correlated positively with *ATM* (Ma, 1997), *self-confidence* (Leung, 2002), and *parents' attitudes towards mathematics* (Hall & Davis, 1999).

The correlation between *perceived parents' attitudes towards mathematics* and students' *attitudes towards mathematics* was strong and positive (r_s = .63, N = 1078, p < .001). Importantly in terms of our present focus, *parents' attitudes towards mathematics* help to explain 39.8% of the variance in students' *attitudes towards mathematics*. Also, *habitus* helps to explain 11.7% of variance in students' *attitudes towards mathematics* compared with cultural capital which explains only 1.3% of the variance in students' *attitudes towards mathematics*. From the results, *cultural capital* correlated positively with *parents' attitudes towards mathematics* (r_s = .080, N = 1078, p < .01) and *habitus* (r_s = .12, N = 1078, p < .01). Likewise, *habitus* correlated positively with *Social Class* (r_s = .08, N = 1079, p < .01) and *parents' attitudes towards mathematics* (r_s = .24, N = 1079, p < .001). Furthermore, students' *attitudes towards mathematics* correlated significantly positively with *Social Class* (r_s = .12, N = 1078, p < .01), *parents' attitudes towards mathematics* (r_s = .63, N = 1078, p < .001), *Cultural capital* (r_s = .12, N = 1078, p < .001) and *habitus* (r_s = .34, N = 1078, p < .001).

A two-way ANOVA test of between-subjects effects in Tables 2 and 3 shows the interaction effect between students' participation in *cultural capital* activities and students'

Table 1 Correlation matrix for key study variables

Variable	AIM	Student ATM	Parental ATM	Cultural capital	Social class	Habitus
AIM		.205*** (N = 1078)	.226** (N = 1011)	.093** (N=1011)	.148*** (N=1011)	.130*** (N=1011)
Student ATM			.631*** (N=1078)	.116*** (N=1078)	.119*** (N=1078)	.342*** (N=1078)
Parental ATM				.08** (N=1078)	.166*** (N=1078)	.243*** (N=1079)
Cultural capital					.0533 (N=1078)	.117*** (N=1078)
Social class						.0798** (N=1079)

Notes. * p < .05, ** p < .01, and *** p < .001. N ranges from 1011 to 1079 due to occasional missing data. Bonferroni adjustment used for the p value

Table 2 Test of between-subjects effects for students' ATM

Source	*df*	*F*	*p*	Effect size
(Intercept)	1	5841.77	.000	.921
Cultural capital	34	1.01	.456	.064
Habitus	28	2.69	.000	.131
Cultural capital x habitus	232	1.06	.297	.330
Error	500			

Note. Effect size = $\eta 2$ or partial $\eta 2$

habitus (aspiration to have a mathematics-related career) on the two dependent variables – *Achievement in Mathematics* (*AIM*) and overall students' *attitudes towards mathematics* (*ATM*). When considering two-way interaction effects on the dependent variables, the results indicated that *cultural capital* and *habitus* interaction had no statistically significant effect on overall students' *attitudes towards mathematics* and students' *achievement in mathematics*. This implies *cultural capital* and *habitus* together in the Model had no noticeable combined effect on *AIM* or *ATM* over and above their respective individual effects.

An unexpected finding was that the *cultural capital* index had no statistically significant effect on either students' *attitudes towards mathematics* (*ATM*) or students' *Achievement in Mathematics* (*AIM*). However, *habitus* introduced statistically significant effects on students' *ATM* (F (28, 500) = 1.711, p = .014, $\eta 2$ = .087) and students' *achievement* (F (28, 500) = 2.693, p = < .001, $\eta 2$ = .131). The partial eta squared value shows *habitus* had a moderate effect on students' *achievement in mathematics* but a large effect on students' *attitudes towards mathematics*.

Table 4 shows a hierarchical multiple regression analysis which was conducted to analyse the predictors, including *school type*, *cultural capital index*, and *habitus*, of students' *achievement in mathematics*. Model 1 refers to the first block of variables called the background variables that were entered (*gender*, *ethnicity*, and *social class*). In Model 2, overall students' *attitudes towards mathematics* and *school type* were added. Finally, *cultural capital* and *habitus* were added in Model 3.

Here we present the coefficients showing the contribution of each model to students' *achievement in mathematics*. The first Model showed that *Gender* (β = .08, p < .01), *Ethnicity* (β = .12, p < .001), and *Social Class* (β = .12, p < .001), all have statistically significant effects on students' *achievement in mathematics*. The regression model, F (3, 1006) = 13.34, p < .001) accounted for 3.8% of the variation in students' *achievement in mathematics*. When *school type* and students' *attitudes towards mathematics* were introduced in Model 2 when

Table 3 Test of between-subjects effects for achievement in mathematics (AIM)

Source	*df*	*F*	*p*	Effect size
(Intercept)	1	646.83	.000	.564
Cultural capital	34	1.36	.089	.085
Habitus	28	1.71	.014	.087
Cultural capital x habitus	232	0.97	.608	.310
Error	500			

Note. Effect size = $\eta 2$ or partial $\eta 2$

Table 4 Summary of hierarchical regression analysis for variables predicting students' achievement in mathematics

Predictor variables	*B*	β	*t*
Model 1			
Gender	1.18	.08	2.65**
Ethnicity	.30	.12	4.00***
Social class	1.94	.12	3.73***
Model 2			
Gender	1.48	.10	3.38**
Ethnicity	.17	.07	2.15*
Social class	1.50	.09	2.92**
School type	.90	.11	3.25**
Students' ATM	.05	.18	5.71***
Model 3			
Gender	1.71	.12	3.82***
Ethnicity	.17	.07	2.18*
Social class	1.44	.09	2.81**
School type	.77	.09	2.78**
Students' ATM	.04	.15	4.64***
Cultural capital	.05	.04	1.27
Habitus	.14	.09	2.87**

Note. R^2 = .038 for Model 1, $p < .001$; $R^2\,\Delta$ = .041 for Model 2, $p < .001$; total R^2 = .79, $p < .001$; $R^2\,\Delta$ = .07 for Model 3, $p < .005$; total R^2 = .089. *$p < .05$, **$p < .01$, ***$p < .001$

controlling for the background variables, they explained an additional 4.1% of variance in *achievement in mathematics,* which was significant, F (5, 1004) = 17.25, $p < .001$. *School type* (β = .11, $p < .01$) and *ATM* (β = .18, $p < .001$) also have a significant effect on students' *achievement in mathematics*. This means schools with a higher OFSTED rating have greater impact on students' *achievement in mathematics*, possibly due to the better standards of teaching and learning mathematics. The influence of *school type* is consistent with understandings of educational inequality that acknowledge the importance of both within-school and wider societal influences on students' educational trajectories (Gorard, 2010).

When *cultural capital* and *habitus* variables were added in Model 3, the results indicate a strong effect of *habitus* (β = .09, $p < .01$) on students' *achievement in mathematics* but *cultural capital*, although positively correlated with *achievement in mathematics*, has no unique contribution in the Model. Therefore, it is evident that the higher a student's aspiration for a mathematics-related career (*habitus*), the higher their *achievement in mathematics, whereas participating in "highbrow" cultural activities appears less influential*. Together when all the variables are considered, Model 3 accounted for 9% of the variance in *mathematics achievement*, which was significant, F (7, 1002) = 14.01, $p < .01$.

6 Discussion and conclusion

The objective of this study was to examine the functioning of habitus and social class in students' mathematical achievement and to explore the role of parental attitudes towards mathematics in the intergenerational reproduction of mathematics achievement inequalities. Since students begin to acquire their attitudes towards mathematics during early socialisation, they may internalise views about mathematics which are held by their parents. Students are less likely to be positive about mathematics learning if they have encountered negative views about mathematics from the familial field (Evans & Field, 2020). Students are therefore likely to reproduce their familial habitus. Our observed correlation between students' and parents' attitudes to mathematics is consistent with previous research (Merttens, 1999; Tocci & Engelhard, 1991). It is also consistent with Bourdieu's model of social reproduction because students from middle-class families have a more positive disposition towards mathematics and such dispositions are reproduced across generations (David et al., 2003). It suggests that middle-class students benefit from cultural transmission from their parents for educational success and therefore social class matters in how students learn mathematics in schools. Whilst we have highlighted the influence of parental ATM on students' ATM, we note that the familial field is not the sole influence of students' mathematical dispositions. In particular, we have noted the importance of school quality, and wider societal discourses about mathematics, gender, and ethnicity.

The findings about the function of habitus and cultural capital are revealing. In our data students' participation in cultural activities does not significantly affect achievement in mathematics and this suggests "cultural capital does affect educational outcomes, but in a limited way" (Dumais, 2002, p. 59). This finding is also consistent with a recent study in the related domain of science, which found that familial science capital had a small impact on science self-concept when compared to the larger effect of social class indicators (Turnbull et al., 2020). However, when habitus, which is operationalised as students' mathematics-related career aspirations, is added to the model after cultural capital, it showed a 2.3% increase of variance in GCSE achievement. Also, notwithstanding the students' attitudes towards mathematics as an important marker in achieving well in mathematics, habitus showed a statistically significant effect on mathematical achievement. Such findings highlight the impossibility of disentangling mathematics achievement from its social context. The non-significance of cultural capital as a predictor of mathematics achievement differs from earlier findings, for example, those of DiMaggio (1982) who reported that cultural capital is positively associated with academic results.

The family of a student functions in habitus as a classificatory scheme and principle of the construction of the social world. Consequently, the view of parents is critical in shaping students' social world and beliefs about mathematics. This study underscored that students' attitudes towards mathematics have a strong positive correlation with achievement in mathematics. More importantly, habitus, which carries the traces of students' histories, has a greater impact than cultural capital on students' mathematical achievement. In the long run, parents' attitudes towards mathematics account for approximately 40% of the variance in students' achievement and attitudes towards mathematics. These results imply that parents provide a major influence on students' perceptions of mathematics and therefore condition their aspirations to have a mathematics-related career. However, schools are not independent from social structures, and are therefore responsible for both transmission and conservation of cultural capital from schools to students' families.

The use of habitus in this study has explicated the way class disparities in mathematics achievement manifest and help us to understand how students construct the habitus, which frames their attitudes towards mathematics. Although the use of habitus is specifically operationalised here as aspirations for a mathematics-related career, cultural capital's effect in the regression model is dwarfed by the presence of the habitus variable. The analysis suggests that cultural capital's effect on achievement in mathematics is indirect and weak. Finally, students' attitudes towards mathematics and mathematical achievement have been shown to be strongly influenced by parental attitudes towards mathematics, through students' habitus and the varying amounts of cultural capital that they bring to the educational field. Further research may develop a deeper understanding of the complex interacting effects of gender, ethnicity, and social class on how well students achieve in mathematics given their habitus.

There are several limitations with this study that should be considered alongside the findings. Firstly, as this study explores students' attitudes towards mathematics, "the method of data collection may be fraught in terms of bias and power relations" (Larkin & Jorgensen, 2015, p. 926). Another limitation of the data was the use of a student self-report measure as a proxy for parental attitudes towards mathematics. This results in a lack of independence of the student and parent attitude measures. Plausibly, a tendency to respond more positively or negatively to survey items in general may have spuriously amplified the correlation between student and parent attitude measures. Secondly, the way cultural capital and habitus were operationalised in the study may not be all-encompassing. Particularly, the cultural capital activities may not be representative of cultural capital in the modern-day UK. Finally, the comprehensive schools involved in the study have an over-representation of students from working-class families which may influence the interaction of some of the variables. However, the findings were replicated across each school in terms of social class differences. In addition to an empirical contribution, this article also makes a methodological contribution to the literature.

In summary, consistent with previous research, this study confirms that parents have a significant effect on how students construct their habitus and attitudes towards mathematics (Sullivan & Heath, 2002). Working-class students show traces of their familial habitus regarding mathematics, reporting lower aspirations to have a mathematics-related career than middle-class students. This study extends previous research (Dumais, 2002; McClelland, 1990) that employs cultural capital alongside habitus and posits that perhaps the impact of cultural capital impact on educational attainment has been overemphasized.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10649-021-10078-5.

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