The Gender Gap in Attitudes and Test Scores: a new construct of the mathematical capability.

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Abstract

In most OECD countries, girls outperform boys in all subjects except mathematics. Usually, only test scores are utilised as a measure of mathematical skills. In this paper, we argue that in order to measure children's capability in mathematics we need to include some indicators of the attitudes of children towards the subject. This is particularly important when we analyse gender gaps, because attitudes towards mathematics differ by gender. We first describe the differences by gender both in test scores and attitudes utilising a model including school fixed effects. Next, we estimate a quantile regression in order to analyse how the gender gap varies across the distribution of the attitudes. Lastly, in addition to the test scores in mathematics, we use indicators of attitudes towards maths to estimate a Structural Equation Model, which takes into account that maths capability is a latent construct of which we only observe some indicators (test scores and attitudes). We use data from the Italian National Test (Invalsi) for year 5 and year 10 in 2014 and 2015. Results confirm that when we measure mathematics capability including attitudes in addition to test scores, the gap between boys and girls is even wider with respect to the analysis of test scores alone, and therefore educational policies aimed at reducing the gender gap in mathematics should address both attitudes and test scores.

JEL: J16; I24; C31.

Keywords Maths gender gap, Attitudes, Structural Equation models, school achievement.

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1.   Introduction and literature review

Girls outperform boys in educational outcomes in most subjects, both in Italy and in other OECD countries. Girls have higher grades since primary school and they graduate with higher scores in all subjects, including STEM (Science Technology Engineering and Mathematics) ones (OECD, 2015). Nevertheless, in some OECD countries and particularly in Italy, girls have lower test scores than boys in mathematics both in primary and secondary school. This gender gap in mathematics is policy relevant because it can lead to an under-representation of girls in the STEM subjects in universities and an under-representation of women in highly technological and innovative labour markets that also yield high wages (European Commission 2006, 2012, 2015; National Academy of Science, 2007). Therefore the gender gap in mathematics in favour of boys is a matter of concerns for policies addressing gender equality.

The gender gap in mathematics for Italian students is one of the highest among OECD countries, according to the latest PISA results (a 20 point difference in Italy against an average difference of 9 points in the OECD, OECD 2016), even if the overall average in Maths test scores for Italian students is aligned to the OECD average results. Similar results also emerge from TIMMS 2015 (Trends in International Mathematics and Science Study) showing that the gender gap in mathematics for Italian children in fourth grade is the highest among all countries included in the survey (Mullis et al 2016). Contini et al (2017) show that boys outperform girls in mathematics from 2° to 10° grade, using the National Assessment for Italy (INVALSI) . Further, the gender gap in mathematics is increasing with age, even after controlling for individual and family characteristics.

A variety of explanations have been proposed for the existence of a gender gap in mathematics. Some studies point to the role of parents' and teachers' beliefs about the innate mathematical abilities of boys and girls[4], others to the role of cognitive and non-cognitive abilities[5]. Although the causal direction is difficult to assess, girls display less maths self-efficacy (self-confidence in solving maths related problems) and maths self-concept (belief in their own abilities), and more anxiety and stress in doing maths related activities boys (Else-Quest, Hyde, & Linn, 2010). Lubiensky et al (2013) used data from USA (ECLS-K) for Grade 3 and 5 and found that gender gaps in mathematical confidence were substantially larger than gaps in actual performance, with disparities in interest being smallest of all. These findings are consistent with TIMSS and PISA reports of girls throughout the world

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[4] See among others, **Fryer and Levitt. (2010).**
[5] See among others: Heckman, J. J. & T. Kautz (2012); Heckman, J. J. & T. Kautz (2014).

having substantially less mathematical confidence than boys (Mullis et al 2008; OECD 2016). There is a vast economic literature on the determinants of human capital formation during childhood. It is becoming increasingly clear that human capital is a complex object with many different dimensions. A large and growing body of evidence points to the importance of both cognitive and non-cognitive skills and to their interaction[6].

The concept of attitudes towards mathematics has been defined in the context of mathematics education[7]. The origin of the "attitude" comes from social psychology (Allport 1935) in the context of predicting choices based on preferences like buying goods or voting. Early studies about attitude in mathematics education are placed in this framework, and focus on the relationship between attitude towards mathematics and school mathematics achievement, trying to highlight a causal relationship. As Neale (1969, p. 631) underlines: *Implicit (…) is a belief that something called 'attitude' plays a crucial role in learning mathematics. (…) positive attitude toward mathematics is thought to play an important role in causing students to learn mathematics.*" Nevertheless, a large portion of studies about attitudes do not provide a clear definition of the construct itself: often attitude is defined implicitly and a posteriori through the instruments used to measure it (Leder 1985; McLeod 1992; Ruffell et al. 1998; Daskalogianni and Simpson 2000). Further, studies that explicitly give a definition of attitude do not share a single definition. In the variety of meanings attributed to the construct, three main different types may be identified: (a) A simple definition that describes attitude as the positive or negative degree of affect associated with mathematics (Haladyna et al. 1983); (b) A tripartite definition that recognises three components in attitude: emotional response towards mathematics, beliefs regarding mathematics and behaviour related to mathematics (Hart 1989); (c) A bi-dimensional definition in which, with respect to the previous one, behaviours do not appear explicitly (Daskalogianni and Simpson 2000).

Another critical point in research on attitude towards mathematics, related to the choice of a definition, is its measurement. Surveys generally propose items like: 'Mathematics is useful', 'I like problem solving', 'I think about arithmetic problems outside school'. Since these items are related to the three different dimensions—respectively beliefs, emotions, and behaviours—questionnaires make implicit reference to the tripartite model. Di Martino and Zan (2010) investigated how students tell their own relationship with mathematics, proposing the essay ''Me and maths'' to more than 1,600 students (1st to 13th grade). Students' attitude towards mathematics comes out as a multidimensional construct. The study also shows how the relationship with mathematics is rarely told as stable, even

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[6] For a complete review and an updated state of the art see: Attanasio O. P. (2015). See also, Newcombe, N.S., Levine, S.C. & Mix, K. S. (2015).

[7] A good review of the literature can be found in Larsen 2013 and in Di Martino and Zan 2010.

by older students. Their result suggests that there is scope for policies that change attitudes over children life course.

This paper defines a mathematical capability of children, which includes both test scores in mathematics and attitudes towards mathematics. We refer to the theoretical construct of the capability approach of Amartya Sen and to the economics of education literature on the importance of cognitive and non-cognitive skills (Heckman 2008; Cunha et al. 2010; Sikora and Pokropek 2012; Cornwell et al. 2013; Gutman and Schoon 2013; Heckman and Mosso 2014) in order to show that the use of test scores is limited and it is important to include other non-cognitive dimensions related to mathematics.

The capability approach (Sen 1985, 1999, 2009; Nussbaum 2003) represents an alternative framework for the evaluation of human well-being, which does not primarily focuses on income and wealth, but also includes other important dimension of well-being such as education, bodily integrity, social interactions etc. (Sen 2009). Similarly, we define a mathematical capability as including the dimension of test scores as well as the dimension of attitudes towards the subject. This is particularly important for analysing gender gaps because in addition to a gender gap in test scores, there is also a gender gap in attitudes. We use the questions related to the attitudes towards mathematics included in Italian National Test (Invalsi) data for year 5 (fifth year of primary school) and for year 10 (second year of secondary school). These questions relate both to beliefs (I am usually good at maths, I learn maths easily, maths is harder for me, I learn a lot of things in maths) and emotions (I like maths, maths is boring) but not behaviours. Therefore, with respect to the different definitions provided above, the Italian National Test utilises a bi-dimensional definition of attitudes.

We begin by describing the differences by gender both in test scores and attitudes using an OLS model with school fixed effects. Next, we estimate a quantile regression for attitudes, in order to analyse how the gender gap varies along the distribution of attitudes. Lastly, in addition to the test scores in mathematics, we use indicators of attitudes towards maths to estimate a Structural Equation Model which takes into account that maths capability is a latent constructs of which we only observe some indicators (test scores and attitudes). Results confirm that when we measure mathematics capability including attitudes in addition to test scores, the gap between boys and girls is even wider with respect to the analysis of test scores alone.

2.   Data and descriptive statistics

Education starts in Italy at age 6. Primary school lasts for 5 years (until age 11) and is followed by 3 years of middle school and 5 years of secondary school. Compulsory education terminates at 16 years old.

Students choose among different types of high school at age 13. There are three main types of secondary schools with substantial differences in the curricula: the Lyceum, the Technical High School and the Vocational High School. Lyceums offer a higher level of academic education with strong focus on the humanities, sciences, languages or arts. Technical institutes provide a general education and a qualified technical specialization in a particular field. Vocational institutes have the objective to prepare students for entering the labour force.

We use data from the National Test INVALSI. In general, INVALSI tested all Italian children in grade 2, 5, 8, and 10 since 2010 and covers the whole population of Italian students (around 400,000 observations in each cohort). However, we use data from a sub-sample which includes students who took the test under the supervision of an external inspector[8] (between around 25,000 and 35,000 observations in each cohort).

The estimation sample only includes native children, because migrants are more likely to repeat and/or to be enrolled in lower grades with respect to their age due to their lack of proficiency in Italian (Contini et al., 2017). The final estimation sample includes almost 95,000 students from the four selected cohorts (see Table 1 for details).

In addition to test scores, in selected years, INVALSI data includes information about attitudes towards maths, including six questions asking students how much they like maths, as well as more specific questions about their learning, confidence and understanding of the subject.

In this study, we use data from grade 5 and grade 10 for the years 2014 and 2015, which are the only datasets including information on attitudes towards maths.[9] These questions relate both to beliefs and emotions. Table A1 and A2 in appendix present descriptive statistics for attitudes towards maths in the estimation sample. In particular, for grade 5 the following six items are included in the survey: I am usually good at maths, I learn maths easily, Maths is harder for me than for most of my class mates, I learn lots of things in maths, I like studying maths, Maths is boring. The first two items relate to the dimension of "beliefs" while the last two items to the dimension of emotions. To each

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[8] For a detailed explanation of the problem of "cheating" in Invalsi data see Angrist et al (2015), Bertoni et al. (2013), Lucifora and Tonello (2015), Paccagnella and Sestito (2014)

[9] There also is some data for attitudes in year 2013 but it includes different questions respect to 2014 and 2015 and therefore has not been considered in this analysis.

statement the pupils had to reply on a Likert scale from 1 to 4, where 1 indicates "strongly disagree" and 4 "strongly agree".   For grade 10, the items are the following: I learn maths quickly, I learn lots of things in maths, I have always thought maths is one of my strongest subject, During maths class I understand the hardest topic, I like studying maths, Maths is boring. The first four items belong to the dimension of beliefs while the last two refer to the dimension of emotions. Tables A1 and A2 show that there is a gender gap in all items for attitudes towards maths and that girls are less likely to like maths and have less confidence in their ability to learn maths effectively. These differences are significantly different from zero. Further, the proportion of students who think that maths is harder for them than for their peers is substantially higher for girls than for boys, and girls are less likely to believe that maths is one of their strongest subjects[10].

Given that the focus of this paper is the analysis of a construct of mathematical capability, including both test scores and attitudes towards mathematics, we begin the analysis by describing the relationship between test scores and attitudes through a graphical analysis. Figures 1 to 4 show the average standardised test scores by answers to the questions on attitudes and by gender. As expected, both boys and girls who express strong preferences for mathematics have on average higher test scores than their peers who do not like the subject. However, the gender differences are noticeable, even among students with strong preference for the subject. For instance, Figure 1 shows that the average standardised test scores for boys in grade 5 in 2014, who answer that they strongly like studying maths is around 0.2 standard deviations, while the same figure for girls is only around 0.1 s.d. So even among pupils who have a strong preference for mathematics, there is a difference in test scores, with boys consistently outperforming girls. This pattern is observed in all the four cohorts, and across all the different questions about preference for mathematics.

In order to analyse the relationship between attitudes and test scores, we construct a single indicator of attitudes towards maths using factor analysis and the students' answers to these six questions regarding their emotions and beliefs in maths. In all four cohorts, results from factor analysis show the there is only one underlying factor for all the attitudes question (one factor with eigenvalue greater than 1), so we are able to define one attitudes index based on the six relevant questions (see table A3 in Appendix A, for the factor loadings of each component in the attitude index). Table 1 reports descriptive statistics of this index for attitudes and the standardised test score. Both indexes are standardised to have mean equal 0 and standard deviation equal 1. The gender gap in attitudes is always higher than the gender gap in test scores, except than for grade 10 in 2015.

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[10] We have also performed a preliminary descriptive analysis of girls' attitudes towards Italian and we found that girls report higher preferences than boys for this subject.

Table 1 – Gender gap (G-B) in attitudes towards maths and test scores

	Year 5 2014	Year 5 2015	Year 10 2014	Year 10 2015
Attitudes towards maths				
Mean (SD)	0 (1)	0(1)	0(1)	0(1)
Minimum	-3.00	-2.95	-1.57	-1.61
Maximum	1.12	1.29	1.83	1.99
Attitudes towards maths – Girls				
Mean (SD)	-0.15 (1.01)	-0.14 (1.00)	-0.13 (1.00)	-0.09 (1.00)
Attitudes towards maths – Boys				
Mean (SD)	0.15 (0.96)	0.13 (0.97)	0.12 (0.98)	0.10 (0.98)
Gender gap in attitudes	-0.30***	-0.27***	-0.25***	-0.19***
Standardized maths test scores				
Mean (SD)	0(1)	0(1)	0(1)	0(1)
Minimum	-3.53	-2.64	-3.12	-2.03
Maximum	2.02	2.06	3.02	2.27
Standardized maths test scores – Girls Mean (SD)	-0.07 (0.97)	-0.1 (0.97)	-0.08 (0.95)	-0.17 (0.96)
Standardized maths test scores– Boys Mean (SD)	0.06 (1.02)	0.09 (1.02)	0.08 (1.04)	0.17 (1.01)
Gender gap in test scores	-0.13***	-0.19***	-0.16***	-0.34***
N	22,246	18,231	31,644	22,772

Note: * indicates that the underlying coefficient is significant at 10% level, ** at 5% and *** at 1%.

Figures 5 to 8 present the cumulative density functions of the indicator of attitudes towards maths, by gender. The distribution of the index in all four cohorts clearly shows evidence of a gender gap in attitudes towards mathematics, with boys generally showing a higher level of preference for the subject.

Figures 7 and 8 present the distribution of the attitudes index in grade 10, by gender. The proportion of students who do not like maths increases with respect to grade 5. However, girls continue to appear less confident and show lower average values of the index of attitudes towards mathematics in both year 10 cohorts.

Figures 9 and 10 show the relation between the index of attitudes and standardised test scores for grade 5 and grade 10 in year 2014 and year 2015[11]. In general, girls have lower level of attitudes towards maths, even if their test scores are equal to those of boys. The only exception is represented

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[11] The graphs have been estimated using a locally weighted regression of attitudes towards maths on test scores (command *lowess* in STATA).

by students in year 10 in 2015. In this case, for low levels of test scores, girls show lower levels of attitudes than equally performing boys, but they show higher level of attitudes at high levels of test scores.

INVALSI data also includes parental characteristics and family background, collected from a students' survey and from school board records. In selected years, INVALSI provides a synthetic indicator of economic and socio-cultural status (ESCS) similar to that the one available in PISA. The ESCS index is calculated by taking into consideration parental educational background, employment and occupation, and home possessions.

The complete set of descriptive statistics for the variables used in the estimation is provided in table A4 in appendix A.

3. Modelling strategies

3.1 Linear cross section model, school fixed effects and quantile regression

Test scores are not measured on the same scale at different school years, and therefore the gender gap on the attitudes towards maths is not comparable across grades. For this reason, we use standardized test scores and the index of attitudes towards maths is standardized (has mean equal to zero and variance equal to one), and therefore the gender gap results show the difference in standard deviations between girls and boys.

We begin our analysis by focusing on the total effect of gender on average maths achievement and attitudes towards maths. We estimate separate OLS models in order to capture the average effect of gender and a set of control variables, including maternal and paternal education, socio-economic status of the family, and geographical area, on test scores and attitudes. We use both the single items for attitudes and the synthetic index for attitudes presented in section 2.

Second, it is important to consider the role of school characteristics in affecting children' learning and the effect of gender might operate both indirectly via school choices and directly net of school characteristics. Students attending the same school are exposed to similar teaching practices, learning targets, and peer characteristics (including socio-economic status, gender, and ability). All of these factors may have a separate effect on students' achievements and attitudes, and may affect the gender gap in test scores and attitudes in a specific way (Contini et al., 2017). For this reason, we estimate the direct effects of gender on maths achievement and attitudes estimating two models including school fixed effects, which exploit within-school variability, and deliver valid estimates of the gender

gap given individual controls and (observed and unobserved) school characteristics. Therefore, the impact of gender on test scores and on maths attitudes is estimated as follows:

$$y_{ijt} = \alpha + \beta g_i + \gamma' x_{it} + u_j + \varepsilon_{it} \tag{1}$$

Where y_{ijt} represents the outcome of interest (maths test scores or attitudes towards maths) for individual i attending school j at time t, β is the coefficient of interest (capturing the impact of students' gender on the outcome), x_{it} is a vector of individual and family characteristics, u_j is a school fixed effect (capturing all time invariants school characteristics, which may have an impact on students' learning and attitudes) and ε_{it} is an individual specific error term.

Last, we focus on the role of gender on attitudes towards maths, and analyse the effect of gender on the entire distributions of the index using quantile regression models (Koenker and Basset, 1978). In practice, we investigate the gender gap at different percentiles of the distribution of the attitudes index, and assess whether female's disadvantage exists throughout the distribution, or instead is stronger among children with very high or very low preference for mathematics. In the simplest case where gender is the only explanatory variables, the quantile regression coefficient gives the difference between the level of attitudes of girls and boys at a specific percentile of the index distribution. The estimated quantile regression includes the same set of independent variables used in the OLS models.

3. 2 Modelling strategy for the Mathematical Capability

The existence of multiple, inter-related indicators to measure mathematical capability raises the question of how to combine them in empirical research. The Multiple Indicators Multiple Causes (MIMIC) model developed in this paper represents one possible approach to solve this problem. One basic strategy could be to choose a single indicator we believe is the closest (replies to the question: "I like maths", for example) to the unobserved construct (mathematical capability), and ignore both measurement error and information on the remaining indicators.

Alternatively, we could use the information in all indicators by creating a synthetic variable, such as a simple mean indicator. The resulting Ordinary Least Squares model represents perhaps the most restrictive model given the neglect of measurement error and the reduction of many indicators to a single one.

Instead, in this approach, we assume that each indicator is a component of mathematical capability; and maths capability is an unobserved variable that is linked to the observable indicators. The principal advantage of this approach is that it does not rely on exact measurement of attitudes. Each indicator represents a noisy signal of attitudes towards maths. This modelling

strategy has been extensively used in psychometrics (Edwards and Bagozzi, 2000) and is founded upon the specification of a system of equations which specify the relationship between an unobservable latent variable (maths capability), a set of observable endogenous indicators and a set of observable exogenous variables.

This approach builds upon the early work of Joreskog and Goldeberger (1975) and Zellner (1970)[12]. The Multiple Indicators and Multiple Causes (MIMIC) approach allows us to think of this model as comprising two parts: a structural equation for mathematical capability and a measurement equation that takes into account that there is no single variable called maths capability. For each of the indicators, a weight (a factor loading) will be estimated. This weight represents how much that specific indicator counts in explaining the capability respect to other indicators.

The structure of the model is as follows:

$$Y = \Lambda^Y y^* + \varepsilon, \, j = 1,........,m \tag{2}$$

where

$Y = \left(Y_1, Y_2, Y_3, ...Y_m\right)'$ is a $m \times 1$ vector with each element representing an indicator of maths capability, denoted Y^*. $\Lambda^Y = \left\{\Lambda^Y_1, \Lambda^Y_2, \Lambda^Y_3.....\Lambda^Y_j\right\}'$ denotes a $m \times 1$ parameter vector of factor loadings, with each element representing the expected change in the respective indicator following a one unit change in the latent variable. ε is a $m \times 1$ vector of measurement errors, with Θ_ε denote the covariance matrix.

In addition we posit that maths capability is linearly determined by a vector of observable exogeneous variables $x = \left(x_1, x_2, ...x_s,\right)'$ and a stochastic error ς giving,

$$Y^* = x'\gamma + \varsigma \tag{3}$$

where γ is a $s \times 1$ vector of parameters.

Examining (2) and (3) we may think of our model as comprised of two parts: (3) is the structural equation and (2) is the measurement equation reflecting that the observed measurements are imperfect indicators. The structural equation specifies the relationship between the observed

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exogeneous causes and the latent construct attitudes towards mathematics. Since Y^* is unobserved, it is not possible to recover direct estimates of the structural parameters γ. Combining (2) and (3) the reduced form representation is written as

$$y = \pi x + v \tag{4}$$

where $\pi = \Lambda^Y \gamma'$ is the $m \times s$ reduced form coefficient matrix and $v = \Lambda^Y \varsigma + \varepsilon$ is the reduced form disturbance.

In our case the indicators are the 6 items for attitudes and test scores (described in section 2 above). The exogenous variables are gender, an indicator of the socio-economic status of the parents, geographical area, father and mother education and type of high school for grade 10 (descriptive statistics for the exogenous variables are presented in Tab. A4).

4. Results

4.1 Results from cross-sectional linear models and school fixed effects

We begin by exploring the gender gap in attitudes toward mathematics and present estimates of the effect of gender on the different items included in the maths attitudes indicator. We present results estimated using OLS, and OLS with school fixed effects[13]. Table 2 present results for each of the four cohorts included in the analysis. Overall, the gender gap is higher in the questions capturing maths self-confidence, such as "I am usually good at maths"; "I learn maths easily" (in year 5); "I have always thought maths is one of my strongest subject"; and "During maths classes I understand the hardest topics"; (in year 10). The impact of gender on these variables ranges from 20% to 30% of a standard deviation in year 5, and from 20 to 25% of a standard deviation in year 10. The gender gap is also high for the question "I like studying maths" for students in year 5 (around 30% of the standard deviation). On the other hand, the gender gap is much smaller in the questions capturing attitudes towards the learning process ("maths is boring" or "I learn lots of things in maths", where the gap is the lowest across all four cohorts), where the impact is usually around 10% of a standard deviation.

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[13] We have also estimated an ordered probit given that the items for attitudes vary on a Likert scale 1 to 4. Results are very similar to the OLS and are available from the authors upon request.

Table 2 – The gender gap in attitudes towards maths.

	Year 5 2014	Year 5 2015	Year 10 2014	Year 10 2015
I like studying maths				
OLS	-0.320 (0.014)***	-0.282 (0.015)***	-0.174 (0.012)***	-0.142 (0.013)***
School FE	-0.320 (0.014)***	-0.280 (0.015)***	-0.047 (0.012)***	0.008 (0.015)
I learn maths easily				
OLS	-0.292(0.012)***	-0.262 (0.013)***	NA	NA
School FE	-0.294 (0.012)***	-0.259 (0013)***		
Maths is harder for me than for most of my class mates				
OLS	-0.217 (0.013)***	-0.173 (0.015)***	NA	NA
School FE	-0.215 (0.013)***	-0.177 (0.015)***		
I am usually good at maths				
OLS	-0.334 (0.011)***	-0.249 (0.0011)***	NA	NA
School FE	-0.338 (0.011)***	-0.248 0.0011)***		
I learn lots of things in maths				
OLS	-0.096 (0.011)***	-0.064 (0.012)***	-0.163 (0.011)***	-0.102 (0.012)***
School FE	-0.096 (0.011)***	-0.057 (0.012)***	-0.052 (0.012)***	0.002 (0.013)
Maths is boring				
OLS	-0.127 (0.013)***	-0.141 (.015)***	-0.061 (0.012)***	-0.037 (0.014)***
OLS FE	-0.128 (0.013)***	-0.135 (0.015)***	0.057 (0.014)***	0.100 (0.015)***
I learn maths quickly				
OLS	NA	NA	-0.309 (0.012)***	0.223 (0.013)***
OLS FE			-0.210 (0.013)***	-0.121 (0.015)***
I have always thought maths is one of my strongest subject				
OLS	NA	NA	-0.362 (0.012)***	-0.325 (0.014)***
OLS FE			-0.244 (0.013)***	-0.193 (0.016)***
During maths classes I understand the hardest topics				
OLS	NA	NA	-0.317 (0.011)***	-0.239 (0.014)***
OLS FE			-0.223 (0.013)***	-0.140 (0.014)***
N	22,246	18,231	31,644	22,772

Note: Std errors are in brackets. ∗ indicates that the underlying coefficient is significant at 5% level, ∗∗ at 1% and ∗∗∗0.1%. All models include area of residence, maternal and paternal education, ESCS index (Socio-economic indicator). Models for year 10 include also the type of high school (Lyceum, Professional or Vocational)

Tables 3 and 4 shows estimates of the gender gaps in maths achievements and attitudes calculated using OLS, and OLS with school fixed effects. Gender has a significant and sizable effect on test scores and attitudes towards in mathematics both in year 5 and in year 10. Results are very stable when we control for school fixed effects, implying that there is no substantial indirect effect of gender via school characteristics, not even at year 10, where schools differ markedly and the choice between school types is strongly related to individual and family characteristics. Overall, table 3 shows that the gender gap in maths attitudes is around 20% -30% of a standard deviation of the index (the index for maths attitudes is standardised to have mean 0

and variance equal to 1). To put this in context, this is around at least 3 times the impact of a standard deviation increase in socio-economic disadvantage (captured by the ESCS index, see table A5). The gap in maths attitudes is slightly lower (but still relevant in size and significance) in year 10 once we control for school fixed effects, and this probably reflects the effect of students' self- selection into different types of high school.

The gender gap in test scores ranges between 15% and 45% of a standard deviation, and increases in year 10 (see table 4). Interestingly, the effect of gender on maths test scores persists in year 10, even after we control for school type. Therefore, our results show the existence of a substantial gender gap that persists even after we take into account the fact that boys and girls could self-select into different high schools (see Contini et al., 2017, for an in-depth discussion of the gender gap in test scores). We have also investigated the gender gap in attitudes by social economic status and grade distribution and results have confirmed that the gap persists in all different groups[14].

Table 3 – The gender gap (G-B) in <u>maths attitudes</u>: gender coefficients in OLS and School Fixed Effect models

	Year 5 2014	Year 5 2015	Year 10 2014	Year 10 2015
OLS	-0.326***	-0.279***	-0.285***	-0.254***
	(0.013)	(0.015)	(0.012)	(0.014)
School FE	-0.327***	-0.277***	-0.144***	-0.071***
	(0.013)	(0.014)	(0.012)	(0.015)
N	22,246	18,231	31,644	22,772

Note: Std errors are in brackets. ∗ indicates that the underlying coefficient is significant at 5% level, ∗∗ at 1% and ∗∗∗0.1%. All models include area of residence, maternal and paternal education, ESCS index (Socio-economic indicator). Models for year 10 include also the type of high school (Lyceum, Professional or Vocational)

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[14] Results are available from the authors upon request.

Table 4 – The gender gap (G-B) in <u>maths test scores</u>: gender coefficient in OLS and School Fixed Effect models.

	Year 5 2014	**Year 5 2015**	**Year 10 2014**	**Year 10 2015**
OLS	-0.132***	-0.204***	-0.339***	-0.467***
	(0.013)	(0.014)	(0.010)	(0.012)
School FE	-0.141***	-0.197***	-0.165***	-0.306***
	(0.012)	(0.013)	(0.009)	(0.011)
N	22,246	18,231	31,644	22,772

Note: Std errors are in brackets. ∗ indicates that the underlying coefficient is significant at 5% level, ∗∗ at 1% and ∗∗∗0.1%. All models include area of residence, maternal and paternal education, ESCS index (Socio-economic indicator). Models for year 10 include also the type of high school (Lyceum, Professional or Vocational).

We also estimate the impact of gender on attitudes using quantile regressions. Results are presented in Figures 11 and 12 and show that the gender gap decreases, as the index for attitudes increases, for all the 4 cohorts considered. These results imply that the impact of gender is lower (closer to zero) among students with high preference for mathematics. For example, consider students in Year 5 in 2014. At the 10th percentile, the difference in attitudes towards maths between girls and boys is around 40% of a standard deviation, while the gap is zero for students in the 90th percentile of the attitudes index. Interestingly, in year 10, the gender gap in attitudes is quite small (around -10 to -20% of a standard deviation) for very low and very high percentiles of attitudes, while it widens (around -40% of a standard deviation) in the middle of the index distribution.

4.2   Estimates of the MIMIC

In this section, we report the results of the estimation of the MIMIC model presented above. In the estimation results, we show both the standardized and unstandardized solutions. Both are meaningful. The unstandardized solution is achieved by setting a lambda parameter equal to 1 and it also reports the standard errors and significance level of the coefficients. The disadvantage of unstandardized solutions is that they are not easily interpretable, as they refer to changes in variables that have no clear and homogeneous measurement unit. The standardized solution overcomes this problem. Standardization is achieved by setting the variance of the latent variable equal to 1, therefore standardized coefficients can be read as the standard deviation change in the dependent variable that follows one standard deviation change in the independent variable.

Table 5 reports the gender gap in mathematical capability as a result of the estimation of the SEM model. Appendix B shows the estimation of the full SEM model. The gender gap in mathematical capability is rather similar to the gender gap in attitudes: being female is associated with a lower mathematical capability, ranging from 15% to 18% of a standard deviation. Indeed the results for the measurement model reported in Table B1 and B2 in Appendix B show that the latent construct mathematical capability is mainly reflected into the indicators of attitude towards mathematics. Liking studying maths has the highest factor loading for grade 5: a standard deviation change in the latent capability leads to an increase of over 80% of a standard deviation in this indicator. The standardised coefficients of the other attitude indicators range from 50% to over 70% of a standard deviation in year 5, and from over 60% to over 80% in year 10. Test scores have the lowest factor scores in all the years and grades: these are approximately 30% in year 5 and 40% in year 10.

The results of the structural model presented in Table B3 and B4 in Appendix B also suggest that the influence of gender on mathematical capability is the highest among all sociodemographic explanatory variables. Similarly to what has been found for the OLS and OLS fixed-effect models, the effect of gender is, for example, twice as high as the effect of ESCS.

Table 5 – The gender gap (G-B) in mathematical capability: gender coefficient in SEM models.

SEM	Year 5 2014	Year 5 2015	Year 10 2014	Year 10 2015
Unstandardised	-0.322***	-0.276***	-0.284***	-0.257***
	(0.015)	(0.018)	(0.013)	(0.021)
Standardised	-0.180***	-0.150***	-0.166***	-0.147***
N	22,246	18,231	31,644	22,772

Note: Std errors are in brackets. ∗ indicates that the underlying coefficient is significant at 5% level, ∗∗ at 1% and ∗∗∗0.1%. All models include area of residence include maternal and paternal education, ESCS index (Socio-economic indicator). Models for year 10 include also the type of high school (Lyceum, Professional or Vocational)

In the SEM model, gender does not directly affect the single item for attitude towards mathematics and test scores, as the relationship between these variables is modelled to be mediated by the latent capability. Nevertheless, the indirect effects of being female on the single indicators of mathematical capability can easily be computed, this being equal to the product of the path from gender to the latent variable by the path from the latent variable to the indicator. Gender indirect effects are presented in

Table 6 both in unstandardized and standardized form. These can be read as the gender gap (G-B) in the single indicators of the SEM model, confirming the higher impact of gender on variables of attitude rather than on the test scores.

Table 6 – The indirect effects of gender (i.e. being female) on the indicators of mathematical capability (unstandardized and standardised)

Unstandardized	Year 5 2014	Year 5 2015	Year 10 2014	Year 10 2015
I like studying maths	-0.322***	-0.276***	-0.284***	-0.257***
	(0.015)	(0.018)	(0.013)	(0.021)
I learn lots of things in maths	-0.183***	-0.152***	-0.235***	-0.187***
	(0.009)	(0.010)	(0.011)	(0.015)
Maths is boring (reversed)	-0.260***	-0.244***	-0.251***	-0.227***
	(0.012)	(0.016)	(0.011)	(0.018)
I am usually good at maths	-0.237***	-0.159***		
	(0.012)	(0.011)		
I learn maths easily	-0.259***	-0.191***	-0.299***	-0.239***
	(0.013)	(0.013)	(0.014)	(0.020)
Maths is harder for me than for my classmates (reversed)	-0.204***	-0.152***		
	(0.010)	(0.011)		
I have always thought maths is one of my strongest subjects			-0.313***	-0.256***
			(0.014)	(0.021)
I understand the hardest topics			-0.292***	-0.226***
			(0.013)	(0.019)
Standardized maths test scores	-0.101***	-0.089***	-0.136***	-0.128***
	(0.006)	(0.007)	(0.007)	(0.012)
Standardized	**Year 5 2014**	**Year 5 2015**	**Year 10 2014**	**Year 10 2015**
I like studying maths	-0.152***	-0.130***	-0.138***	-0.126***
I learn lots of things in maths	-0.113***	-0.093***	-0.122***	-0.102***
Maths is boring (reversed)	-0.130***	-0.116***	-0.114***	-0.108***
I am usually good at maths	-0.137***	-0.100***		
I learn maths easily	-0.138***	-0.104***	-0.146***	-0.122***

Maths is harder for me than for my classmates (reversed)	-0.103***	-0.075***		
I have always thought maths is one of my strongest subjects			-0.144***	-0.121***
I understand the hardest topics			-0.144***	-0.118***
Standardized maths test scores	-0.051***	-0.045***	-0.068***	-0.063***

Note: Std errors are in brackets. ∗ indicates that the underlying coefficient is significant at 5% level, ∗∗ at 1% and ∗∗∗0.1%.

5. Conclusions

The gender gap in mathematics is particularly wide in Italy. Despite the growing concern about this problem, both at the European and at national level, there are not many policies to address it.

This paper contributes to the existing literature on the gender gap in mathematics by adding an analysis of the attitudes towards mathematics in a gender perspective. Attitudes towards mathematics are strongly correlated to test scores but the direction of causality (if test scores influence attitudes or viceversa) is not particularly interesting when trying to design policies. Much more important is to understand how the gender gap changes when considering both elements.

We use a Structural Equation Model, where we estimate a single indicator of mathematical capability including both tests scores and attitudes and we show that the gender gap is even wider in mathematical capability than in test scores alone. Therefore policies that tackle the gender gap should not only address test scores but also attitudes. In particular, our estimates for the measurement equation of the model show that the factor loadings for attitudes are higher in absolute value than the factor loadings on test scores, suggesting that tackling differences in attitudes could be more effective than tackling test scores alone.

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Figures

Figure 1 – Average standardised test scores by attitudes and gender. Year 5, 2014

Figure 2 – Average standardised test scores by attitudes and gender. Year 5, 2015

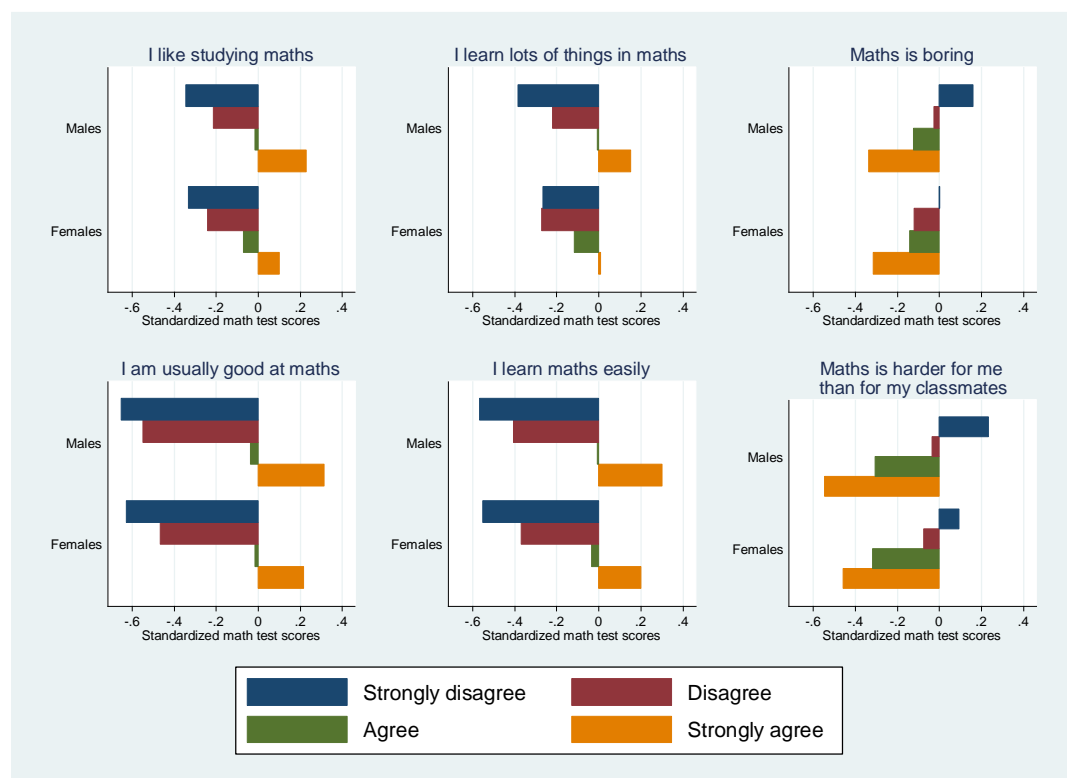Figure 3 – Average standardised test scores by attitudes and gender. Year 10, 2014
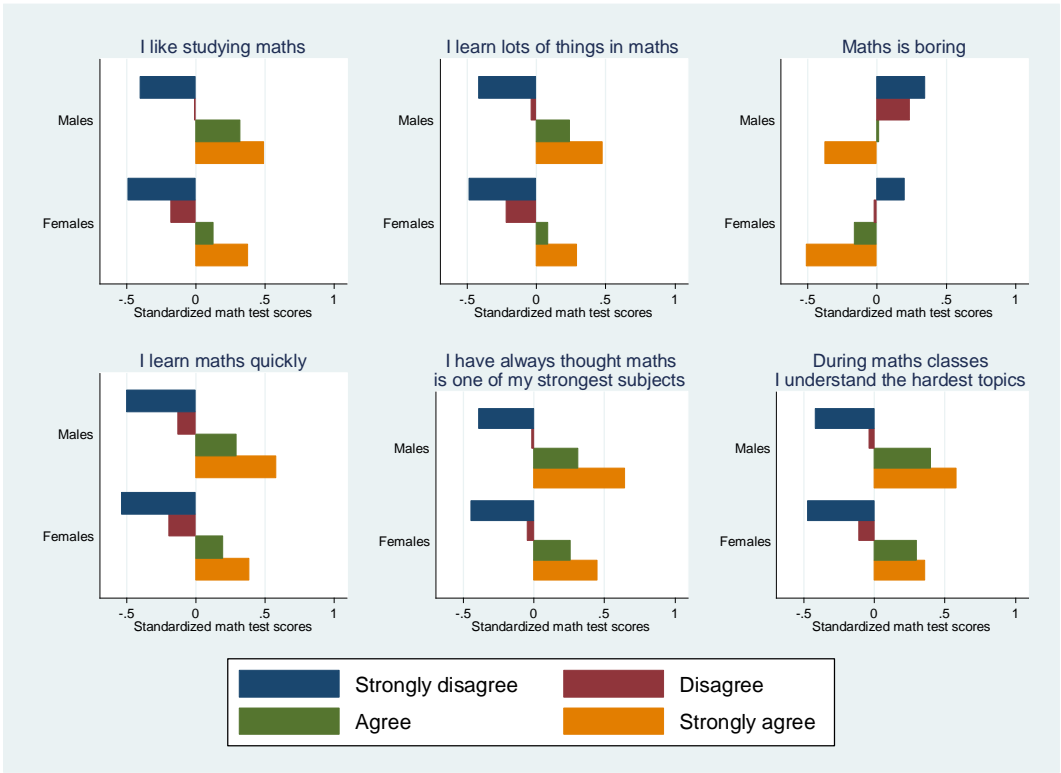
Figure 4– Average standardised test scores by attitudes and gender. Year 10, 2015
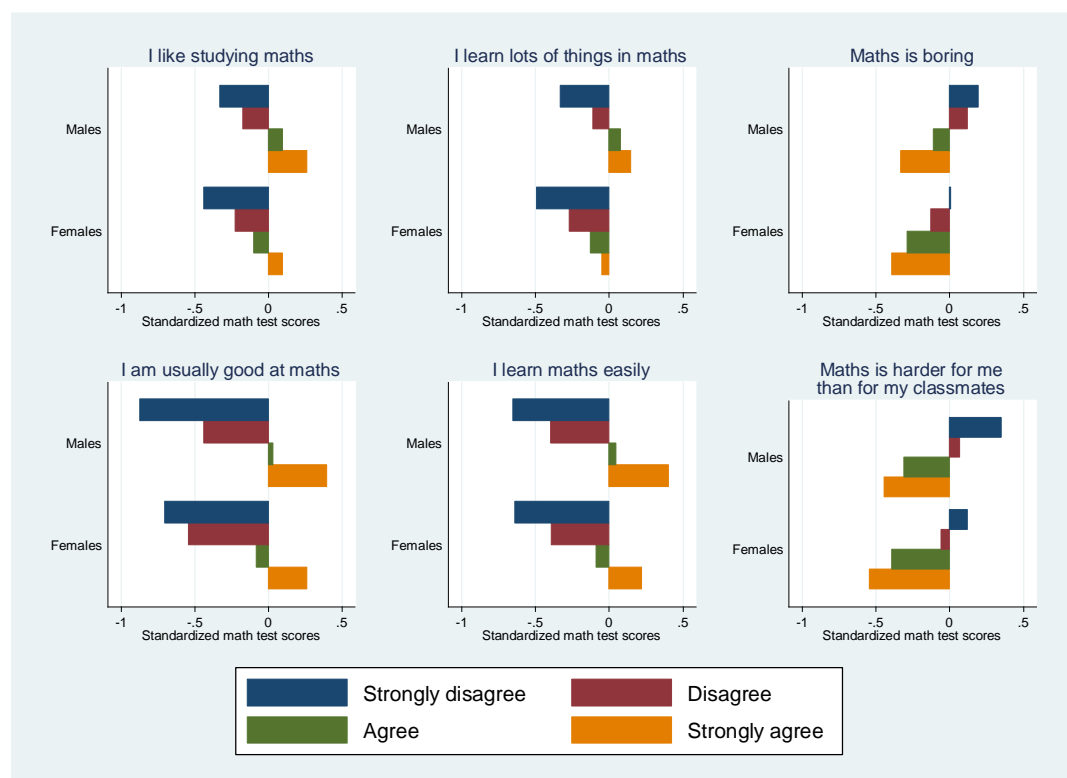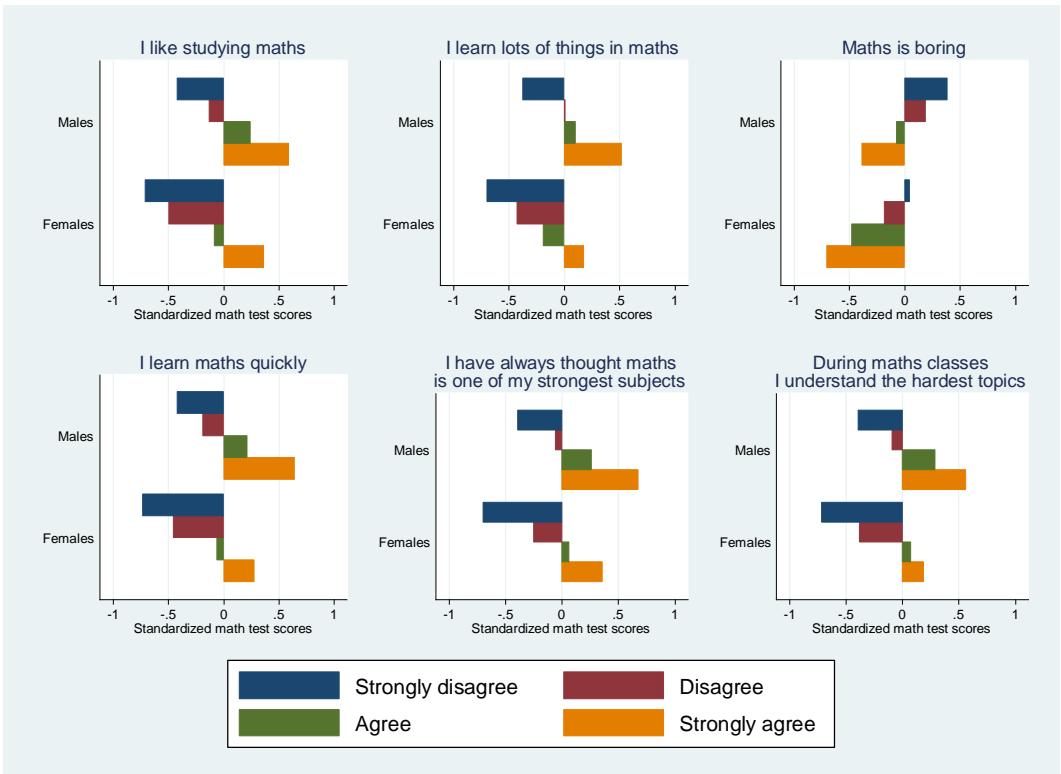
Figure 5 – Attitudes towards maths by gender - Year 5, 2014
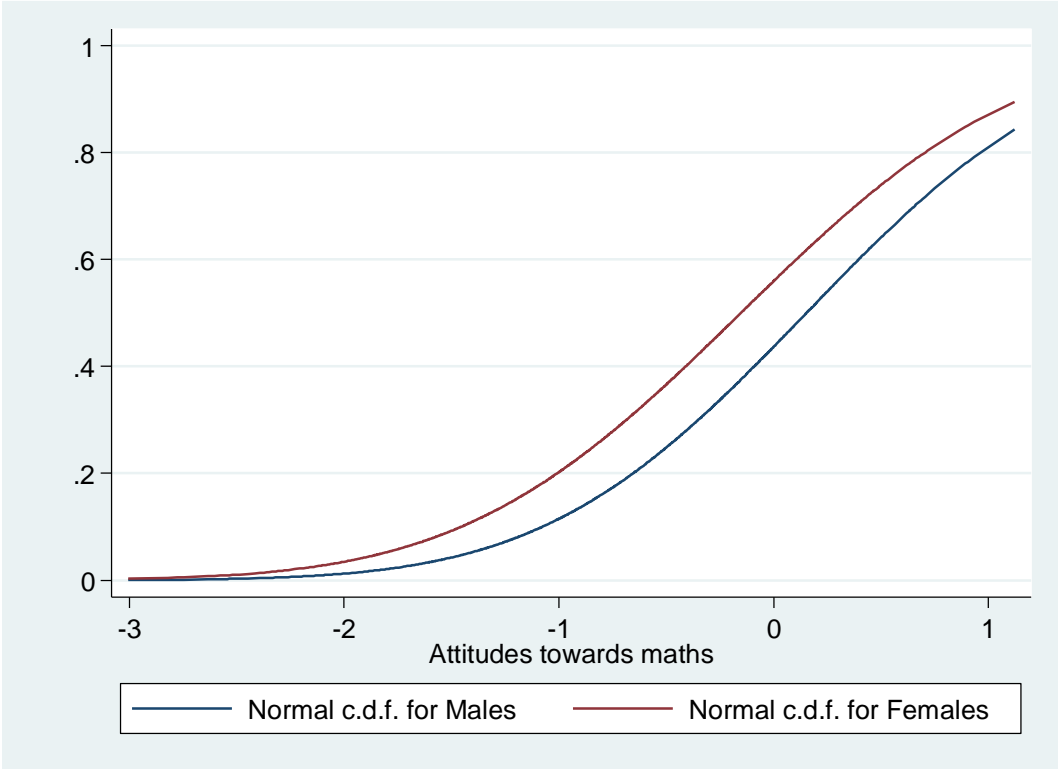
Figure 6 – Attitudes towards maths by gender - Year 5, 2015
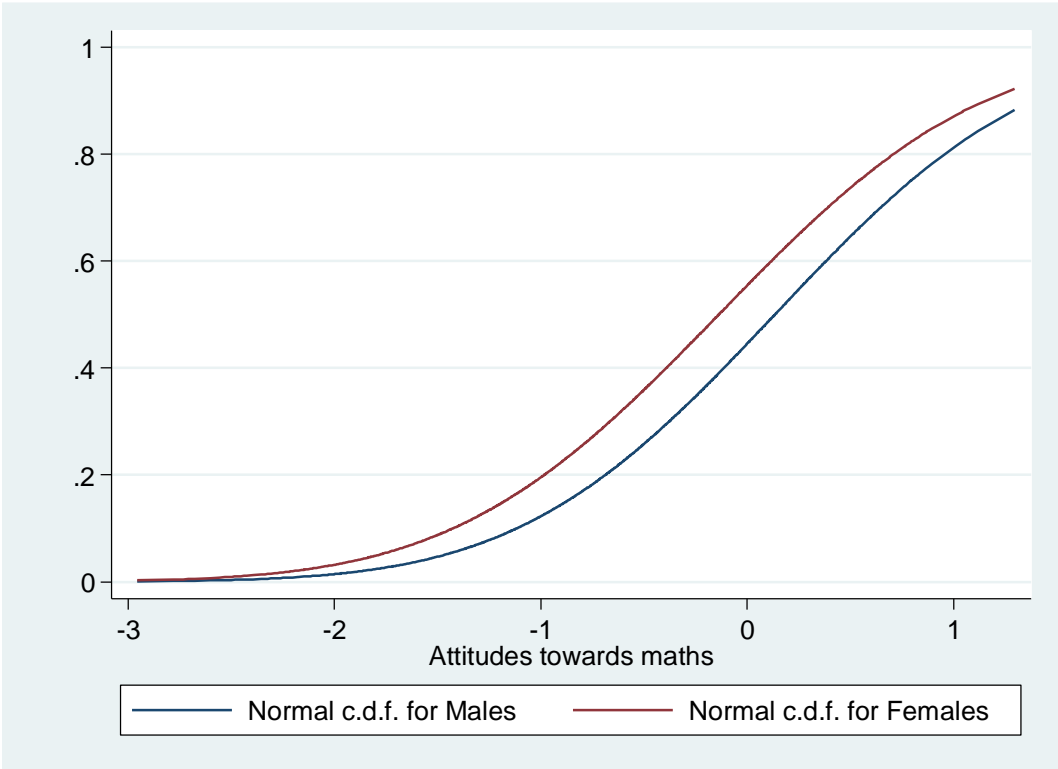
Figure 7– Attitudes towards maths by gender - Year 10, 2014
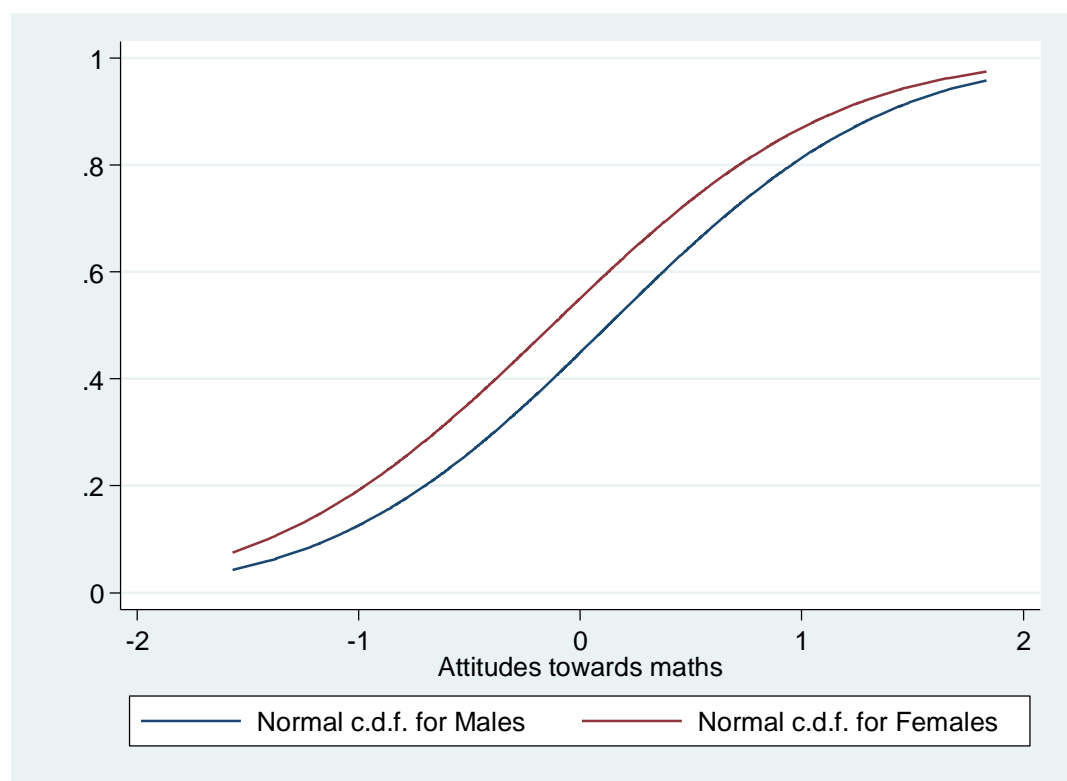
Figure 8– Attitudes towards maths by gender - Year 10, 2015
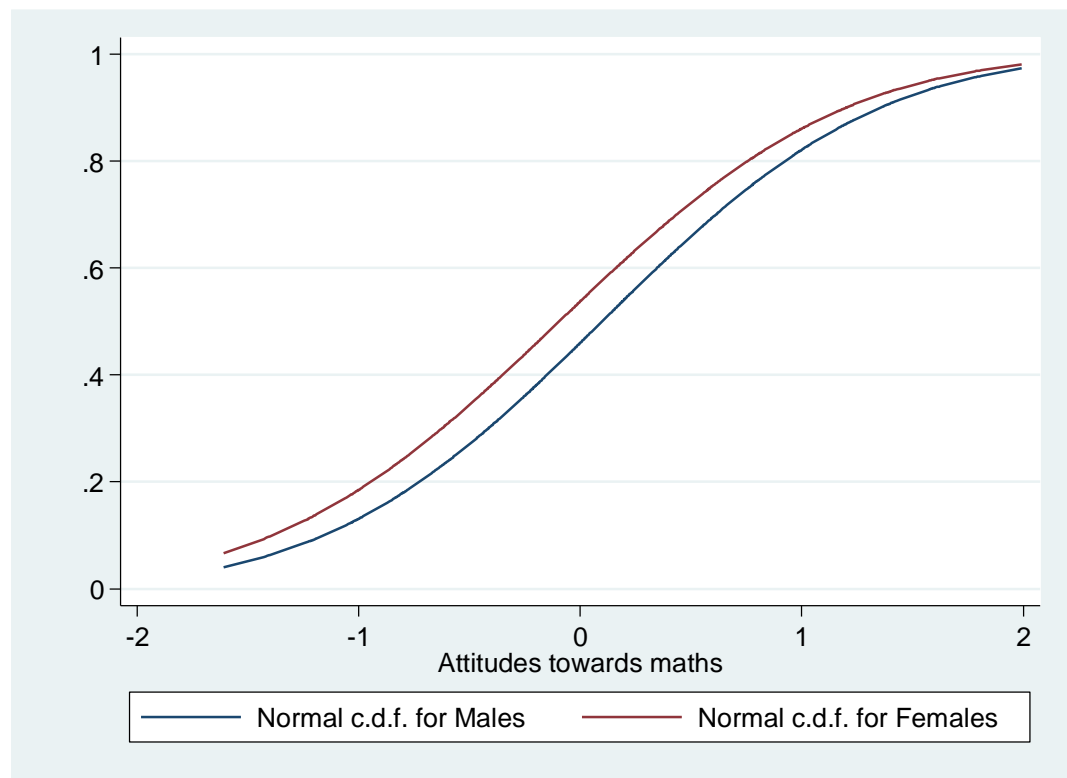
Fig.9 - Standardised test scores in mathematics and an index of attitudes towards mathematics – Year 5
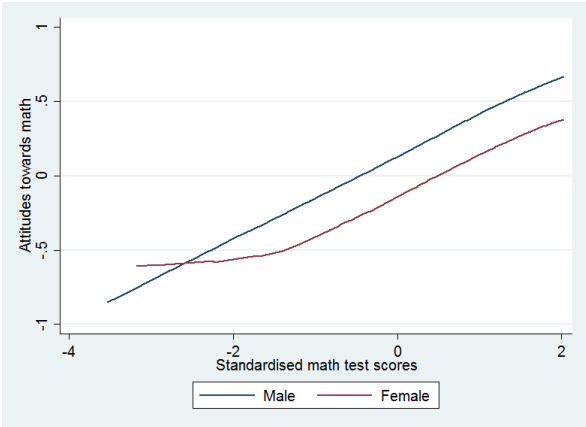
2014   2015
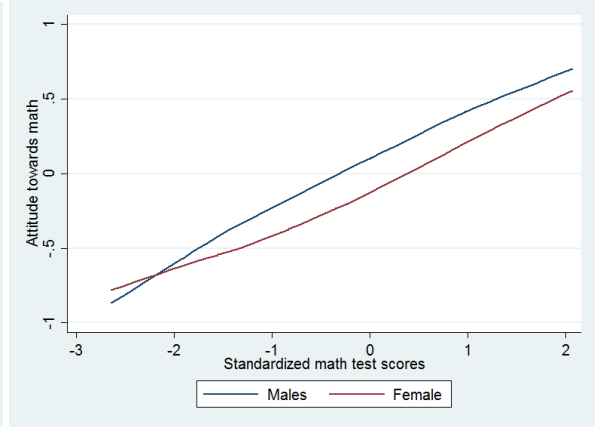
Fig.10 - Standardised test scores in mathematics and an index of attitudes towards mathematics – Year 10
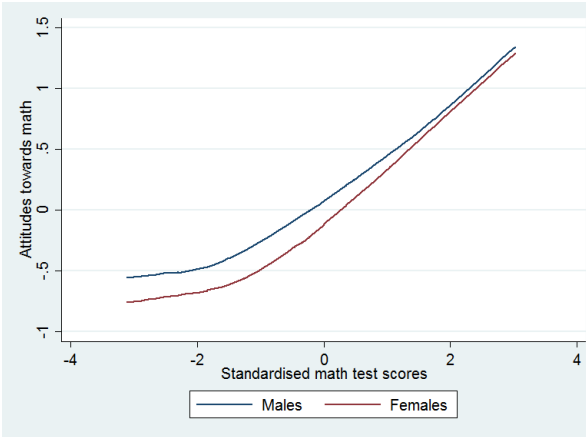
2014   2015

Fig. 11 – Results from quantile regression: impact of gender on attitudes towards maths (Year 5)

2014   2015

Fig. 12 – Results from quantile regression: impact of gender on attitudes towards maths (Year 10)
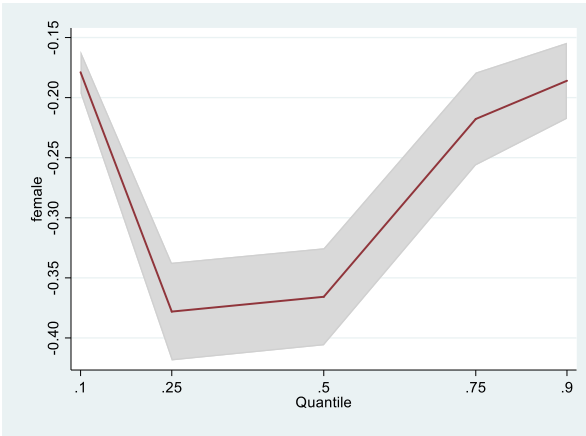
2014   2015
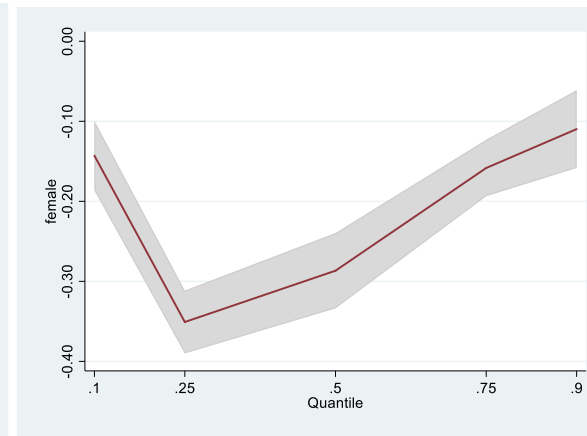
Appendix A

Table A1– Attitudes towards maths for year 5 students

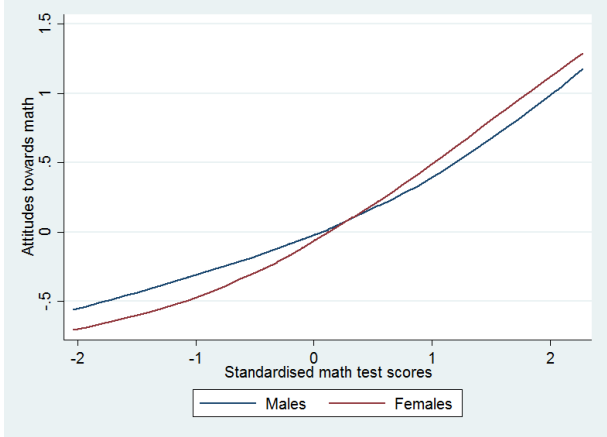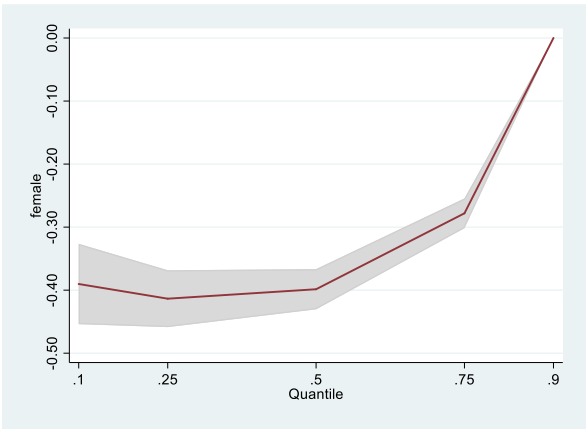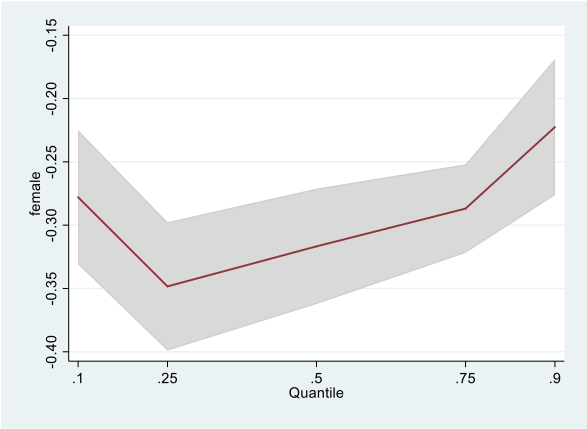|	Year 5 2014				Year 5 2015			
	(% all sample)	Gender gap (F-M)	% Girls	% Boys	(% all sample)	Gender gap (F-M)	% Girls	% Boys
I am usually good at maths								
Strongly disagree	5.84	3.17	7.44	4.27	4.50	1.57	5.30	3.73
Disagree	14.07	6.83	17.51	10.68	13.14	6.21	16.32	10.11
Agree	41.47	8.35	45.68	37.33	47.62	6.17	50.77	44.60
Strongly agree	38.03	-18.39	28.76	47.15	28.54	-13.52	21.63	35.15
P value t test Difference mean (Girls- Boys)=0	0.000				0.000			
I learn maths easily								
Strongly disagree	7.80	2.90	9.26	6.36	7.51	3.52	9.31	5.79
Disagree	16.45	6.46	19.71	13.25	16.55	6.29	19.76	13.47
Agree	35.71	5.39	38.42	33.03	37.42	2.62	38.76	36.14
Strongly agree	39.27	-14.71	31.86	46.57	32.18	-11.69	26.20	37.89
P value t test Difference mean (Girls- Boys)=0	0.000				0.000			
Maths is harder for me than for most of my class mates								
Strongly disagree	51.47	-11.28	45.79	57.07	39.55	-7.80	35.56	43.36
Disagree	25.02	4.90	27.49	22.59	26.57	2.50	27.85	25.35
Agree	14.10	4.00	16.12	12.12	17.88	3.51	19.68	16.17
Strongly agree	8.78	2.47	10.02	7.55	9.49	2.38	10.71	8.33
P value t test Difference mean (Girls- Boys)=0	0.000				0.000			
I like studying maths								
Strongly disagree	12.60	4.81	15.02	10.21	13.47	4.08	15.56	11.48
Disagree	14.19	5.73	17.08	11.35	15.85	5.79	18.81	13.02
Agree	27.19	5.18	29.81	24.63	28.47	3.94	30.48	26.54
Strongly agree	45.21	-15.36	37.47	52.83	36.13	-13.24	29.36	42.60
Missing	0.81		0.63	0.98	6.08	-0.57	5.79	6.36
P value t test Difference mean (Girls- Boys)=0	0.000				0.000			
I learn lots of things in maths								
Strongly disagree	3.83	0.08	3.87	3.79	3.95	-0.47	3.71	4.18
Disagree	9.39	1.43	10.11	8.68	9.28	1.28	9.93	8.65
Agree	32.66	4.94	35.15	30.21	33.81	3.51	35.61	32.10
Strongly agree	53.41	-6.22	50.27	56.49	46.64	-3.81	44.69	48.50
P value t test Difference mean (Girls- Boys)=0	0.000				0.000			

Maths is boring

Strongly disagree	57.78	-7.47	54.02	61.49	48.72	-7.63	44.82	52.45
Disagree	22.41	4.58	24.72	20.14	21.78	4.57	24.12	19.55
Agree	9.27	1.71	10.13	8.42	11.89	2.89	13.37	10.48
Strongly agree	9.88	1.46	10.62	9.16	11.22	0.78	11.62	10.84
P value t test Difference mean (Girls- Boys)=0	0.000				0.000			
N	22,246		11,061	11,185	18,231		8,970	9,261

Table A2– Attitudes towards maths for year 10 students

	Year 10 2014				Year 10 2015		
	(% all sample)	Gender gap (F-M)	% Girls	% Boys	(% all sample)	Gender gap (F-M)	% Girls	% Boys
I like studying maths								
Strongly disagree	25.46	7.00	29.00	22.00	26.42	6.49	29.63	23.14
Disagree	26.54	-0.28	26.39	26.67	26.89	-1.75	26.00	27.75
Agree	31.70	-4.50	29.46	33.96	32.78	-3.78	30.85	34.63
Strongly agree	15.25	-2.01	14.21	16.22	13.71	-0.76	13.31	14.07
P value t test Difference mean (Girls- Boys)=0	0.000				0.000			
I learn lots of things in maths								
Strongly disagree	30.28	12.13	36.45	24.32	18.25	1.85	19.16	17.31
Disagree	29.48	-0.46	29.26	29.72	30.98	2.54	32.24	29.70
Agree	26.70	-5.26	24.00	29.26	39.06	-2.11	38.01	40.12
Strongly agree	12.63	-6.25	9.45	15.70	11.37	-2.13	10.32	12.45
P value t test Difference mean (Girls- Boys)=0	0.000				0.000			
Maths is boring								
Strongly disagree	27.54	-0.06	27.49	27.55	20.87	0.71	21.21	20.50
Disagree	30.34	-1.91	29.43	31.34	30.79	-1.59	30.01	31.60
Agree	19.73	-0.19	19.64	19.83	26.31	0.44	26.54	26.10
Strongly agree	21.48	2.27	22.59	20.32	21.65	0.68	21.97	21.29
P value t test Difference mean (Girls- Boys)=0	0.000				0.485			
I learn maths quickly								
Strongly disagree	23.29	9.47	28.11	18.64	24.07	8.42	28.22	19.80
Disagree	26.84	2.54	28.13	25.59	24.63	0.39	24.85	24.46
Agree	32.11	-3.85	30.16	34.01	37.43	-4.68	35.14	39.82
Strongly agree	16.81	-7.93	12.77	20.70	13.54	-3.87	11.59	15.46
P value t test Difference mean (Girls- Boys)=0	0.000				0.000			
I have always thought Maths was one of my strongest subjects								
Strongly disagree	34.87	14.87	42.45	27.58	37.57	14.48	44.72	30.24
Disagree	26.96	-2.24	25.83	28.07	24.15	-2.51	22.95	25.46
Agree	21.56	-5.23	18.90	24.13	24.36	-6.95	20.91	27.86
Strongly agree	15.77	-7.27	12.06	19.33	13.55	-4.77	11.17	15.94
P value t test Difference mean (Girls- Boys)=0	0.000				0.000			

**During Maths classes,
I understand the hardest topics**

Strongly disagree	30.28	12.13	36.45	24.32	27.87	10.29	32.93	22.64
Disagree	29.48	12.13	29.26	29.72	30.31	-1.51	29.58	31.09
Agree	26.70	-0.46	24.00	29.26	32.38	-5.04	29.92	34.96
Strongly agree	12.63	-5.26	9.45	15.70	9.02	-3.42	7.30	10.72
P value t test Difference mean (Girls-Boys)=0	0.000				0.000			
N	31,594		15,536	16,058	22,772		11,517	11,255

Table A3 – Factor Analysis. Maths attitudes

Factor	Factor loadings for Factor 1 (math attitudes index)	Variables
Year 5 –2014	0.8057	I am usually good at maths
	0.8163	I learn maths easily
	0.6619	Maths is harder for me than for most of my class mates
	0.8660	I like studying maths
	0.7089	I learn lots of things in maths
	0.7886	Maths is boring
Year 5 –2015		
	0.7596	I am usually good at maths
	0.7850	I learn maths easily
	0.6086	Maths is harder for me than for most of my class mates
	0.8587	I like studying maths
	0.6907	I learn lots of things in maths
	0.7954	Maths is boring
Year 10 – 2014	0.8863	I like studying maths
	0.8157	I learn lots of things in maths
	0.7701	Maths is boring
	0.8802	I learn maths quickly
	0.8753	I have always thought maths is one of my strongest subject
	0.8717	During maths classes I understand the hardest topics
Year 10 – 2015		
	0.8874	I like studying maths
	0.7565	I learn lots of things in maths
	0.7976	Maths is boring
	0.8567	I learn maths quickly
	0.8473	I have always thought maths is one of my strongest subject
	0.8370	During maths classes I understand the hardest topics

Table A4: Descriptive statistics of the independent variables used in the estimation

Gender				
Male	50.40	51.13	51.09	50.33
Female	49.60	48.87	48.91	49.67
ESCS index				
Mean	0.12	0.21	0.024	0.075
Standard deviation	(0.99)	(0.92)	(0.97)	(0.95
Area of residence				
North-West	16.30	20.20	19.05	27.06
North-East	19.02	22.8	21.01	29.77
Centre	17.80	20.26	17.24	21.65
South	25.64	22.39	24.91	13.32
Islands	21.23	14.35	17.78	8.19
Maternal education				
Degree	15.84	18.55	20.97	23.51
High school	33.74	35.77	32.57	33.78
Middle school	31.52	30.66	36.83	31.67
Missing	18.88	15.02	9.71	11.04
Paternal education				
Degree	11.92	14.40	19.19	20.89
High school	29.71	31.75	30.05	29.63
Middle school	38.38	37.67	38.68	35.26
Missing	19.97	16.17	12.06	14.21
Maternal occupation				
Professional	9.00	10.85	13.55	15.78
Self-employed (small business)	5.96	6.93	9.00	9.64
Teacher or employee	22.67	25.24	18.84	20.84
Manual worker	9.59	10.67	16.30	17.93
Out of the labour force	32.06	30.28	37.23	28.32
Missing	20.71	16.00	5.06	7.47
Paternal occupation				
Professional	17.82	20.62	28.38	27.71
Self-employed (small business)	15.81	17.25	20.00	19.94
Teacher or employee	17.08	18.11	13.45	13.61
Manual worker	21.15	21.48	23.98	23.43
Out of the labour force	4.38	4.98	7.00	5.85
Missing	23.75	17.54	7.19	9.42

Table A5 – Effect of other independent variables on maths attitudes (linear model with fixed effects)

	Year 5 2013-14	Year 5 2014-15	Year 10 2013-14	Year 10 2014-15
Female	-0.327***	-0.277***	-0.144***	-0.071***
	(0.013)	(0.014)	(0.012)	(0.015)
Escs index	0.099***	0.104***	0.040***	0.042***
	(0.011)	(0.013)	(0.008)	(0.009)
Region of residence				
(ref NW)				
NE	n.a.	n.a	n.a	n.a
Centre	n.a	n.a	n.a	n.a
South	n.a	n.a	n.a	n.a
Islands	n.a	n.a	n.a	n.a
Type of school				
(ref Lyceum)				
Vocational high school	n.a	n.a	-0.420***	-0.166**
			(0.059)	(0.069)
Technical high school	n.a	n.a	-0.136***	-0.003
			(0.046)	(0.049)
Maternal education				
(ref University)				
Middle school	0.013	-0.037	0.001	0.013
	(0.028)	(0.030)	(0.019)	(0.023)
High school	0.043*	-0.001	0.022	0.023
	(0.024)	(0.024)	(0.017)	(0.019)
Missing	-0.010	-0.064	-0.007	0.002
	(0.044)	(0.047)	(0.028)	(0.032)
Paternal education				
(ref University)				
Middle school	-0.022	-0.006	-0.031	-0.048**
	(0.029)	(0.030)	(0.020)	(0.022)
High school	0.025	0.017	0.001	-0.008
	(0.026)	(0.026)	(0.018)	(0.020)
Missing	-0.019	-0.014	-0.061**	-0.079***
	(0.043)	(0.045)	(0.026)	(0.029)
R squared	0.038	0.031	0.040	0.005
N	22,246	18,231	31,644	22,772

Notes. Std errors are in brackets. * indicates that the underlying coefficient is significant at 5% level,
** at 1% and ***0.1%. Missing is a dummy variable equal 1 if the specific variable is missing; equal 0 otherwise.

Appendix B

Table B1 - Results of SEM model – Measurement Model - Unstandardized Solution

	(1) SEMV1315	(2) SEMV1415	(3) SEMX1314	(4) SEMX1415
I like studying maths	1.000	1.000	1.000	1.000
	(.)	(.)	(.)	(.)
I learn lots of things in maths	0.568***	0.550***	0.829***	0.728***
	(0.008)	(0.008)	(0.005)	(0.008)
Maths is boring (reversed)	0.808***	0.886***	0.885***	0.885***
	(0.008)	(0.008)	(0.006)	(0.010)
I am usually good at maths	0.735***	0.577***		
	(0.009)	(0.011)		
I learn maths easily	0.804***	0.692***	1.052***	0.933***
	(0.010)	(0.012)	(0.007)	(0.012)
Maths is harder for me than for my classmates (reversed)	0.633***	0.550***		
	(0.011)	(0.012)		
I have always thought maths is one of my strongest subjects			1.102***	1.000***
			(0.008)	(0.012)
I understand the hardest topics			1.030***	0.881***
			(0.007)	(0.012)
Standardized maths test scores	0.315***	0.324***	0.478***	0.499***
	(0.011)	(0.012)	(0.009)	(0.014)
Observations	22,246	18,231	31,594	22,772

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B2 - Results of SEM model – Measurement Model - Standardized Solution

	(1) SEMV1315	(2) SEMV1415	(3) SEMX1314	(4) SEMX1415
I like studying maths	0.849	0.865	0.833	0.859
I learn lots of things in maths	0.631***	0.623***	0.738***	0.693***
Math is boring (reversed)	0.726***	0.773***	0.688***	0.732***
I am usually good at maths	0.764***	0.668***		
I learn maths easily	0.769***	0.695***	0.882***	0.827***
Maths is harder for me than for my classmates (reversed)	0.575***	0.502***		
I have always thought maths is one of my strongest subjects			0.872***	0.822***
I understand the hardest topics			0.867***	0.800***
Standardized maths test scores	0.283***	0.300***	0.408***	0.429***
Observations	22,246	18,231	31,594	22,772

Standard errors are not presented because the significance level of the regression coefficients is computed with respect to the unstandardized solution. In STATA, the standardized solution is derived from the unstandardized one and standard errors of the standardized coefficients are not-reported.

*** p<0.01, ** p<0.05, * p<0.1

Table B3 - Results of SEM model – Structural Model - Unstandardized Solution

VARIABLES	(1) SEMV1315	(2) SEMV1415	(3) SEMX1314	(4) SEMX1415
Female	-0.322***	-0.276***	-0.284***	-0.257***
	(0.015)	(0.018)	(0.013)	(0.021)
Escs	0.092***	0.074***	0.061***	0.058***
	(0.012)	(0.014)	(0.009)	(0.016)
North West	-0.013	0.105***	-0.007	0.030*
	(0.027)	(0.027)	(0.018)	(0.018)
Center	0.078***	0.148***	-0.000	-0.057**
	(0.025)	(0.027)	(0.020)	(0.025)
South	0.188***	0.322***	0.062***	0.058**
	(0.023)	(0.026)	(0.017)	(0.029)
Islands	0.150***	0.352***	0.030	0.085**
	(0.025)	(0.037)	(0.020)	(0.040)
Vocational High School			-0.220***	-0.229***
			(0.019)	(0.029)
Technical High School			-0.056***	-0.117***
			(0.015)	(0.025)
High school - father	0.044	0.002	0.001	-0.009
	(0.030)	(0.031)	(0.020)	(0.031)
High school - mother	0.065**	-0.005	0.012	0.001
	(0.027)	(0.029)	(0.019)	(0.030)
Middle school - father	0.009	-0.023	-0.042*	-0.068**
	(0.034)	(0.035)	(0.022)	(0.034)
Middle school - mother	0.041	-0.010	-0.018	-0.014
	(0.034)	(0.036)	(0.022)	(0.035)
Missing education (father)	0.071	-0.026	-0.132***	-0.159***
	(0.050)	(0.052)	(0.035)	(0.049)
Missing education (mother)	0.033	-0.023	0.015	-0.031
	(0.048)	(0.051)	(0.036)	(0.051)
Observations	22,246	18,231	31,594	22,772

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

The reference categories are males, living in North East, whose parents have achieved tertiary education. For year 10, the reference category for type of school is Lyceum.

Table B4- Results of SEM model – Structural Model - Standardized Solution

VARIABLES	(1) SEMV1315	(2) SEMV1415	(3) SEMX1314	(4) SEMX1415
Female	-0.180***	-0.150***	-0.166***	-0.147***
Escs	0.102***	0.075***	0.070***	0.065***
North West	-0.005	0.045***	-0.003	0.013*
Center	0.033***	0.065***	-0.000	-0.026**
South	0.088***	0.152***	0.031***	0.028**
Islands	0.063***	0.100***	0.013	0.036**
Vocational High School			-0.096***	-0.098***
Technical High school			-0.031***	-0.063***
High school - father	0.022	0.001	0.000	-0.005
High school - mother	0.034**	-0.003	0.007	0.001
Middle school - father	0.005	-0.012	-0.024*	-0.038**
Middle school - mother	0.022	-0.005	-0.010	-0.007
Missing education (father)	0.032	-0.010	-0.049***	-0.060***
Missing education (mother)	0.014	-0.009	0.005	-0.011
Observations	22,246	18,231	31,594	22,772

Standard errors are not presented because the significance level of the regression coefficients is computed with respect to the unstandardized solution. In STATA, the standardized solution is derived from the unstandardized one and standard errors of the standardized coefficients are not-reported.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

The reference categories are males, living in North East, whose parents have achieved tertiary education. For year 10, the reference category for type of school is Lyceum.