The Effects of Gender and Social Class on Mathematics Outcomes in Scotland

by

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Abstract

This research uses quantitative methods to study gender and social class differences in mathematics performance in Scotland. The data used to carry out this analysis is the Scottish sub-sample from the 2012 OECD Programme for International Student Assessment (PISA). The key variable is the student maths score achieved during the maths assessment. Relevant variables were selected from the data set, after performing a literature review that highlighted the role of cultural capital, habitus, subject choice, language and patriarchy on maths outcomes.

Initial analysis considers mean math score values for populations broken down by each of the independent variables. Ordinary least square regressions were carried out to consider what affects student maths score, building up a final model from regressions on each set of independent variables.

The research concludes that being female has a negative effect on maths score, confirming concerns around female involvement in maths. The key social class variable was parental occupational status, which has a positive effect on maths score as occupational index increases. Social class was found to be related to cultural capital, which in turn has a strong effect on maths score. Analysis shows that there is a structural difference between what affects male and female students' maths scores.

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1. Introduction

This research uses quantitative methods to study gender and social class differences in maths performance in Scotland, with the primary research question being: do gender and class have a significant effect on Scottish students' maths scores? The data used to carry out this analysis is the Scottish sub-sample from the 2012 OECD Programme for International Student Assessment (PISA) with the dependent variable being student maths score. Further questions include whether cultural capital, socialisation and future study intentions have a significant effect on maths score and whether there is a structural difference between what affects male and female students.

Relevant variables were selected from the data set, after performing a literature review that highlighted the role of cultural capital, habitus, subject choice, language and patriarchy on maths outcomes. Initial analysis considered sub-group means to identify whether any characteristics had an effect on maths score. Ordinary least squares (OLS) regressions were performed in three ways. Initially regressions were used to ascertain what variables had a significant effect on maths score; these were kept for the final regression. The sample was then reduced to allow for comparison between the regressions. Thirdly, the final regression was repeated while systematically removing variables to consider how each of the independent variables interacted.

The Scottish Government (Boyling et al, 2013) carried out research on the PISA data; however, this did not include investigation into the key factors identified in the literature review. The Joseph Rowntree Foundation (Sosu and Ellis, 2014) recently highlighted the gap in educational success between students from the richest and poorest families in Scotland, yet required further enquiry into the causes of this. The gender skills gap in the field of science, technology, engineering and maths (STEM) has been a concern over the last 40 years (Phipps, 2008) and was recently raised as a key equalities focus within the Developing the Young Workforce policy, which aims to reinvent the vocational curriculum in Scotland (SG, 2014).

Within an academic context there remain fewer studies on samples of Scottish school students than English school students. While quantitative research is abundant within educational research, fewer quantitative studies are used to consider the effects of gender or habitus on educational outcomes (Edgerton & Roberts, 2014).

To the end of S3 students (14 to 15 years old) are required to learn a broad range of subjects under the Broad General Education (Education Scotland, 2015[3]); this is extended to the Senior Phase where students can specialise and begin to prepare for examinations. However, most students are required to continue mathematics and English lessons at this stage. It is from the age of 16 that maths can be taken as a non-compulsory course. The Scottish Curriculum for Excellence (CfE) aims to build four capacities within all students, making them successful learners, confident individuals, responsible citizens and effective contributors (Education Scotland, 2015[1]).

This dissertation will begin by covering the relevant literature on what affects student maths performance, giving a summary of the main research questions and hypotheses. It will then discuss the methods used, including the complexities of the PISA data. The analysis section has three main areas: initial analysis, regression analysis and reliability checks. The final section will discuss the findings of the analysis within the context of the literature and consider the implications for the Scottish education system.

2. Literature review

Education has often been seen as a mechanism for reducing inequality by generating mobility between social classes. Bourdieu claims that although this is possible, educational practice instead preserves the arbitrary dominant culture in society, reproducing social inequalities (Webb et al, 2002, 106). The two key ideas that Bourdieu relies on to make this claim are cultural capital and habitus.

2.1 Cultural Capital

Cultural capital is both an individual's access to cultural practice and products, but also their ability to effectively embody these cultural experiences.

Bourdieu helpfully categorises cultural capital into three groups: objectified, embodied and institutionalised cultural capital (Bourdieu, 1986). Objectified cultural capital refers to the cultural goods that individuals can own, such as books, art and technology (ibid). This is the form of cultural capital most frequently discussed in quantitative analysis (Edgerton & Roberts, 2014, 206). Embodied cultural capital is the long-term dispositions and skills developed through familiarisation with objectified cultural capital (Bourdieu, 1986). Finally, institutionalised cultural capital is that which is "officially accredited", such as educational qualifications (Edgerton & Roberts, 2014, 206), and is therefore both an outcome of access to cultural capital and a form of cultural capital. This definition suggests that measures of cultural capital should consider its diverse nature, taking into account these three forms of cultural capital.

As Bourdieu astutely points out, it is here that "the school fails to give explicitly to everyone that which it implicitly demands of everyone" (in Sullivan, 2001, 910), leaving a gap between those who have and have not been familiarised with the dominant culture at home. For example, schools expect students to understand lesson content, have a positive attitude to learning and a suitable vocabulary, all of which require students to have been familiarised with these at home.

The role of parents is key in transmitting cultural capital to their child through informal education, communication and in how they invest economic capital, particularly in access to educational cultural experiences that position their children well in the education system.

It is due to this unequal footing that social structures of power and inequality are reproduced. Educational attainment requires individuals to familiarise with the dominant culture, which children from lower classes are unable to realise. Bourdieu claims that this therefore means that they are less able to gain qualifications.

In the UK, educational qualifications have the power to determine an individual's future occupation, status and power. Qualifications in areas where there are high levels of cultural capital required, either as embodied or objectified, such as English literature, science and in some cases mathematics, are highly valued by employers and further education establishments. In a society with a growing demand for qualified workers, attainment in these subject areas allows students access to the top jobs associated with the ruling classes, yet these successful students more often than not are the children of the ruling classes (SMCPC, 2014).

The students most likely to succeed in these subject areas have access to cultural capital at home and are therefore more likely to come from a family where the parents are members of the ruling class. This means that children from working class backgrounds are less likely to gain these sought after qualifications and remain in similar work to their parents, resulting in the reproduction of the social class system.

Sullivan's (2001) research into cultural capital and educational attainment found that cultural capital is strongly associated with parental social class and qualifications. Her research also found that the schools in her study did not transmit cultural capital[1] (ibid), reinforcing her earlier comment that schools expect something that they do not provide. This validates Bourdieu's claim that parents transmit cultural capital to their children.

In respect to educational attainment, it was found that the cultural capital of students and parents did have an effect on students' GCSE performance (Sullivan, 2001). However, this finding was not gendered, suggesting that parental cultural capital is transmitted equally to both boys and girls. Gendered distributions of cultural capital will be further investigated in this research.

[1] Although Sullivan does suggest that looking at private, grammar and state schools could affect this result.

2.2 Habitus

"*Habitus* is the learned set of preferences or dispositions by which a person orients to the social world. It is a system of durable, transposable, cognitive 'schemata or structures of perception, conception and action'" (Bourdieu in Edgerton & Roberts, 2014, 195)

An individual's habitus is developed through socialisation within the family, through the informal and unconscious learning that takes place within the home, and is determined by their position within society (Edgerton & Roberts, 2014). Individuals who occupy a similar position in the social structure, including a similar class background, are likely to have a similar habitus.

In an educational context these preferences and dispositions would include characteristics such as a student's attitude to school and learning, including whether they believe certain knowledge to be useful, modes of reasoning, communication, values and social understandings (Nash, 2002).

Therefore, for individuals who have an 'educated habitus', one in which education is valued, acted upon and usually encouraged in the home, there is an easy transition from life at home to life in school. These students can easily navigate school, fitting in with what it expects from them. Yet, students from other backgrounds may experience conflict between their habitus and the characteristics and expectations of the school (Webb et al, 2002).

2.3 Subject choice

In Scotland, subject choice is free beyond the age of 16; until then mathematics education is compulsory. How then does subject choice relate to gender inequalities?

Quantitative studies have found a clear difference between the number of girls and boys that choose to take mathematics (Roger & Duffield, 2000; van Langen et al, 2006; Croxford 2000).

Mendick points out that mathematics is more than just a school subject; it is a "signifier of intelligence that acts as a 'critical filter' (Sells, 1980) controlling entry to high-status areas of academia and employment" (Mendick, 2005, 236). Therefore, female students choosing not to take non-compulsory mathematics further increases gender inequality later in life.

Mendick (2005) interviewed female students who did choose to progress onto advanced mathematics at school. She discusses how that in choosing mathematics the girls in her study “were doing masculinity” and how performances of masculinity, in this case taking maths and the actions associated with this, interacted with the girls’ day-to-day lives as women. The identification of mathematics with the masculine is a social construct, which causes conflict between the habitus of female students as feminine and their opportunity to learn mathematics. In turn, this affects girls’ subject choices and ability to perform within maths classes.

Roger and Duffield also point out that “Career aspirations (Durndell *et al.,* 1990) evolve from interactions between the way individuals see themselves and the opportunities they perceive to be open to them” (Roger & Duffield, 2000, 374). As male-dominated careers, such as those in STEM, have the label of ‘masculine’, students’ awareness of these labels affects their perception of this field as an appropriate option for them, in turn generating further gender division within the field. Female students are faced with concerns around how they can ‘fit in’ to this masculine environment without rejecting femininity.

Parental opinions around what subjects are appropriate for male and female students were also found to have a strong effect on what subjects their children selected (Roger & Duffield, 2000; Croxford, 2000). This again suggests that socialisation at home, which determines habitus, directs a student’s pathway in education. Having prior gendered preferences and dispositions, through socialisation, makes it harder for female students to both relate to the value of mathematics and the content of the mathematics curriculum.

2.4 Language

The complex and abstract nature of mathematical language is one way in which mathematics asserts its status within the classroom. Both an ‘educated habitus’ and cultural capital allow students to use more complex language, such as that found in maths and science as well as languages and classical literature. Therefore, the nature of mathematical discourse could negatively impact on both female students and those from working class backgrounds.

Sullivan (2001) found that linguistic ability was transmitted at home and affected by reading and watching sophisticated TV. This suggests that cultural capital has an important role in developing an individual’s habitus, in parallel to Bourdieu’s theory.

In the same way that Mendick (2005) describes “doing maths” as “doing masculinity”, mathematical discourse can also be considered as male discourse. Roger and Duffield sum up the language of STEM as reflecting "a masculine, white, Eurocentric power-knowledge discourse" (Roger & Duffield, 2000, 378). Therefore, when girls are socialised into the use of a non-scientific vocabularies, their capacity to engage in the content of mathematics classes is reduced. This is due to a lack of *fit* between how the maths class demands language to be used and the vocabulary of the female student.

However, Nash also points out that the "modern scientific and mathematical curriculum is essentially correct in its representation of the world and should therefore be recognised as non-arbitrary in that respect" (Nash, 2002, 43). Considering the non-arbitrary nature of much of the content of the maths curriculum it would seem that it is the skills developed through cultural capital in adapting to new types of complex discourse combined with the effects of not being fluent in masculine discourse that can disadvantage students in their ability to succeed in mathematics.

2.5 Patriarchy

The feminist concept of patriarchy links together two of the concerns discussed above: habitus and subject choice.

An individual's habitus is developed through early socialisation, primarily in the home. This rings true to ideas expressed in feminist literature where individuals are believed to socialised into masculinities and femininities at youth:

"Every girl (or boy) has a unique view of the world and life [...] Their individual views and their unique positioning in relation to aspects of 'femininity', for instance, are continually changing. These are formed out of their own experiences, family, friends, the media [...] and the 'formal' education of school" (Walkerdine et al, 2001, 109)

Girls' understanding of what is suitable behavior is reinforced by the social structures around them, including beliefs about masculinity and femininity, and therefore can be considered an aspect of their habitus. For example, beliefs that males are rational problem solvers and females are emotional and non-rational are created and reinforced by society. These gender stereotypes affect female involvement in mathematics, as it is viewed as a masculine subject, and their conception of their ability, linked to ideas of women as irrational. Ultimately this can have a negative affect on their ability, as time is not spent developing the skills that are needed to become successful in the field of mathematics.

Secondly, the feminist dual systems theory proposes that gender inequalities are the result of capitalist and patriarchal structures. Hartmann considers men's control over women to be through this dual system founded on women's exclusion from better kinds of work (Walby, 1990, 39) while maintaining the work of the private sphere as both feminine and unskilled. As argued above, subject choice is a defining time for routing a girl's path into work. It is through women's exclusion from mathematics education that they are therefore systematically excluded from the field of mathematics and the jobs within that (Phipps, 2008). Therefore, it can be seen that the gendered nature of subject choice reinforces patriarchal structures within society.

Walby argues that a "woman's access to forms of paid employment [… is as much] issues of material power as well as normative values" (Walby, 1990, 58). Therefore, a secondary way in which the patriarchal power can be asserted is a family's economic investment into their daughters. This is where the gendering of cultural capital is key: are girls less likely to have access to cultural capital than boys? Sullivan (2001) found that cultural capital was not distributed in a gendered way. If cultural capital was gendered, this could be a mechanism in which male power is asserted within the structure of informal education within the home. If female students had less access to cultural capital than their male counterparts, this could be detrimental to their ability to succeed in school.

2.6 Hypotheses:

The general hypothesis for this research is that gender and class have an effect on student maths performance. Previous studies have suggested that being from a working class background has a negative impact on maths performance, while being female has been found to have a negative effect. Considering the number of women working in mathematics-based careers it also suggests that few women continue to achieve advanced levels in maths.

$\mu_{(\text{independent variable})}$ = coefficient of stated independent variable

Hypothesis 1: Access to cultural capital has a positive effect on maths score

H_1: $\mu_{(\text{cultural capital})} > 0$

H_0: $\mu_{(\text{cultural capital})} \leq 0$

Hypothesis 2: Habitus and patriarchy have an effect on maths score

H_2: $\mu_{(\text{habitus and patriarchy})} \neq 0$

H_0: $\mu_{(\text{habitus and patriarchy})} = 0$

Hypothesis 3: Students' intention to continue maths has a positive effect on maths score

H_3: $\mu_{(\text{continue maths})} > 0$

H_0: $\mu_{(\text{continue maths})} \leq 0$

Hypothesis 4: Being female has a negative impact on maths score

H_4: $\mu_{(\text{female})} < 0$

H_0: $\mu_{(\text{female})} \geq 0$

Hypothesis 5: Parents' occupation has a positive effect on maths score

H_5: $\mu_{(\text{HPOS})} \neq 0$

H_0: $\mu_{(\text{HPOS})} = 0$

Hypothesis 6: There is a structural difference between what affects male and female students μ_x (x=1…n)

H_6: $\mu_{x(\text{female})} \neq \mu_{x(\text{male})}$

H_0: $\mu_{x(\text{female})} = \mu_{x(\text{male})}$

3. Methodology

3.1 The Data

The data used for this analysis was the Scottish sample from the 2012 OECD's Programme for International Student Assessment (PISA) which focused on mathematical literacy. PISA is an "international survey which aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students" (OECD, 2015).

The PISA mathematics score is generated through a mathematics test, which covers four broad areas of mathematics: change and relationship, space and shape, quantity and uncertainty and data. These employ three key mathematical processes of formulating, employing and interpreting mathematics (OECD, 2013). The definition of mathematical literacy that the PISA test aims to measure is:

"An individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen" (ibid, 17).

Therefore, when considering a student's mathematics score they aim to measure a broad idea of mathematical literacy that goes beyond the mathematics curriculum found within the mathematics classroom[2].

Individual surveys are also used to gather information about the education system and student background through a pupil, parent and school survey. This includes information on cultural possessions, parental occupation and attitudes towards mathematics. While this research will not make comparisons between countries, the available data provides rich information on individual student's backgrounds.

3.2 The Sample

The PISA data is gathered using a two-stage stratified sample. The sampling units for the first stage are all schools that have 15-year-olds enrolled. The sampling units for the second

[2] Aspects of the CfE have a similar aim such as creating 'responsible citizens' and 'confident individuals (Education Scotland, 2015[1])

stage are the 15-year-old students within these schools (OECD, 2014, 66). Therefore, the students within the final sample are clustered by school.

To ensure a good representation of 15-year-olds within each country, there was a series of compulsory response rate targets (OECD, 2014, 67-69). Scotland met the necessary sample requirements for both school and student responses, with a 95.6% school response rate from the main sample[3] and a total of 2,945 students[4] (Boyling et al, 2013).

There were 1,494 boys and 1,451 girls within the final sample of Scottish students (figure 1). The parental occupational status uses an index that ranges from 0 to 100 but for the Scottish students 11.56 to 88.7 (figure 2). Students are distributed throughout the index however, around one third of students in the Scottish sample have an index score between 60 and 80.

Ammermüller's (2004) study, using the Finnish and German samples from the 2000 PISA data, removed outliers which he judged to be "unrealistically low" scores below 200. While three of the five student scores (explained further in section 3.5.1) within the sample are less than 200, equating to three students, I have chosen not to remove these students from the sample. Firstly, for all three students only one of their five scores are below 200. Secondly, while they have achieved low scores the test questions have been completed as has at least half of the survey information. Therefore, I believe that to remove these students would not reflect the true picture of the young people in the education system in Scottish schools. Finally, the residuals for the final regression were saved and imported into Stata, then checked using the Cooks Distance Test (Stata, 2015; IDRE, 2015; Williams, 2015). The Cooks Distance Test suggested that none of the scores produced outliers for each of the PVs.

Table 1: Maximum and minimum values for the five dependent variables

Dependant Variable	Minimum	Maximum
Maths Plausible Value 1	197	800
Maths Plausible Value 2	219	782
Maths Plausible Value 3	184	770
Maths Plausible Value 4	194	778
Maths Plausible Value 5	228	811

[3] 108 schools from the main sample supplemented by 3 schools from the supplementary sample

[4] 3944 students were selected from the schools from the sample. 337 students were deemed to be unable to take part so were excluded. Of the remaining students, 2945 agreed to take part

Figure 1: **Bar Chart:** Gender distribution in Scottish sample

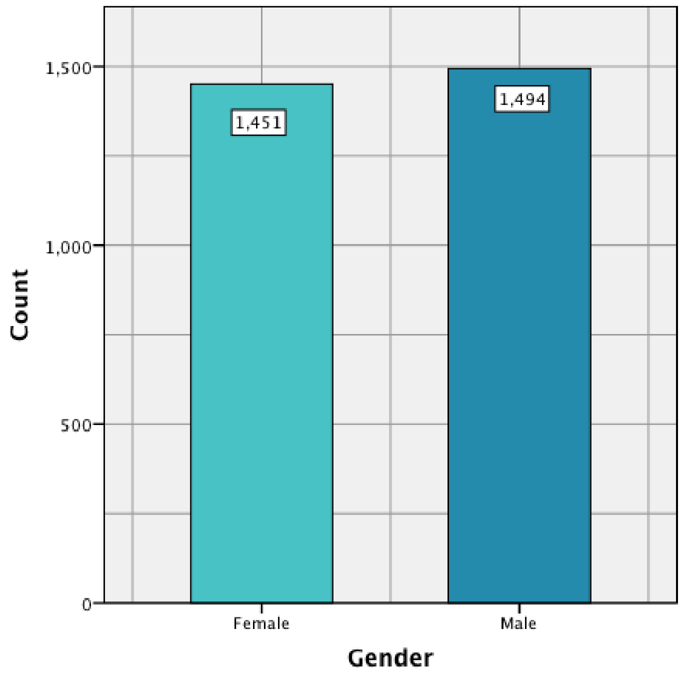
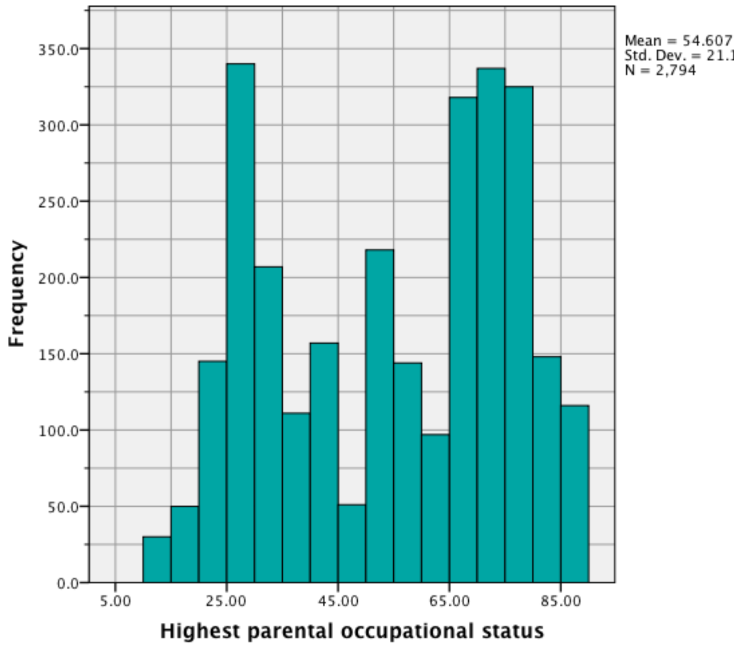


Figure 2: Histogram: Distribution of scores for Highest Parental Occupational Status Index



For the regression analysis the sample requires complete, non-missing, responses for all the variables involved. Therefore, the sample number is reduced to 1,744 in the final regression. The analysis was initially carried out on different sample sizes; however, to allow for comparison, all regressions were carried out again on the same sample of 1,744 students.

As this is a sample of 15- year-old students and not a census, the data is a representation of the Scottish population of 15-year-old students but will include sampling error.

3.3 Weights

Students within the sampled schools are chosen with equal probability, rather than, for example, selecting a whole class within the chosen school. However, using the two-stage sampling method, rather than a simple random sample, means that some students within the total population have a higher likelihood of selection as their school has already been chosen (OECD, 2009). Even between schools, a student's probability of selection varies depending on the size of the population of 15-year-olds within the school.

In Scotland, 622 students chose not to take part in the assessment. The noted dropout rate can result in the over or under representation of students with certain characteristics, in turn affecting the statistical results (OECD, 2009, 36). For example, if a higher number of students from wealthy backgrounds chose not to take part, then any population statistic is likely to be affected due to wealth's correlation with other measures recorded in the PISA data.

Finally, within the PISA data, Scotland is sampled as a sub-nation of the United Kingdom. However, the Scottish Government, so as to allow for analysis such as this piece of work, increased the sample size at a sub-nation level (Boyling et al, 2013). The over-sampling of some strata, for example students with minority characteristics, allows for meaningful analysis but means that the sample does not reflect the true population makeup.

The sample weights provided in the PISA data take into account the bias caused by the above sampling methods to create a closer sample to the country's population.

3.4 Replicates

As mentioned previously, the probability that a student is selected from the total population varies between students. The two-stage sample affects the population standard errors as can be demonstrated through the following example:

"A simple random sample of 4000 students is therefore likely to cover the diversity of the population better than a sample of 100 schools with 40 students observed within each school. It follows that the uncertainty associated with any population parameter (i.e. standard error) will be greater for a two-stage sample than for a simple random sample of the same size." (OECD, 2009, 39)

To take this into account, the PISA data provides 80 replicate weights for each student. The replicate weights are produced using Fay's variation of the Balanced Repeated Replication method (ibid, 72) with a factor of 0.5. "The standard BRR procedure can become unstable when used to analyse sparse population subgroups, but Fay's method overcomes this difficulty, and is well justified in the literature" (OECD, 2014, 139). The replicates allow for the selection of sub-samples from within the total sample or within a country sample, allowing for the comparison of the population estimate and the replicate estimates, in turn allowing for the computation of the sampling variance and standard error. Both the student weights and the replicate weights have been included in all calculations.

3.5 Variable Selection

3.5.1. Dependent Variables

The dependent variable used for this analysis is the student maths score. This will suggest how maths outcomes are affected by the selected independent variables that have been chosen as measures of gender and class.

The student's maths score is calculated using the Rasch model, where question difficulty and student ability are taken into account. For a student whose ability is equal to the question difficulty they have probability equal to 0.5 that they get the correct answer, and 0.5 that they get an incorrect answer (OECD, 2009). As the difference between student ability and question difficulty grows the probability of a correct answer increases or decreases. Each student is then awarded relevant points dependent on the question difficulty. The OECD have modified the Rasch model to include the possibility of a student giving a 'partially correct' answer (ibid).

> "The scores have then been standardized, to an international mean of 500 and standard deviation of 100, which facilitates the comparison across countries" (Ammermüller, 2004, 3).

While the scoring system aims to measures a student's ability in maths, the PISA assessment has a broader remit than to measure individual student performance. While measuring an individual performance there are multiple sources for measurement error in a student's score, including:

- The concept to be measured, mathematical literacy, is broad
- The student's capacity on the day
- The test condition (OECD, 2014)

To avoid drawing conclusions about the total population from data that contains high levels of measurement error, the use of plausible values (PVs) results in a distribution that better represents the "underlying continuous population distribution" (Wu, 2005,117).

For each student five plausible scores are provided, they represent "the range of abilities that a student might reasonably have […] Instead of directly estimating a student's ability θ, a probability distribution for a student's θ, is estimated. […] plausible values are random draws from this (estimated) distribution for a student's θ." (Wu and Adams in OECD, 2009, 96).

The use of PVs affects the method for all calculations that involve population estimates, as not one but 5 calculations must be made. For example, to calculate regression coefficients with student maths score as the dependent variable, five regressions must be computed, one with each PV as the dependent variable. The coefficient for the independent variables can then be calculated by taking the mean of the relevant coefficients for each regression.

$PV1 = \beta_{1,1}X + \beta_{1,2}Y + \beta_{1,3}Z$

$PV2 = \beta_{2,1}X + \beta_{2,2}Y + \beta_{2,3}Z$

$PV3 = \beta_{3,1}X + \beta_{3,2}Y + \beta_{3,3}Z$

$PV4 = \beta_{4,1}X + \beta_{4,2}Y + \beta_{4,3}Z$

$PV5 = \beta_{5,1}X + \beta_{5,2}Y + \beta_{5,3}Z$

So to calculate the coefficient (β_1) for independent variable X, the mean must be taken of each coefficient of X in the above 5 regressions:

$\beta_1 = (\beta_{1,1} + \beta_{2,1} + \beta_{3,1} + \beta_{4,1} + \beta_{5,1}) \div 5$

As the analysis will include OLS regression with the five PVs for maths score as dependent variables, the distribution of scores must be considered. For an OLS regression, the dependent variable must have a normal distribution. Each of the PVs has an approximately normal distribution, although PVs four and five (figures 6 and 7) have a slight double peak. When we consider all PVs on the X-axis, the dependent variables have a good normal distribution with most of the bars being within the normal curve (figure 8).

Figure 3: Histogram of Plausible Value 1 Student Maths Score Distribution

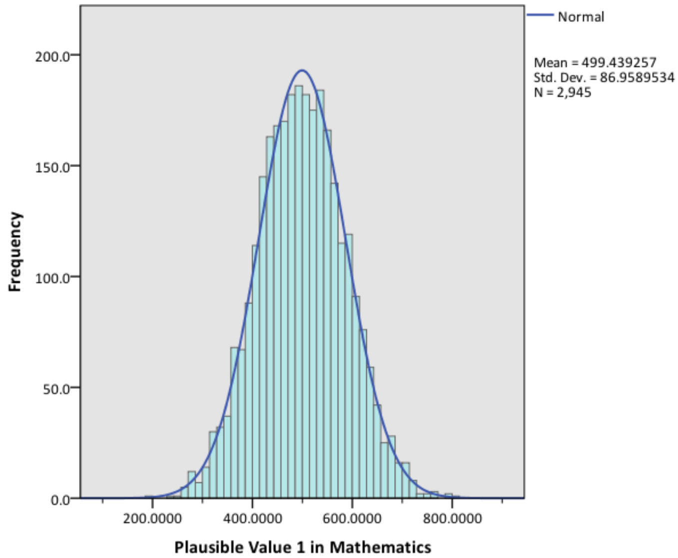


Figure 4: Histogram of Plausible Value 2 Student Maths Score Distribution

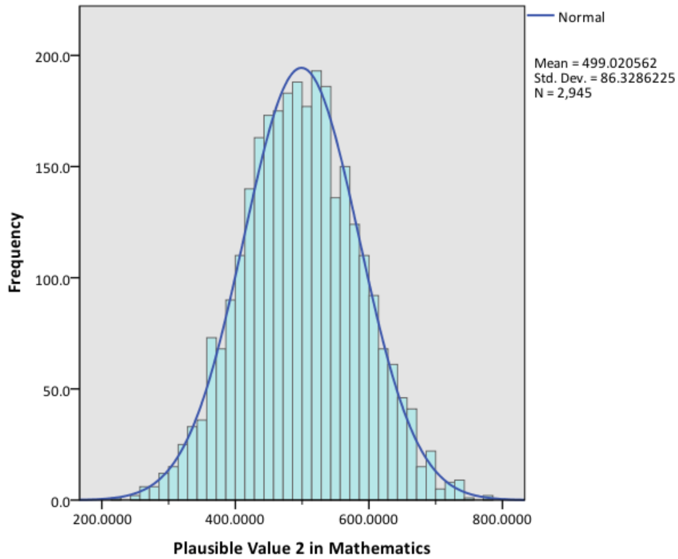


Figure 5: Histogram of Plausible Value 3 Student Maths Score Distribution

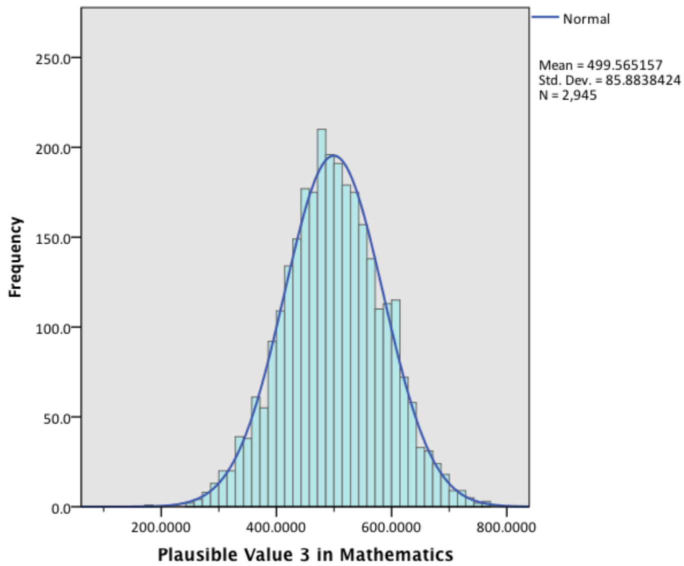


Figure 6: Histogram of Plausible Value 4 Student Maths Score Distribution

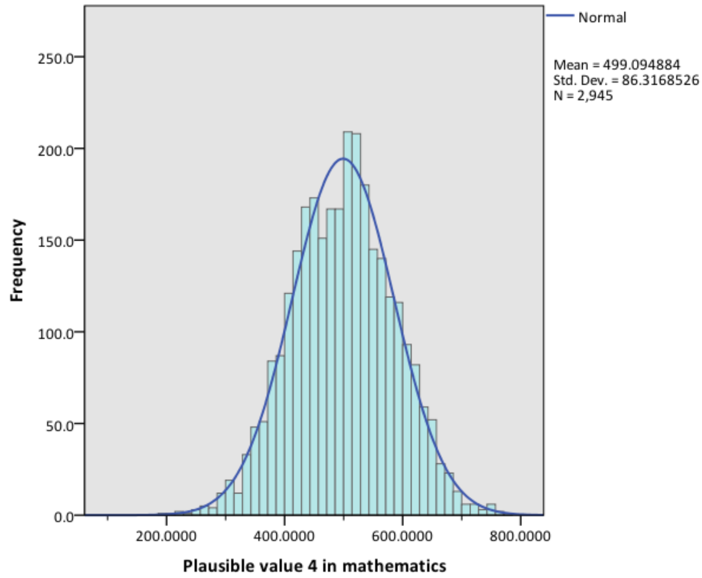


Figure 7: Histogram of Plausible Value 5 Student Maths Score Distribution

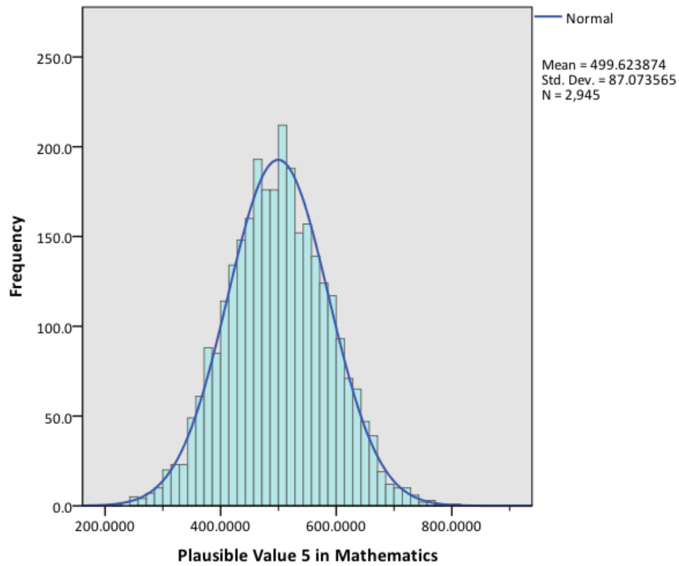
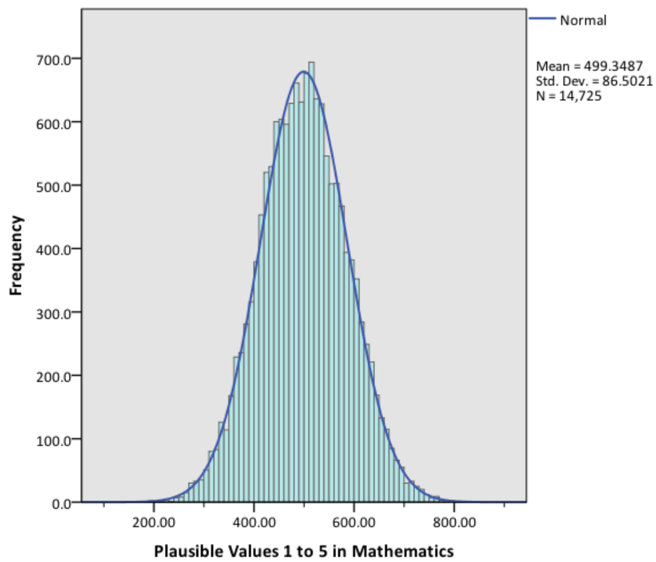


Figure 8: Histogram of Plausible Values 1 to 5 for Student Maths Score Distribution



3.5.2. Gender and Class

Gender is clearly defined in the PISA data with a high completion rate and the options of female (1) and male (2). ***Gender*** was recoded so that female students have the value 1 and male students have the value 0. Therefore, when reading the analysis, discussions of ***gender*** are in fact referring to being female.

Socio-economic class is a complex concept, however, for much of the twentieth and twenty first century a key identifier of an individual's class is the work that they do (Anyon, 1980, 70) or occupation. While there are many identified flaws with using occupational status as the main identifier for class position (Crompton, 2009), it has been selected as the basic measure of class for the following analysis.

The PISA survey includes a question on parental occupation. The parent with the highest occupational level is then selected and indexed on a scale of 0 to 100 creating the variable ***highest parental occupational status*** (***HPOS***) (OECD, 2009, 462).

Concerns around the use of occupational status include: how are economically inactive individuals categorised?; how do you take account of invested wealth?; and how do we take account of other aspects of status? (Crompton, 2009, 50-52)

Some of these concerns will be addressed through the use of other measures in the research such as cultural capital. This may suggest wealth holdings (although not explicitly) and other aspects of status. Economic inactivity in most cases will be a useful indicator for this research. Few parents will be economically inactive due to retirement, considering the age of the sample, therefore inactivity may suggest a parent's negative relationship with the job market.

3.5.3. Cultural Capital

The cultural capital variables that have been selected reflect Bourdieu's objectified cultural capital. They all measure access to cultural resources rather than embodied cultural capital. This is partly due to the variables available for analysis; for example, there are no questions asking students about the cultural experiences they have had at home, such as visiting museums. The second reason for this is that, as discussed earlier, there is a strong link between embodied cultural capital and habitus. Therefore, embodied aspects of cultural capital are included when we consider habitus and patriarchy.

In previous studies the number of books at home, unlike other cultural capital predictors, was found to have a positive effect on maths outcomes (De Graaf et al, 2000; Sullivan, 2001). In the PISA study the number of books at home was selected by students from six available categories. As the ***number of books at home*** is a categorical variable, dummy binary variables were created to represent each category.

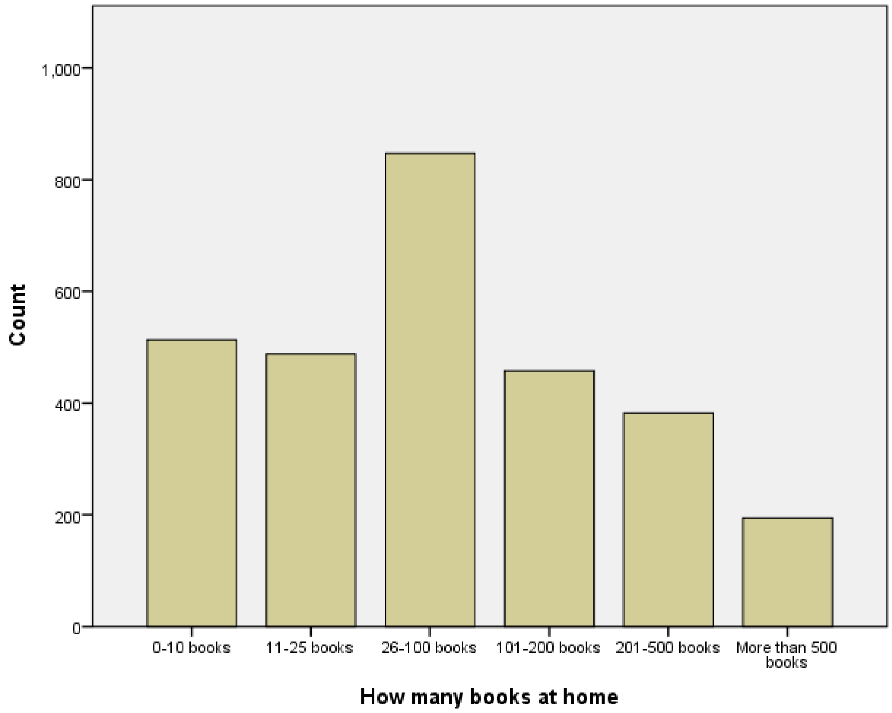
Art, ***literature*** and ***textbooks at home*** were also added to the cultural capital variables. There was only a 'yes' or 'no' option response for students; therefore these variables were already in a suitable format for regression analysis.

A second book variable was generated to consider the number of books at home in a less numeric fashion. The numeric categories selected by the OECD for the PISA survey seem rather arbitrary. What I intended to ask when I consider a child's access to books is whether they have more or less books than the average population and therefore how this impacts on the student's maths score.

Considering the number of Scottish students falling into each 'number of books at home' categories, it can be seen in figure 9 that the largest number of students fall into the category '26-100 books'. Aggregating the categories into ***few books, middle number of books*** and ***many books*** will allow for a better understanding of where a student sits within the population. Due to the purpose intended by this categorisation, the middle category should contain the average number of books therefore was an aggregate of the students in the '26-100 books' and '101-200 books' categories. The ***few books*** and ***many books*** categories are aggregates of the two categories below and above the middle grouping. Again, due to the purpose of the recoding, wanting to consider the effects of being above or below the 'normal' number of books, the middle category is chosen as the reference category when this variable is used in the regression.

Private tuition has boomed in recent years (Burns, 2013) and has been linked to widening attainment gaps between those who can and cannot afford the fees. Private tutoring not only gives children one-to-one learning time but also focuses on teaching students how to approach exams and exam questions. Therefore, investment of economic capital into private tuition develops a student's approach to the dominant culture, learning how to communicate appropriately and engage with the dominant culture.

Figure 9: Distribution of students by number of books at home



3.5.4. Habitus and Patriarchy

Considering the role of socialisation in reinforcing patriarchy (Kelly. E, 1981) and in developing a student's habitus, the variables chosen for this section aim to cover aspects of a student's background that relate to both.

Whether ***parents believe maths is important for their child's career*** links with parental attitudes to the role and importance of education, and in particular to the role and importance of mathematics. The connection between education and employment opportunities, education as a means to employment, was also found to be important for students from working class backgrounds (Nash, 2002).

As a measure for student self-conception I have used student survey question:

"Suppose that you are a student in the following situation:

Each week, your mathematics teacher gives a short quiz. Recently you have done badly on these quizzes. Today you are trying to figure out why.

How likely are you to have these thoughts or feelings in this situation?" (OECD, 2012)

Students were asked to rate, on a scale of 'very likely' to 'not at all likely', the likelihood of having various thoughts or feelings about their maths performance. The response used for this analysis was those who were ‘likely’ or ‘very likely’ to have the thought:

“I’m not very good at solving mathematics problems” (ibid)

As mentioned earlier, the PISA scoring system has a mean student score of 500 through the entire sample. Students who answered either agree or strongly agree, yet had a score of 500 or more, were categorised as ‘not confident’. These students are average or above but claim that incorrect answers are due to being ‘not good at maths’. This suggests an unjustified lack of confidence in maths.

In the Scottish sample there were 206 students who had ***low confidence*** (coded 1) and 766 other valid responses (coded 0). The second grouping includes students with a less than average score who would attribute this to being ‘not good at solving maths problems’ and students with an average or above score who would not attribute an error to be ‘not good at solving maths problems’.

3.5.5. Subject Choice

Students’ interest in mathematics is likely to affect subject choice at advanced levels and in turn, female students’ access to employment in STEM. Whether students think maths is important for their future and for what they want to do later relates to the idea of education as a tool for entering the labour market. Mendick’s study (2005) suggested that girls’ advanced mathematical study is often motivated by the power associated in wider society, outwith the school environment, with success in mathematics and how this may positively affect their position in the labour market.

4. Analysis

4.1 Initial Analysis

In this section mean scores are presented in table 4 below.

4.1.1. Gender and Class

The mean was initially taken for plausible maths score 1 for all female students, taking into account the 80 student weights and 1 population weight, and then repeated for each of the five plausible maths scores. The mean of these five averages was then taken to give the final female population mean. This was repeated for the male population. The syntax provided by the OECD was used to make the above calculations (OECD, 2009). However, minor adjustments were made to allow for it to run on a more recent version of SPSS.

The mean score for the male (505.5) and female (491.2) population are both statistically significant ($p>0.99$). The difference between the male and female scores of 14.3 points is also significantly different from zero ($p>0.99$). This suggests that ***gender*** has a significant impact on student performance.

As the ***HPOS*** is an index it is a continuous variable. Therefore, the population cannot be easily or meaningfully separated to consider the impact of ***HPOS*** on the mean score, as an increase in 1 unit on the index does not clearly relate to a distinct difference of occupation in reality.

4.1.2. Cultural Capital

The mean maths score is presented below with the population split by having or not having the specified cultural capital at home. The mean score is statistically significant for each of the populations ($p>0.99$).

Students with access to ***literature at home*** have a maths score that is 51.083 ($p>0.99$) points higher than those without. A similar pattern is seen for students with ***art*** or ***textbooks at home*** (an increase in 29.255 and 47.849 respectively). The average maths score increases steadily as the number of books at home increases. There is a difference of 124.602 points ($p>0.99$) between students with access to ***0-10 books*** and ***500 plus books***. The difference between all categories is statistically significant with the exception of the difference between having ***201-500 books*** and ***500+ books*** at home. Receiving ***maths lessons*** outside of school has an unexpectedly negative effect on mean maths score; however, the difference of 6.948 points is not statistically significant.

The mean maths score for each category of students by the new book categories ***few books***, ***26-200 books*** and ***many books*** at home increases as the number of books increases. The difference between each of the categories is also statistically significant (p>0.99). This has a similar pattern to the previous book categories; however, there is a statistically significant difference between all categories, this could partly be due to the larger sample size in each grouping.

The distribution of cultural capital does not seem to take a gendered form as can be seen in table 2 below.

Table 2: Distribution of cultural capital by gender

Cultural Capital Variable	At Home (Yes/No)	Female	Male
Art at home	No	36%	43%
	Yes	64%	57%
Total		1388	1414
Literature at home	No	65%	69%
	Yes	35%	31%
Total		1387	1404
Textbooks at home	No	7%	10%
	Yes	93%	90%
Total		1418	1434
Maths lessons	No	54%	57%
	Yes	46%	43%
Total		1388	1414
Number of books at home			
0 - 10 books at home	Yes	15%	20%
11 - 25 books at home	Yes	18%	16%
26 - 100 books at home	Yes	28%	31%
101 - 200 books at home	Yes	16%	15%
201 - 500 books at home	Yes	15%	12%
500+ books at home	Yes	7%	6%
Total		1427	1455

4.1.3. Habitus and Patriarchy

Students who have ***parents that believe maths is important for their child's career*** have a higher mean maths score than students whose parents do not believe maths is important for their child's career (502.789 and 489.295 respectively). The difference of 13.493 points is statistically significant (p>0.95).

As the group coded '0' for the confidence variable is made up of students from both extremes of the maths score spectrum, those who are below and above average, it does not make sense to discuss the mean maths score of that sub-group of the population.

4.1.4. Subject Choice

For both variables where it can be assumed students intend to continue with maths, ***worthwhile for what I want to do later*** and ***important for future study***, there is a significant difference (p>0.99) between the mean of those who believe maths to be useful and those who do not. Having an interest in maths has the largest population mean (513.566, p>0.99) of all subject choice variables.

Considering the literature, all of the above attitudes are associated with the continuation of maths at an advanced level and have been considered to be gendered. Comparing the responses to these attitudes (table 3) for the male and female population there seems to be slightly fewer girls who are ***interested in maths*** than boys (51% and 58% respectively). 76% of boys believe that maths is ***important for future study*** while just 64% of girls give the same response. Almost all students (male and female) believe that maths is worthwhile for what they want to do later.

Table 3: Attitudes to maths by gender

	Not interested in maths	Interested in maths	Not worthwhile for what I want to do later	Worthwhile for what I want to do later	Not important for future study	Important for future study
Female	49% (475)	51% (504)	15% (152)	85% (830)	36% (348)	64% (632)
Male	42% (401)	58% (552)	14% (136)	86% (823)	24% (233)	76% (727)

Table 4: Differences in population mean scores

Variable	Mean	Standard Error	Difference
Gender (n = 2945)			
Female	491.23**	3.181839	14.308**
Male	505.538**	2.996357	
Number of books at home (n = 2882)			
0 - 10 books at home	438.76**	4.667025	-
11 - 25 books at home	474.776**	3.578603	-
26 - 100 books at home	499.648**	3.133867	-
101 - 200 books at home	527.965**	4.419435	-
201 - 500 books at home	550.22**	5.393246	-
500+ books at home	563.362**	8.404832	-
Few books at home	456.193**	3.547609	-
26 – 200 books at home	509.54**	2.696199	-
Many books at home	554.641**	5.059323	-
Lessons out of school (n = 2802)			
No maths lessons	500.705**	3.737058	6.948
Maths lessons	493.757**	3.451758	
Literature at home (n = 2791)			
No literature at home	486.258**	2.787969	-51.083**
Literature at home	537.341**	3.551872	
Art at home (n = 2802)			
No art at home	484.713**	3.28526	-29.255**
Art at home	513.968**	2.546241	
Textbooks at home (n = 2852)			
No textbooks at home	457.467**	6.888401	-47.849**
Textbooks at home	505.317**	2.393513	
Parental attitude to maths as useful for career (n = 1929)			
Parents DO NOT believe maths is important for career	489.295**	5.319365	-13.493*
Parents believe maths is important for career	502.789**	3.079253	
Student attitude to maths as worthwhile (n = 1941)			
Not worthwhile for what I want to do later	477.803**	6.171432	-26.374**
Worthwhile for what I want to do later	504.178**	3.010012	
Student interest in maths (n = 1932)			
Not interested in maths	484.368**	3.743857	-29.197**
Interested in maths	513.566**	3.141351	
Maths as important for future study (n = 1940)			
Not important for future study	480.015**	4.556135	-28.89**
Important for future study	508.905**	3.395025	

*p>0.95 **p>0.99

4.2 Regression Analysis

Regressions were initially performed on all valid observations, containing no missing values, in the Scottish sample (with a total of 2,794 observations in the simplest regression). These regressions were then used to select the most statistically significant and appropriate variables for the final regression.

The final regression had 1,744 valid observations. Reducing the Scottish sample to these 1,744 observations and rerunning each of the regressions by our four areas of analysis allows for comparison as the sample contains exactly the same students with the same characteristics.

In sections 4.2.1 to 4.2.6 regressions, coefficients and probabilities can be found in table 5.

4.2.1. Gender and Class Regression

The initial regression reflects the relationship between the two key variables under consideration, ***gender*** and class (***HPOS***), and student maths score, the dependent variable.

The negative relationship found between being female and maths score for the sample (table 4) can be further confirmed in regression 1.

All regressions have been calculated using the SPSS syntax provided by the OECD (OECD, 2009) where a regression is calculated for each plausible value, using the provided weights, and the regression coefficients are then averaged. The adjusted R-squared was calculated manually using the equation:

Adjusted $R^2 = 1 – ((1 – R)(N – 1))/(N – p – 1)$

R = R-square

p = Number of predictors

N = Total sample size (used in that regression)

The R-squared shows that ***gender*** and ***HPOS*** explain 12% of variation in maths score. While in some statistical research this explanatory value is low, in this context, an R-squared above 10% is notable. As the maths score is measuring maths ability there is no way to account for a student's aptitude that underlies this. It would be unrealistic to assume that every student should achieve to the same standard; the point of this exercise is to consider the consistent advantages and disadvantages that affect student performance. In previous studies "scores on tests of cognitive 'ability' (various IQ-type tests), or prior achievement, often account for the largest proportion of variance in academic attainment" (Edgerton & Roberts, 2014 204). Other major effects on educational performance have not been included, such as school absence, ethnicity and whether first language is that of the test.

It can be seen that ***gender*** has a statistically significant negative effect on maths score (β=-13.774, p>0.99) while ***HPOS*** has a small but significant effect. In this case, the impact of ***gender*** is stronger than that of socio-economic class.

4.2.2. Cultural Capital Regressions

The first cultural capital regression (regression 2) has an R-squared value of 0.271 and adjusted R-squared of 0.266. The adjusted R-squared value and R-squared value are similar, suggesting that the number of independent variables is not causing a spurious increase in the R-squared value.

When we have a set of dummy variables, where every member of the population is in one of the groups, there is complete correlation between the dummy variables, violating assumption five of the OLS regression (Kennedy, 2008, 42). Therefore, one of the dummy categories must be removed so as to allow for a reliable regression (Fox, 1997). The category ***0-10 books at home*** was removed from the regression to create a reference category for the ***number of books at home***. In this case, ***0-10 books at home*** was selected, as it allows for the easy analysis into the relationship between increasing number of books and maths score, as every coefficient will show the impact of having increasingly more books.

500 or more books at home had the largest positive impact on maths score (β=98.435, p>0.99). Being female (***gender***) has a negative impact on maths score (β=-20.792, p>0.99) as does receiving ***maths lessons*** outside of school (β=-11.904, p>0.99). Having ***textbooks at home*** had a positive impact on math score (β=14.938) however is significant only to the 95% level. Only ***art at home*** does not have a significant effect on maths score.

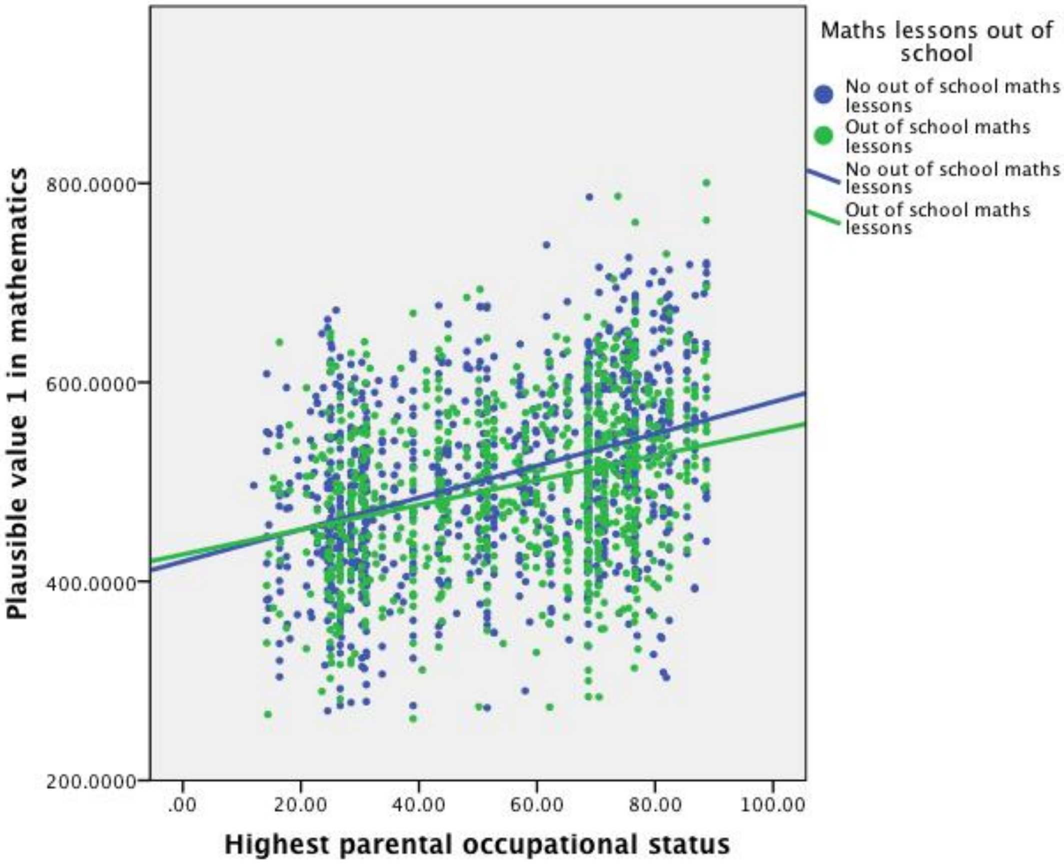
Table 5: Regressions using Scottish sample

Regression statistics	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5	Regression 6	Regression 7	Regression Final	Regression 9 (Male)	Regression 9 (Female)
R-squared	0.117	0.271	0.251	0.117	0.059	0.114	0.144	0.259	0.236	0.273
Adjusted R-squared	0.116	0.266	0.248	0.110	0.058	0.113	0.142	0.255	0.229	0.267
Intercept	435.783	413.628	454.003	529.878	571.551	426.005	408.661	434.447	416.033	432.403
Number of observations	2794	1734	1734	497	954	1849	1846	1744	840	904
					Independent variables					
Gender	-13.774**	0.748**	0.799**	-6.557		-12.807**	-10.63**	-15.941**		
Highest Parental Occupational Status (HPOS)	1.334**	-20.792**	-19.166**	0.714**		1.293**	1.273**	0.797**	0.916**	0.691**
Books at Home (reference category 0 – 10 books)										
11 - 25 books at home		29.749**								
26 - 100 books at home		41.741**								
101 - 200 books at home		67.576**								
201 - 500 books at home		82.089**								
500+ books at home		98.435**								
Books at Home (reference category 26 – 200 books)										
Few books at home			-33.452**					-36.304**	-37.386**	-34.912**
Many books at home			34.248**					30.946**	25.778**	35.329**
Literature at home		16.742**	21.645**					16.895**	8.499	24.367**
Art at home		-0.606	0.51							
Textbooks at home		14.938*	19.461**					14.047	21.742	5.421
Maths lessons		-11.904**	-11.374**							
Low confidence in Maths				-24.261**	-33.653**					
Parents believe maths is important				-1.929		15.017**		-1.364	10.657	-8.386
Worthwhile for what I want to do later							8.788			
Interested in maths							20.516**	20.112**	14.699**	23.587**
Important for future study							15.811*	18.366**	19.986*	17.62*

*p>0.95 **p>0.99

The second cultural capital regression (regression 3), while it has fewer regressors, has a similarly large R-squared value (R^2=0.251) to the initial cultural capital regression. Having ***many books*** has the largest coefficient value (β=34.248, p>0.99) followed by having ***literature at home*** (β=21.645, p>0.99) then by ***textbooks*** (β=19.461, p>0.99). The coefficient for the independent variable ***HPOS*** remained with a small significant coefficient (β=0.799, p>0.99). ***Art at home*** remained statistically insignificant. The ***gender*** coefficient remained negative (β=-19.166, p>0.99) while having ***few books*** has a larger negative effect (β=-33.452, p>0.99). ***Maths lessons*** continue to have a negative effect on maths score (β=-11.374, p>0.99). Out of both the negative and positive coefficients, the number of books students have at home has the strongest effect on student maths score.

Figure 10: HPOS, Maths Lessons Out of School and PV 1 Maths Score



It would seem logical that a wealthy parent's investment in their child's education, through purchasing out of school maths lessons, would result in improved maths score. The unexpected negative result of ***maths lessons*** on maths score suggests that this variable may not be suitably representing parental investment in education. The purpose of including ***maths lessons out of school*** was to measure whether a child's success can be purchased with economic capital. The results would suggest that investing in out of school lessons instead has a negative effect on maths score.

However, firstly, we should always be cautious in interpreting the causal direction of relationships between independent and dependent variables (Kennedy, 2008). It could be the case that a student is performing poorly, therefore receives lessons, meaning the causality is from poor performance to receiving maths lessons rather than lessons causing poor performance.

Secondly, without knowing the student's success prior to the out of school maths lessons, we are only measuring their current ability, which may be better than it would have been prior to maths lessons.

Finally, it could also be the case that the least successful students from wealthier families can improve to average students through attending out of school lessons, while students from poorer backgrounds remain below average as they cannot afford out of school lessons.

Considering the distribution of student plausible maths score 1 against ***HPOS*** by attending and not attending maths lessons it suggests that in Scotland students from a variety of background are receiving out of school maths lessons (figure 10), contrary to the final interpretation. Students at both extremes of the maths score scale are also receiving maths lessons. The distribution was also plotted for PVs 2 through to 5 showing a similar pattern (figures not presented).

As ***maths lessons out of school*** tells us little about either improvement in performance or parental investment in education, it should be removed from the final regression.

A secondary motivation for its removal is that its addition to the final regression reduces the sample to less than 1000 observations due to missing values.

4.2.3. Habitus and Patriarchy Regressions

In regression 4, only ***low confidence in maths*** (β=-24.261, p>0.99) and ***HPOS*** (β=-0.714, p>0.99) are statistically significant. The coefficient for ***HPOS*** remains with a value less than one. The coefficient for ***gender*** has increased to -6.557, having a much smaller effect on maths score, the finding was also not statistically significant. When ***low confidence in maths*** is removed from the regression (regression 6) the coefficient for ***parents believe maths is important*** increases to 15.017 (p>0.99).

Considering the large change in the ***gender*** coefficient it indicates that ***gender*** is mediated by ***low confidence in mathematics***, reducing the coefficient value for both. It can be seen in table 6 below that there is some correlation (correlation=-0.108) between ***gender*** and ***low confidence*** however this is not a noticeably large correlation (as a value of 1 would represent complete correlation).

Table 6: Correlation between gender and low confidence

Variable 1	Variable 2	Correlation	Standard Error
Gender	Confidence	-.108**	.033809

*p>0.95 **p>0.99

When considering the singular relationship between ***low confidence*** and maths score it can be seen that ***low confidence*** explains just 6% of variation in maths score yet has a large coefficient (β=-33.653, p>0.99). Considering the construction of the ***low confidence*** variable, using the dependent variable maths score as a cut off for ability, there is a clear constructed relationship between the two. This could suggest that the measure is being distorted by its origin, making it an unreliable indicator for confidence. Therefore, this should be removed for the final regression. In future research it would be helpful to include a measure that captures self-conception and confidence in maths more explicitly.

4.2.4. Subject Choice Regression

Regression 7 considers how the subject choice variables are related to maths score and whether these are gendered.

Interest in maths has the largest coefficient (β=20.516, p>0.99) followed by students who think that maths is ***important for future study*** (β=15.811, p>0.95). ***HPOS*** remains statistically significant however, has a small coefficient (β=1.273, p>0.99). Whether maths is ***worthwhile for what students want to do later*** is not statistically significant. ***Gender*** remains significant (p>0.99), however, has a smaller negative coefficient.

4.2.5. Designing the Final Regression

The final regression kept variables that were statistically significant ($p>0.95$) in regressions 1 to 7, with the exception of ***low confidence*** and ***maths lessons out of school***. As mentioned previously, the variable representing a student's confidence uses the dependant variable within its construction, causing unwanted correlation between the two. ***Maths lessons out of school*** did not act as a measure of improvement or parental investment and was therefore removed.

The final regression has an R-squared that explains around 26% of variation in maths score. The R-squared and adjusted R-squared have similar values (0.259 and 0.255 respectively) suggesting that there has not been a spurious increase in explanatory value as independent variables were added.

The variable with the largest positive coefficient is the cultural capital measure ***many books*** ($\beta=30.946$, $p>0.99$). This is followed by ***interested in maths*** ($\beta=20.112$, $p>0.99$), ***important for future study*** ($\beta=18.366$, $p>0.99$) and ***literature at home*** ($\beta=16.895$, $p>0.99$). ***HPOS*** is statistically significant to the 99% level however, has an extremely small affect on maths score with a coefficient of just 0.797. ***Textbooks at home*** is no longer statistically significant, with a coefficient of 14.047.

Having ***few books*** has the largest impact on maths score of all independent variables in the final regression, in this case a negative effect ($\beta=-36.304$, $p>0.99$). ***Gender,*** being female, also has a negative relationship to maths score ($\beta=-15.941$, $p>0.99$). ***Parents believe maths is important for career*** now has a negative coefficient; however, this not statistically significant, suggesting that conclusions should not be drawn from this.

4.2.6. Splitting the Sample by Gender

It was seen that there was a difference in maths score between male and female students; however, the literature suggests that there is both a gendering of maths outcomes but also in attitudes and practices that support girls' advancement and continuation in mathematics. To consider whether there is a difference between the structures that cause maths score differences between girls and boys, the sample was split in two, males and females, and the final regression was run on each of these samples, excluding the ***gender*** variable.

As residuals at a student level for the final regression coefficients are not available, due to the use of PVs, it is not possible to conduct a Chow test for significant difference between the two samples. Therefore, differences can only be assumed to be the case.

The number of books at home, both ***many books*** and ***few books***, have a significant impact for male and female students. For male students access to ***few books*** has a more detrimental impact ($\beta=-37.386$, $p>0.99$) than the positive impact of having access to ***many books*** ($\beta=25.778$, $p>0.99$). For girls, the number of books has a more steady impact on maths score, with ***few books*** having a negative coefficient of -34.912 ($p>0.99$) and ***many books*** a positive coefficient of a similar magnitude ($\beta=35.329$, $p>0.99$).

Parental occupational status remains with a low, yet significant, coefficient. The coefficient for males is fractionally higher than that for females, which could suggest parents' occupations are more influential for male students. Another possible explanation is that it reflects the gendering of occupations, so girls are less likely to see themselves in maths related careers, therefore have a lower coefficient. In future studies it would be interesting to code parents' occupations both by status and as to whether they require a STEM background.

Literature at home is statistically significant for female students with a high coefficient of 24.367 ($p>0.99$). For male students, ***literature at home*** has a coefficient with a value that is less than half that of the female population ($\beta=8.499$) and it is not a statistically significant finding.

For both male and female students ***interested in maths*** has a statistically significant influence on maths score. The coefficient is larger for female students ($\beta=23.587$, $p>0.99$) than for male students ($\beta=14.699$, $p>0.99$) having a larger effect on maths performance for girls. This may suggest that only girls who are achieving highly are interested in maths while a broader range of boys are interested in maths. This relates to ideas of early socialisation and gender stereotyping, suggesting that having an interest in maths is not as reliant on ability for male students.

Whether maths is ***important for future study*** has a similar effect for male and female students ($\beta=19.986$, $p>0.95$; $\beta=17.62$, $p>0.95$ respectively).

Whether ***parents believe maths is important for career*** has an unexpectedly negative effect on female student maths score. However, both ***parents believe maths is important for career*** and ***textbooks at home*** do not reach the 95% confidence level for either male or female students, not allowing us to reject our null hypothesis, or come to a conclusion about their relationship to maths score.

4.2.7 Comparison Between Regressions

To allow for comparison, a reduced sample was used, including all observations that were not missing any entries for any of the regressors that were included in the final regression, then regressions 1 to 7 were repeated. All coefficients, probabilities and regressions discussed in section 4.2.7 can be found in table 7.

The final regression has the largest adjusted R-squared. Of each of the areas being researched, cultural capital explained the most variation in the maths scores (adjusted-R^2=0.225). This would be expected as this regression contains the variable ***number of books at home*** that had the largest coefficients in the previous regressions. Interestingly, the ***gender*** coefficient (β=-19.634, p>0.99) in the cultural capital regression has the strongest negative effect compared to its coefficients in the other four regressions. Comparing the ***HPOS*** coefficient in the initial gender and class regression (β=1.249) with that in the cultural capital regression (β=0.795) there is a reduction. This suggests that there is some shared explanatory value between cultural capital and ***HPOS***.

The inclusion of subject choice variables increased the ***gender*** coefficient from β=-15.459 in the initial regression to β=-11.704. This suggests that the subject choice variables are mediating part of the ***gender*** effect on maths score. Whether ***parents believe maths is important*** has a similar effect to the subject choice variables with a similar adjusted-R^2 value.

4.2.8 Relationships between Independent Variables

To further consider the relationships between the independent variables the final regression was carried out systematically removing independent variables. This will allow us to see how they interact with each other through change in the variable coefficients. All coefficients, probabilities and regressions discussed in section 4.2.8 can be found in table 8.

The removal of ***few books*** causes an increase in the coefficients for each of the other cultural capital variables. While the removal of ***many books*** causes a decrease in the coefficients for ***few books*** and ***textbooks at home*** and an increase in ***literature at home*** in comparison to the final regression. This suggests that there is a relationship between cultural capital variables, as expected; being able to invest in one suggests an ability to invest in the other.

When each of the cultural capital variables are removed (controlling for all other independent variables), there is an increase in ***HPOS*** compared to the final regression. This suggests that some of the effect of ***HPOS*** is mediated by cultural capital. Interestingly, the removal of ***few books*** and ***many books*** causes a change in the ***gender*** coefficient, while removing ***literature*** and ***textbooks at home*** causes slight change. This suggests that there is a stronger link between ***gender*** and ***number of books at home***, this could be partly explained by the differences in how male and female students use cultural capital (see male and female regressions in table 7).

Whether ***parents believe maths is important*** remains statistically insignificant in each of the regressions with its value fluctuating from roughly -2 to 9. The removal of ***parents believe maths is important*** has little effect on any of the independent variables, including the two key variables, ***gender*** and ***HPOS***.

Believing maths is ***important for future study*** has a clear effect on the ***gender*** coefficient (controlling for all other independent variables) when compared to the final regression (decreasing from -15.941 to -17.092). This suggests that the effects of ***gender*** are partly mediated by believing maths is ***important for future study***. This could be due to a difference in the numbers of male and female students intending to take subjects that require mathematical knowledge which would be supported by the findings earlier that fewer female students believed that maths was important for future study (table 3).

The removal of ***important for future study*** had little effect on the coefficients for the cultural capital variables, although had a small effect on ***HPOS***. The most interesting effect, outside of that of ***gender***, was the increase in the coefficient for ***parents believe maths is important*** (from -1.364 to 8.74). However, this variable remains statistically insignificant, allowing us to draw little from this change.

Whether a student is ***interested in maths*** follows a very similar pattern to that seen in the other subject choice variable, ***important for future study***. This again suggests the gendered nature of advanced maths uptake.

Table 7: Regressions using final sample

Regression statistics	Regression Gender and Class	Regression Cultural Capital	Regression Socialisation & Patriarchy	Regression Subject Choice	Final Regression	Final Regression Male	Final Regression Female
R-squared	0.109	0.228	0.114	0.144	0.259	0.236	0.273
Adjusted R-squared	0.108	0.225	0.112	0.142	0.255	0.229	0.267
Intercept	445.431	455.186	430.726	419.284	434.447	416.033	432.403
Number of observations	1744	1744	1744	1744	1744	840	904
Gender and Class Variables							
Gender	-15.459**	-19.634**	-13.952**	-11.704**	-15.941**		
Highest Parental Occupational Status (HPOS)	1.249**	0.795**	1.26**	1.241**	0.797**	0.916**	0.691**
Cultural Capital Variables							
<u>Books at Home (reference category 26 – 200 books)</u>							
Few books at home		-36.196**			-36.304**	-37.386**	-34.912**
Many books at home		31.871**			30.946**	25.778**	35.329**
Literature at home		16.823**			16.895**	8.499	24.367**
Textbooks at home		18.18*			14.047	21.742	5.421
Socialisation and Patriarchy							
Parents believe maths is important			16.108**		-1.364	10.657	-8.386
Subject Choice							
Important for future study				17.665**	18.366**	19.986*	17.62*
Interested in maths				22.407**	20.112**	14.699**	23.587**

*p>0.95 **p>0.99

Table 8: Systematic removal of variables from final regression (1744 observations)

Regression statistics	Removing Few Books	Removing Many Books	Removing Literature	Removing Textbooks	Removing Socialisation & Patriarchy	Removing Important For Future	Removing Interested in Maths	Final Regression
R-squared	0.226	0.24	0.251	0.257	0.259	0.252	0.246	0.259
Adjusted R-squared								0.255
Gender and Class Variables								
Gender	-16.192**	-14.404**	-15.632**	-15.638**	-15.89**	-17.092**	-16.384**	-15.941**
Highest Parental Occupational Status (HPOS)	0.893**	0.862**	0.84**	0.812**	0.798**	0.804**	0.797**	0.797**
Cultural Capital Variables								
Books at Home (reference category 26 – 200 books)								
Few books at home	-	-42.759**	-40.161**	-37.736**	-36.316**	-36.141**	-36.586**	-36.304**
Many books at home	40.766**	-	35.953**	30.805**	30.931**	30.824**	31.586**	30.946**
Literature at home	24.825**	23.661**	-	17.235**	16.926**	17.082**	16.964**	16.895**
Textbooks at home	23.791**	13.418	15.174*	-	14.066	15.432*	15.314*	14.047
Socialisation and Patriarchy								
Parents believe maths is important	-1.866	-0.924	-2.034	-1.481	-	8.74	2.225	-1.364
Subject Choice								
Important for future study	17.983**	18.177**	18.58**	18.843**	17.828**	-	23.839**	18.366**
Interested in maths	20.509**	20.705**	20.159**	20.374**	19.997**	23.406**	-	20.112**

*p>0.95 **p>0.99

4.4 Residual Analysis

Assumption three of the classic linear regression model is that the "disturbance terms all have the same variance and are not correlated with one another" (Kennedy, 2008, 41). Therefore analysis of the residual shall be carried out to check for heteroscedasticity (when the errors, or disturbances, are not all the same).

As the regressions above use the students' five PVs calculating the residual for each student would require us to calculate the mean of all five residuals and compare to the mean of the five scores. However this would interfere with the standard errors for the population (OECD, 2009). Therefore, residual analysis has been considered independently on each of the regressions for the five PVs. The residuals were calculated in SPSS and saved alongside the student information used in the final regressions. This was then imported into Stata for further analysis.

For PV1 the histogram of residual frequency (figure 12) has a roughly normal distribution while the kernel density plot suggests a good distribution under the normal curve (figure 13). The 'close to normal' distribution can be confirmed by looking at the normal probability plot (figure 11) where the residual has equal variance throughout.

The scatter plot of the predicted y of the regression (yhat) against the residual is roughly spherical which again suggests that the variance is not correlated (Kennedy, 2008, 112-129).

The Skewness and Kurtosis test (presented in table 9) was used to validate the visual inspections of the residuals. The null hypothesis, that the residuals are normally distributed, cannot be rejected (Stata, 2015) confirming that the residuals are normally distributed.

Table 9: Skewness and kurtosis test

	Observations	Pr(Skewness)	Pr(Kurtosis)	Adj chi2(2)	Prob>chi2
Residual 1	1.7e+03	0.4630	0.9735	0.54	0.7623
Residual 2	1.7e+03	0.2843	0.5528	1.50	0.4725
Residual 3	1.7e+03	0.2189	0.5873	1.81	0.4054
Residual 4	1.7e+03	0.0054**	0.3763	8.49	0.0143
Residual 5	1.7e+03	0.3887	0.5282	1.14	0.5648

*p>0.95 **p>0.99

Residual analysis for plausible maths score one

Figure 11: Normal Probability Plot

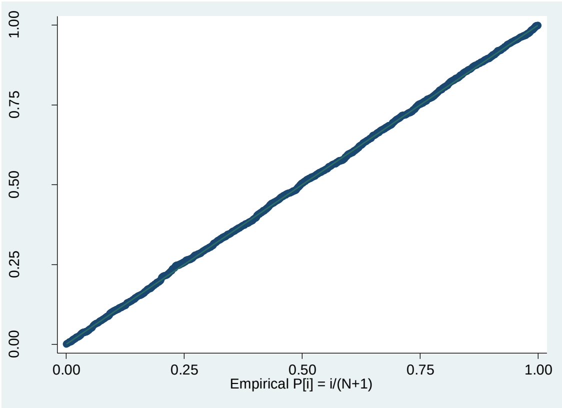


Figure 13: Kernel Density Plot of Residual

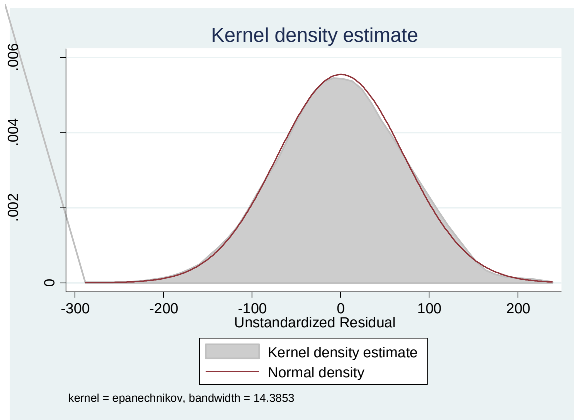


Figure 12: Histogram of Residual Frequency

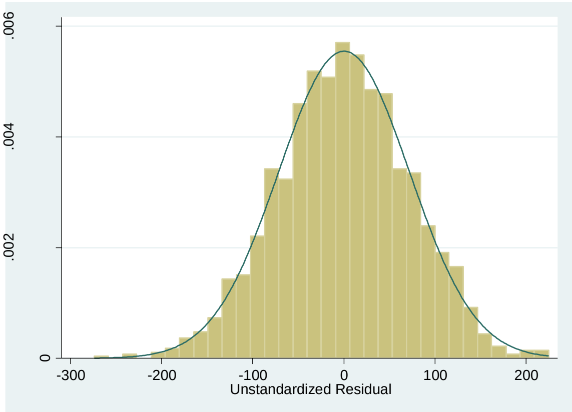


Figure 14: Scatter Plot of Residual Against Yhat

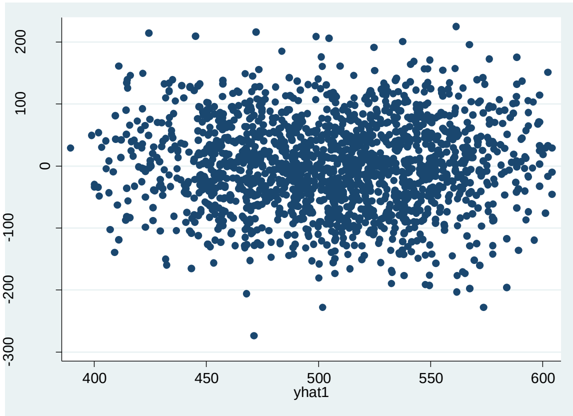
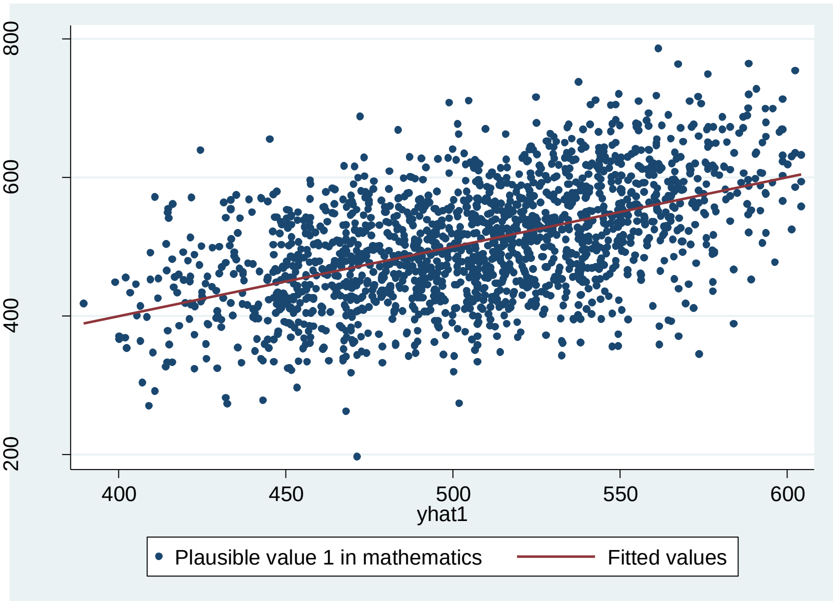


Figure 15: Scatter plot Yhat against plausible maths score one



These tests were computed for each of the PVS, all with similar results with the exception of PV4. This suggests that the residuals for the regressions onto PV1, PV2, PV3 and PV5 were normal and homoscedastic.

Values for the Skewness and Kurtosis test are presented above, in table 9, indicating that the null hypothesis, that the residuals are normally distributed, can be rejected for PV4 (Stata, 2015[2]), as the probability of skewness is statistically significant (p>0.99).

When the residuals for the regression onto PV4 are plotted the slight skewness of the residuals can be seen (figures 16 and 17 below). While the residuals are clearly skew, most of the bars remain below the normal curve. As the regressions are combined for the final regression, the slight skewness is not of concern and will be dismissed.

Figure 16: Histogram of Residual Frequency PV4

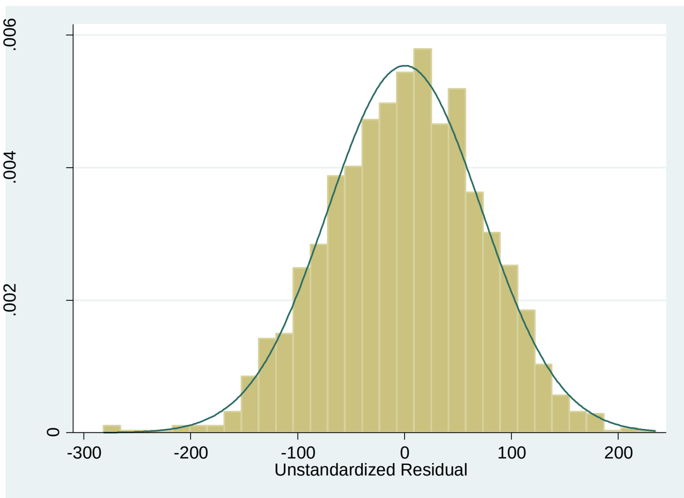
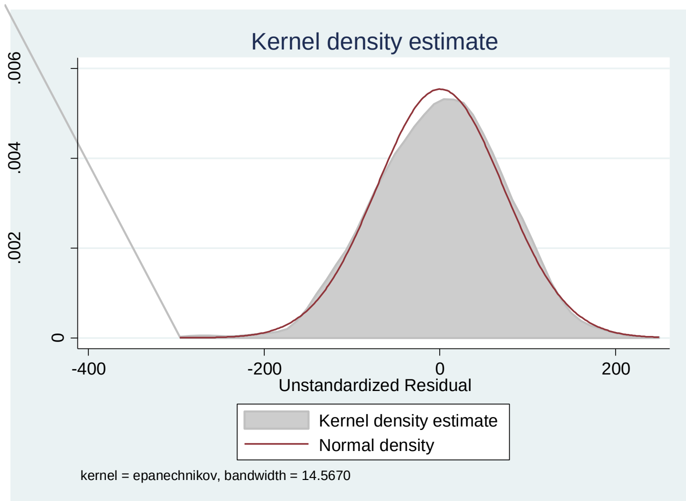


Figure 17: Kernel Density Plot of PV4 residual



4.5 Multicollinearity

The fifth assumption of the classic linear regression model is that none of the independent variables have a linear relationship with each other (Kennedy, 2008, 41), which can be a cause of heteroscedasticity.

“The primary concern is that as the degree of multicollinearity increases, the regression model estimates of the coefficients become unstable and the standard errors for the coefficients can get wildly inflated” (UCLA SCG, 2015).

Therefore, the independent variables were checked for mulicollinearity using the ‘collin’ command (UCLA SCG, 2015) as for this a regression is not required. The VIFs for each variable remained below 5 and tolerance above 0.1 (table 10) suggesting that there is no collinearity within the model.

Table 10: VIF and tolerance of independent variables

Variable	SQRT VIF	VIF	Tolerance
Gender	1.03	1.02	0.9693
HPOS	1.02	1.01	0.9826
Literature at Home	1.25	1.12	0.8018
Few Books	1.27	1.13	0.7859
Many Books	1.25	1.12	0.7988
Textbooks at Home	1.07	1.03	0.9347
Interested in Maths	1.14	1.07	0.8786
Important for Future Study	1.44	1.20	0.6925
Parents believe maths is important	1.38	1.18	0.7220

4.6 Non-linearity

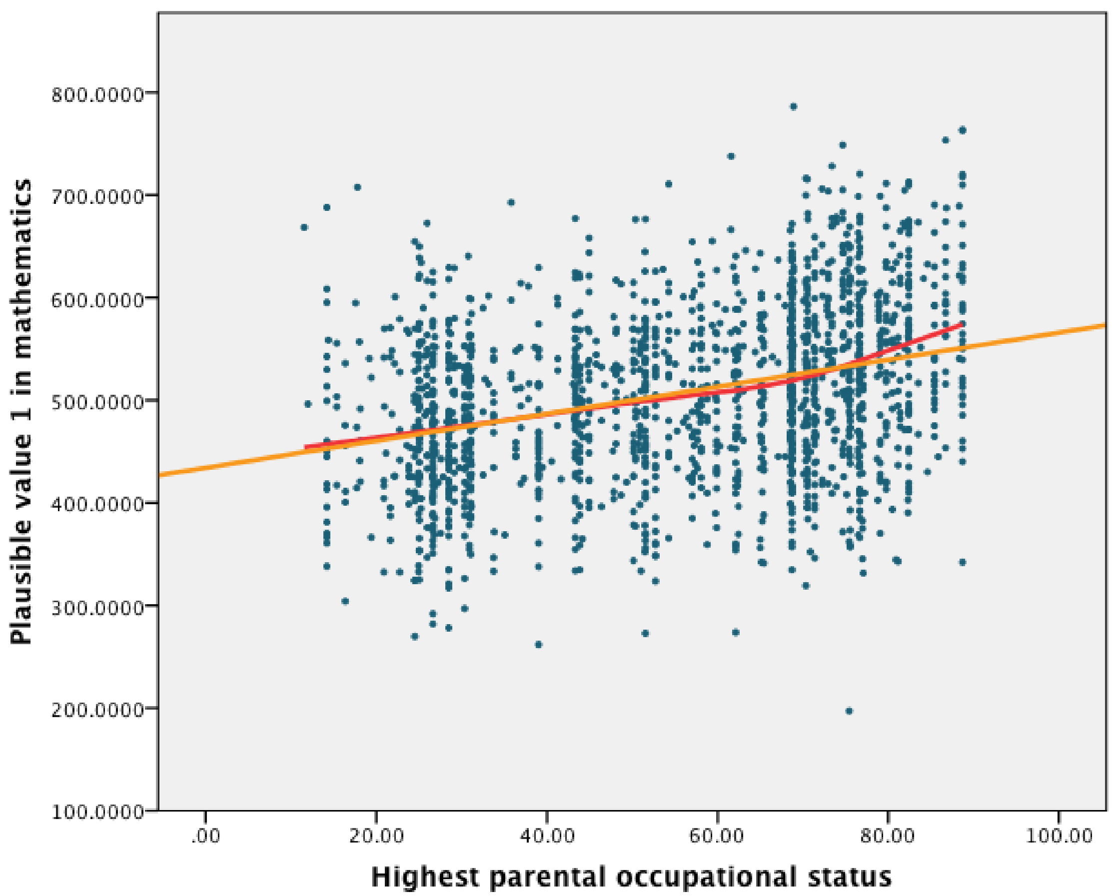
The linear regression model assumes that the relationship between the dependent variable and each of the independent variables is linear, therefore if a variable was to have a non-linear relationship it would be violating this assumption. As all but one of the independent variables are binary dummy variables, only the continuous independent variable ***HPOS*** has been tested for non-linearity.

A scatter was produced of ***HPOS*** against each of the PVs for maths score and the loess (locally weighted scatterplot smoothing) line plotted. All of the PVs had a similar relationship to that seen in figure 18 below. There is a clear linear relationship until around 70 on the ***HPOS*** index where there seems to be an upward turn. However, beyond that point a different linear relationship continues.

This suggests a break in the sample where for students with parents at the top end of the ***HPOS*** scale, parental occupation has a stronger effect on maths score.

When considering the linearity of the relationship, it can be seen that there is little difference between the line of best fit (orange) and the loess line (red). Therefore, it would seem that the relationship between ***HPOS*** and student maths score is linear enough for regression analysis. In future research it may be interesting to split the sample at the point where ***HPOS*** is 70 to consider whether there is further differences between the two samples.

Figure 18: Scatter Plot of PV1 maths against HPOS



5. Discussion

5.1 Cultural Capital: Objectified Cultural Capital and Maths Score

Edgerton and Roberts (2014) state that institutionalised and embodied cultural capital are often neglected in quantitative analysis. In this analysis, the chosen cultural capital variables only represented objectified cultural capital. However, although embodied and institutionalised cultural capital were not explicitly represented by a variable, I will go on to argue that both have been found to have an effect on maths score.

Access to cultural capital was shown to have a significant positive effect on maths score ($\mu>0$, $p>0.95$, table 7), allowing us to reject null hypothesis 1, that cultural capital does not have an effect on maths score. When each of the cultural capital variables were individually removed from the final regression (table 8) the coefficient for ***HPOS*** increased, showing that the effect of class (***HPOS***) on maths score is partly mediated by cultural capital. This rings true to Bourdieu's conception of cultural capital, whereby a parent's economic capital (an aspect of ***HPOS***) allows for their investment in cultural capital, which in turn improves their child's educational performance or, in this case, maths score.

When considering the final regression (table 7), having ***fewer books*** than the reference category had a negative impact on maths score ($\mu=-36.304$, $p>0.99$) while those above the reference category had a strong positive effect on maths score ($\mu=30.946$, $p>0.99$). The other forms of capital that had a significant effect were ***literature*** ($\mu=16.895$, $p>0.99$) and ***textbooks at home*** ($\mu=14.047$) (although ***textbooks at home*** was not found to be statistically significant in the final regression). Having ***art at home*** did not have a significant effect on maths score and was not included in the final regression. This confirms Sullivan's (2001) finding that participation in formal culture did not have any effect on linguistic ability or cultural knowledge, while reading had a positive, significant effect. Access to reading material has consistently been shown to have a positive effect on educational outcomes (De Graff et al, 2000; Sullivan 2001; Flere et al, 2010).

This suggests that objectified cultural capital takes two forms; capital that has symbolic relevance, indicating the owner's status, and capital which has practical application. Symbolic cultural capital is similar to what Sullivan (2001) refers to as 'formal capital'[5], represented in this analysis by the variable ***art at home*.** While cultural capital that has practical application may also function symbolically, it can notably be used to maintain and improve educational ability, as well as encouraging an educated habitus, this includes the variables ***number of books, literature*** and ***textbooks at home*.**

One possible explanation for this distinction is that the school curriculum in France, the system on which Bourdieu's theory of cultural reproduction was developed, is dissimilar to that found elsewhere. Dumais (2002) suggests that the dominant culture in the United States is not as strong, which could also be the case in Scotland, meaning that the curriculum does not have as strong a connection with the dominant culture. For example, in the Scottish Education system, expressing an appreciation of art is one aspect of the art curriculum, while literacy, vocabulary and communication skills are helpful in every subject area, including maths (see below for more detail). As the symbolic aspect of cultural capital gains less recognition within the curriculum, this could explain why ***art at home*** does not have a significant effect while the practical cultural capital variables do.

A second possibility, as the direction of causation cannot be assumed for an OLS regression, is that educational ability has a positive effect on a student's access to practical forms of cultural capital, with students that are better at reading getting parents to invest in cultural goods. The objects of practical cultural capital, such as books, are more widely accessible to students from all social classes compared to symbolic cultural capital, such as artworks. However, in Scotland where there is a system of public and school libraries, reading material is widely accessible so there is no reason why enjoying reading would require substantially more books at home. In future research, this could be confirmed by gathering information from students on their reading habits as well as the books available to them at home.

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5 Also found to be statistically insignificant

This identified distinction in the educational 'usefulness' of certain types of cultural capital suggests that improving students' access to cultural capital must take a specific form, focusing on practical types of cultural capital.

The cultural capital variables found to be statistically significant in the final regression are practical in their development of students' reading skills and general knowledge. It is therefore interesting that they have a strong effect on maths score when the content is unlikely to be mathematical. This suggests that there is more to these cultural objects than their practical application to students' learning or in their symbolic representation of culture. I would suggest that it is in fact improving the individual's embodied cultural capital and developing an educated habitus.

Dumais highlights that it is often the parents "who hold the key to children's cultural participation […] or, as Bourdieu (1984) argued, by demonstrating an interest in culture to the children at home" (Dumais, 2002, 53). In this case, parents choose to invest in these practical cultural objects. Through this investment the parent's positive attitude to cultural capital is exhibited and passed on to their children via socialisation, promoting the characteristics and attitudes towards culture that are required for an educated habitus. Having access to these cultural objects also allows children to learn how to use them, being shown by their parents in the home. This lets students develop embodied cultural capital that again contributes to school performance. Therefore, access to non-mathematical objectified cultural capital could be improving maths score due to its role in developing a student's educated habitus. Therefore, some of the explanatory value assigned to the objectified cultural capital variables is in fact caused by the educated habitus and embodied cultural capital that children develop through these goods.

While institutionalised cultural capital could not be measured using this data, as the students are below examination age, the institutionalised cultural capital that a student would like to achieve is indicated by the student's response to the variable ***important for future study***. Through choosing a non-STEM pathway female students are diminishing their institutionalised cultural capital, as they no longer have the appropriate capital to move into STEM careers. Further discussion around subject choice can be found in section 5.3.

Finally, it was found that students from a range of backgrounds with a variety of maths scores were receiving maths lesson outside of school (figure 10). As ***HPOS*** increased, maths score also increased, yet, within this relationship, students from diverse backgrounds (different ***HPOS*** values, y-axis) achieving a range of maths scores (x-axis) received out of school ***maths lessons*** (green). This implies that there are a variety of situations in which parents choose to fund out of school tuition. Further research should try to understand parent's reasoning behind accessing out of school tuition, the quality of tuition and the effects on student maths ability after tuition, which would involve measurement over time.

5.2 Patriarchy and Habitus: Measuring Overarching Social Structures

The null hypothesis 2, that habitus and patriarchy do not have an effect on maths score, could not be rejected, as the only variable included in the final regression did not have a coefficient statistically different from zero.

When the relationship between independent variables was considered (table 8), it was found that the effect of ***gender*** on maths score is partly mediated by whether ***parents believe maths is important***. While few conclusions can be drawn, as this variable was not statistically significant, it does suggest that there is a gendered more than classed nature to habitus. This will be discussed further in section 5.6 below.

The confidence measure was not suitable for the regression due to its construction. However, using the original confidence question from the survey would have measured both students that are 'not confident' and those that are in fact 'not very good at solving maths problems'. Further questions around confidence and attitudes should be developed for a more in-depth understanding of habitus and socialisation.

While the variables chosen to measure patriarchy and habitus were not statistically significant, this does not suggest that there should not be further research into the effects of socialisation on students' maths outcomes. As with cultural capital in section 5.1, other variables will inherently measure some of the effects of an individual's habitus, in particular, variables that are known to be highly influenced, and in some cases constructed, by the social structures surrounding them. Therefore, while this research cannot draw any major conclusions about habitus or patriarchy alone, it can highlight where they may have some relationship to other variables due to their overarching nature.

5.3 Subject Choice: Navigating Pathways

Three variables were initially selected to represent subject choice, ***worthwhile for what I want to do later, interested in maths*** and ***important for future study***. However, only the last two were found to be statistically significant (μ=20.112 and 18.366 respectively, table 7). As two of the variables had a coefficient statistically different from zero, the null hypothesis for subject choice can be rejected.

The initial analysis (table 3) showed that more boys thought that maths is ***important for future study*** than girls (76% compared to 64% of girls). However, a similarly high percentage (85% and 86%) believed it would be ***worthwhile for what they want to do later,*** a broader conception of usefulness. ***Worthwhile for what they want to do later*** was not found to be statistically significant so was not included in the final regression.

Considering the initial analysis, it suggests that female students do recognise some usefulness in mathematical knowledge, however, fewer explicitly feel a need to continue into future study that requires more advanced mathematics. This contradicts Nash's (2002) finding that girls tended to place more value on language-based courses as, as here female students do see mathematical literacy as a useful life skill. Yet the finding around *future study* confirms concerns about women continuing in mathematics education. This combination could suggest that while increasing numbers of women can recognise that mathematics is no longer just for men, they remain set in pathways that lead to non-mathematical study with STEM being 'not for them', a finding reflected in much of the research into women accessing STEM (Archer et al, 2012; Sharpe, 1994). Research into parental attitudes towards the gender suitability of subjects suggests that this pattern can be extended to the family (Roger & Duffield, 2000).

When the variable ***important for future study*** was removed from the final regression (table 8), the ***gender*** coefficient decreased further. Therefore, the effects of ***gender*** on maths score is partly mediated by ***important for future study***, confirming its gendered nature. As ***important for future study*** has a significant positive effect on maths score, it is crucial that the gender imbalance in STEM study (where maths is likely to be required) is tackled in Scotland.

Whether a student is ***interested in maths*** follows a very similar pattern to that seen in the other subject choice variable, ***important for future study,*** again suggesting the gendered nature of advanced maths uptake.

Nash (2002) discusses the 'relevance of practice', suggesting that students who found maths directly relevant to their future interests were likely to have a positive attitude towards the subject, particularly at more advanced levels. This could suggest that connecting the content of the Scottish maths curriculum with issues that concern female students may improve their interest in the subject (Phipps, 2008). Burton proposes that in fact the issue around the gendered nature of maths is more deeply entrenched; it is at the epistemological level that the concept of 'knowing mathematics' should be further scrutinised. However, her conclusions suggest that this includes the need for an emphasis on knowing maths in "the globality of its application" (Burton, 2008).

5.4 Measuring Language

Language skills could not easily be measured in this data set. The student language or literacy score could theoretically have been used but was not selected for two reasons. Firstly, the use of two sets of plausible values is methodically challenging. Secondly, while it may measure literacy skills it does not measure a student's ability to tackle the technical or abstract language used in mathematics.

5.5 Class and Maths Scores: There Remains a Gap

The variable chosen to represent social class (***HPOS***) was found to have a small but statistically significant effect on maths score ($\mu=0.797$, $p>0.99$, table 7). Therefore, the null hypothesis, that social class has either no effect or a negative effect on maths score, can be rejected.

When the cultural capital variables were removed from the final regression (table 8), each had an effect on ***HPOS*** confirming the link between having objectified cultural capital at home and parental occupation. As cultural capital has a strong connection with ***HPOS*** and had a large positive effect on maths score, it can be shown that social class remains a firm predictor of maths outcomes in Scotland.

In figure 18, a scatter plot shows the relationship between ***HPOS*** and maths score. Around ***HPOS*** index value 70 the relationship takes a steeper slope, seen on the red loess line, suggesting that the relationship between parental occupation and maths score differs after this point. In future analysis, further research could be done by splitting the Scottish sample above and below this point, considering whether students at the upper end of the scale perform remarkably better than those in the lower and middle sections of the index. This could suggest that students from the lower middle and working classes have a smaller difference in scores than those from the upper middle and upper classes.

As detailed information is gathered on parental occupation, future analysis should consider whether there is a relationship between a parent's occupation requiring an understanding or use of STEM and whether this affects their child's attitudes to continuing maths study. This may confirm whether parental attitudes and practices in the home environment affect student's attitudes and maths outcomes. In this context, occupation would relate more closely to habitus and patriarchy due to the role of socialisation on transferring attitudes and practices.

5.6 Gender Difference in Maths Scores and How Girls Come to Succeed

The initial analysis (table 4) suggests that there was a significant difference in the average score for male and female students (505.538 and 491.23 respectively). ***Gender*** (female) also had a significant negative effect on maths score (μ=-15.941, $p>0.99$, table 7), allowing us to reject the null hypothesis, that being female has a positive or no effect on maths score.

While it is clear that ***gender*** has an effect on maths score, it is necessary to consider the structural differences that cause female students to perform less well than male students. This also enables us to work against conceptions of female students not being as good at maths as boys due to biological differences. When the final regression was performed on the male and female populations (table 7), the effects of the independent variables on maths score varied between boys and girls. However, the null hypothesis, that there is no structural difference between what affects male and female students, cannot be rejected, as the statistical significance between groups could not be calculated.

The independent variables used in the final regression explain more variation for female students than for male students (adjusted-R^2= 0.267 and 0.229 respectively, table 7). This suggests that the variation in female maths score is explained better by the independent variables than the variation in boys' scores. This structural difference between male and female students suggests that while they may come from "the same social class, their habitus may be quite different, on the basis of their socialization and the views they form of the opportunity structure available to them" (Dumais, 2002, 45). The rest of this section will consider the differences between the male and female regressions and how this may affect policy and methods to overcome gender differences in maths outcomes.

The coefficients for the cultural capital variables vary between the male and female regressions (table 7), suggesting that boys and girls require different cultural goods to improve educational performance. Having ***fewer books*** than the reference category has a stronger negative effect for male students (μ=-37.386) than for female students (μ=-34.912) while having more than the reference category has a smaller positive effect for male students (μ=25.778 compared to μ=35.329). This suggests that boys need access to fewer books to improve their maths score than female students. Interestingly, ***literature at home*** had a large positive coefficient (μ=24.367) and a statistically significant effect on maths score for female students while for male students the coefficient was smaller and not significantly different from zero. ***Textbooks at home*** was not significant for male or female students.

While cultural capital had different effects for boys' and girls' maths scores it was not found that cultural capital was distributed in a gendered manner (table 2) indicating that boys and girls have similar access to cultural capital but use cultural capital differently. Dumais suggests that cultural capital "may help female students become more visible to teachers or may give them the sense of mastery and confidence necessary to become more assertive in the classroom" (Dumais, 2002, 61). The findings around ***literature at home*** would confirm this, as well as supporting Nash's (2002) conclusion that female students build strength in their language based skills, relying on these in the classroom. The systematic removal of variables from the final regression (table 8) also indicates that there is a relationship between the ***number of books at home*** and ***gender***, although there was little effect on the ***gender*** coefficient when ***literature*** or ***textbooks*** were removed. The gendered nature of earlier recommendations around cultural capital must therefore be considered.

The habitus and patriarchy variable, ***parents believe maths is important***, does not have a statistically significant effect for the male or female population however, the vast difference in the coefficients for the male and female regression is large (μ=10.657 and -8.386 respectively, table 7). While the lack of statistical significance does not allow us to draw clear conclusions, it would suggest that there remains a gendered attitude by parents towards what is considered appropriate knowledge necessary for their child's career.

The relationship between student maths score and parent occupation is also gendered, with male students having a higher coefficient than female students (μ=0.916 and 0.691 respectively, table 7). Two possible reasons for male maths score being affected more by parental occupation are society's' emphasis on boys to continue in maths and the expectation that they should have a career, or in other words, continuing in maths and having career is less important for a women.

Fewer female students were likely to report that they agreed or strongly agreed that maths was ***important for future study*** or that they were ***interested in maths*** (table 3). This indicates that girls consider maths as having a different role in their future to boys. In the male and female regressions (table 7) there is a slight difference between the coefficients for ***important for future study*** (μ=19.986 and 17.62 respectively) and a large difference between the male (μ=14.699) and female (μ=23.587) coefficients for the variable ***interested in maths***.

When ***important for future study*** was removed from the final regression (table 8) it was found to mediate the effect of both class (***HPOS***) and ***gender*** on maths score, as both coefficient values were affected. This finding suggests that whether a student believes maths to be ***important for future study*** is related to both the student's class and ***gender***. This makes sense considering that fewer working class students are likely to continue into further study (Ianelli, 2013), while, as shown in table 3, a smaller proportion of female students (12 percentage points less) believed maths was important for future study.

This would seem to confirm findings from previous studies that suggest middle class girls are more likely to continue in STEM courses than working class girls (Archer et al, 2012; Walkerdine et al, 2001). Mendick (2005) also found that the female maths students she interviewed justified their continuation of maths by relating their success in advanced maths to the wider opportunities and positions of status that this would allow them. While the two interviewees did not necessarily plan to enter STEM careers they did feel that advanced maths at school would open up future study options to them. Therefore, considering the significant effect of ***important for future study*** on male and female students, it is worth considering how to help students to recognise the value of further maths study on a wide range of future careers.

As female students justified their continuation of mathematics through the social positions that possessing mathematical qualifications allowed, this could suggest that for female students maths qualifications can act as valuable insitutionalised cultural capital (Mendick, 2005; Kelly, 1981).

Unlike ***important for future study***, there was found to be a large difference in the coefficient for ***interested in maths*** between the male and female regression. The relationship between ***gender*** and being ***interested in maths*** was confirmed when the variable ***interested in maths*** was removed from the final regression (table 8), having a negative effect on the ***gender*** coefficient. For female students there is a larger increase in maths score if the student is interested in maths than for boys (μ=23.587 and 14.699 respectively, table7). While a more similar proportion of male and female students said they were interested in maths, this is less strongly linked to maths performance for boys compared to girls. This could suggest that boys across a range of abilities find maths interesting while only those girls who are performing well are interested. Therefore, further research must be carried out to understand better how female students come to be interested in maths.

5.7 Implications and Future Research

While this research has highlighted clear areas for improvement in relation to gender and class, the solutions to such concerns must be considered in light of previous research. This section will highlight three main areas for improvement, relevant to both an academic audience and the wider public, in terms of previous research.

5.7.1 Access and use of cultural capital

This research highlighted that certain forms of cultural capital, primarily practical cultural capital, have a prominent role in improving student educational outcomes beyond those directly linked to the subject content, such as mathematics. For students from families who do not have the economic capital to invest in reading materials, there must remain provision of reading material for *all* students. This finding would support the continuation of programs such as 'BookBug' (The Scottish Book Trust, 2015) that makes available reading material to all families, and may highlight the role of libraries within the wider educational agenda. It could also indicate that school libraries should be encouraged more for students whose families do not attend other public libraries, working against negative conceptions of education children may be socialised into within the home, however, further research is necessary.

A second area for future investigation is how to develop a student's embodied cultural capital that was found to have a role in improving maths score. Developing a student's appreciation for reading is a complex task, affected highly by a student's home life due to socialisation. Nash's (2002) research showed that working class students in a literature course did not always 'connect' to the content of the chosen literature but also did not understand the nuance behind much of the chosen text. This suggests that more independent reading may benefit students from the working classes where they select their own reading material developing some of the skills required for an educated habitus. Further research must be conducted to understand whether only 'literature' develops a student's embodied cultural capital and educated habitus.

Finally, it was found that female students used cultural capital differently from male students. Earlier I suggested that this finding related to Dumais's (2002) assertion that female students use embodied cultural capital to assert themselves in the classroom. Applying this to the maths classroom suggests supplying cultural capital directly linked to maths, such as maths articles in the news or maths textbooks, could allow female students to develop their confidence within the maths classroom.

5.7.2 Mathematics Lessons and the World of Work

Gaining student interest and linking further maths study to careers students consider viable could significantly affect student maths score. Linking school curriculum to the job market has long been suggested as a method for getting more working class students to succeed in school (Anyon, 1980; Kelly 1981), particularly through vocational programs, and is often used as a justification for educational change in policy discourse[6]. While similar methods have been used in the UK to tackle gender inequality within STEM, justified by the economic impact of women's exclusion from the increasingly important STEM workforce (Phipps, 2008), it often focuses the curriculum towards more feminine occupations or concerns.

Much of this work relates to curriculum content and/or using role models to help students identify with scientists and mathematicians. Archer et al (2005) found that many of the female students interviewed cited as a defining moment meeting or hearing about a female scientist. Considering widening participation in general, including male students from working class backgrounds and students from ethnic minorities, this may include meeting role models who come from similar backgrounds. This could justify the creation of links between the wider STEM community and the education system, allowing students to understand that maths is used in a diverse range of careers and that these options are available to them.

Reviewing and connecting curriculum content to real life challenges may allow students to relate maths to their community. In interviews with maths keen students, it is often the case that they can understand the wider applicability of maths within society (see Leon's interview in Nash, 2002, 38).

However, both of these strategies raise concerns as to whether they will further entrench social class and gender divisions within maths and also within the wider domain of STEM. Nash (2002) found that students in a school where "practical maths" was offered, instead of involving more students in maths that would be useful for their futures, it instead created further social class boundaries. The middle class female students interviewed believed that while practical maths may be more useful that the course was below them, or in their words 'cabbage maths'

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[6] For example, recent Scottish Government policy to improve outcomes for low attaining students through improved vocational qualifications (SG, 2014).

(ibid, 37). Similarly, it can also be questioned whether creating "girl-friendly science […] reiterated essentialist constructions" (Phipps, 2009, 62) of gender.

Further considerations must be made as to how mathematics can appeal to students from a wider range of backgrounds and across both genders. This can be worked on at an individual level, with teachers connecting course material and content to concerns within that specific community and classroom, and on a wider level through the Scottish CfE.

5.7.3 Relationships Between Mathematics and Femininity

Considering the impact of being ***interested in maths*** and ***important for future study*** on female maths score, this section will reflect on the link between the continuation of mathematics, interest in the subject and relationship to an individual's femininity.

The conflict between the masculine nature of maths and a student's identity or habitus as feminine could not be analysed using this data. However, it could be the case that the "identity work" (Archer et al, 2012) required of female students in the maths classroom, that Mendick (2005) describes as "doing masculinity", requires more commitment and personal conflict for female students. This conflict and "identity work" could be the reason behind fewer female students identifying as either being ***interested in maths*** or believing it to be ***important for future study***.

While there is a general conception of maths as masculine, feminist research has stressed the more complex dichotomies at work within the field of maths. Mendick (2005) highlights the gendered binary oppositions asserted in the maths classroom and how these are aligned with either masculinity or femininity, with the feminine being considered less valuable by teachers and students. These include active/passive, reason/calculation, real understanding/rote learning and naturally able/hardworking (also found to be true in Archer et al's research (2012)). These pairings are asserted both within and out with the maths classroom, with maths students and the maths curriculum often stereotyped in other areas of a school and vice versa.

This suggests that to reduce gender stereotyping within the field of education there must be improvement in two areas: collaboration between subject departments in schools and the valuing of both aspects of the binary pairs within the classroom, without relation to gender. In practice this could include better communication and collaboration between departments. The

CfE has begun to challenge this with its emphasis on interdisciplinary learning and numeracy within all classrooms (Education Scotland, 2015[2]). Secondly, it requires further development of teaching methods and materials within the maths classroom that allow for students to succeed and flourish with a balance of these dichotomies, recognising accomplishment where deserved.

6. Conclusion

Considering the findings of this research it can be concluded that gender and class have a significant impact on student maths score in Scotland.

There was a significant difference between the average score for the male and female population and a structural difference between what supports male and female students to do well in maths. Therefore, this research would advocate that gender must be taken into account in educational policy and practice to find effective ways of helping female students to succeed in mathematics.

The structural break found within the class variable (***HPOS***) suggests that further analysis should be carried out on the populations above and below this point. Further analysis must also be undertaken to gain a better understanding of how specific social class situations affect students in maths. While occupational status was an appropriate measure in this research, the use of an index makes it hard to relate what changes can be made in reality, particularly if policies wish to target specific social groups.

Maths score was found to be further affected by student cultural capital, in particular access to reading material. Cultural capital was classed, with children of families with higher parental occupational status and with other forms of cultural capital being more likely to have cultural capital. This supports Bourdieu's (1986) conceptualisation of cultural capital and Sullivan's (2001) finding that cultural capital was strongly related to parental social class and qualifications.

Being ***interested in maths*** had a stronger effect on maths score for female students, although a similar proportion of male and female students stated that they were interested in maths. The concern around girls not progressing into advanced maths and STEM careers was shown to be relevant to the Scottish sample, as fewer female students identified that maths was important for their career.

Habitus and patriarchy could not be shown to have an effect on maths score. This is partially due to the measures available in the chosen data set. The research highlighted a need for further information on student attitudes, character traits and family life to allow for better quantitative analysis into the effects of socialisation. This suggests that the lack of quantitative research carried out on habitus within education (Edgerton &Roberts, 2014) could be due to the data available for researchers.

While quantitative regression analysis allows us to raise questions around what relationships can be found between maths scores and various independent variables, it is not possible to explain why these relationships are the case. The research raised possible explanations for these relationships based on previous research. However, it would seem that further qualitative research is required, particularly to understand the difference in how male and female students use cultural capital, how cultural capital comes to affect maths score and how to get girls interested in maths.

To conclude, it is crucial that the Scottish education system takes on board the significant impact of gender and class on student's maths ability.

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