



THE FEAR FACTOR

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Maths Anxiety in girls and women

Dr Samantha Callan

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Samantha Callan

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Executive summary

If we want to make the most of half of our workforce, if we want to eliminate the gender pay gap and if we want that same half of the workforce to succeed in jobs that boost our economy, then we must make sure that teenage girls don't feel, and certainly aren't told, that certain subjects are the preserve of men.

Rt Hon Nicky Morgan MP, Secretary of State for Education and Minister for Women and Equalities
Speaking at the launch of the 'Your Life' campaign, 10 November 2014

The interrelated problems of maths and money for many British women

Mathematics – maths – is a social justice issue: around one in five adults in the UK lack even basic numeracy skills¹ without which they find it difficult to budget and make money stretch as far as possible; they feel stressed and insecure about money regardless of their income, and they struggle to overcome barriers to progression in work. Yet senior educationalists agree that it is culturally acceptable, especially for women, to say, 'I hate maths, I was never any good with numbers'.

As well as awareness that the relationship between females and maths is typically not a happy one, there is also a growing sense that something needs to be done about it. Even though girls outperform boys at school overall, closer inspection reveals they lag behind when it comes to this indispensable subject. There is a deep-seated and widespread belief that boys are born with an ability to do maths, whereas girls are not. Yet there is no biological reason or evidence from research to support this belief.

A generation of girls are nervous about maths and science...
this is a matter of culture.²

In order to meet Britain's industrial and commercial needs and to be globally competitive, it is vital that the country moves up international league tables for achievement in subjects that will lead to maths-based careers: no one should be left behind. The development of mathematical skills sufficient to the challenges of the 21st century society and workplace must

1 BAE Systems poll, conducted by YouGov, questioned 2,016 adults between March 2 and 6 and the National Numeracy survey, also conducted by YouGov, questioned 2,151 adults between February 27 and March 1.

2 Speech by then-Parliamentary Under Secretary of State for Education and Childcare, Rt Hon Elizabeth Truss MP, Institute of Physics, 11 December 2013

not be seen as something that ends at the age of sixteen, or when young people leave the education system. There is a flawed perception and hope, especially among girls and young women, that the need to do maths ends when the school gates finally close behind them.

A limiting factor to national competitiveness

Future progress will be very hard for Britain to effect if nearly half the future workforce considers itself fundamentally ill-suited to maths. Internationally respected research has proved that it is differences in confidence – and not ability – that are determinative for the gender gap in maths attainment. However, the fear of maths, which affects many girls and women, is rarely discussed – yet it constitutes a massive barrier to the realisation of many ambitions.

The landmark Education Acts of 1870 and 1902 paved the way for the provision of universal primary and secondary schools for both sexes, and were indispensable for England's competitiveness in the 20th century. An era of advances in machinery and organisation was beginning and we were better able to exploit the opportunities it presented because educational reform, at a basic level, met the challenge.

This legislation represented a massive shift in attitudes towards support for properly educating the entire future workforce, and not just certain classes or one sex. A similarly seismic shift in attitudes is now needed urgently, if both women and men in the British workforce are to compete with other industrial countries. Although fear of maths is markedly more prevalent in girls and women, many boys and men also have a fixed – rather than a growth – mindset when it comes to maths. They write themselves off when they fail to succeed early in life, rather than assuming either that this might be the result of bad teaching or that continued effort to master the subject will bear fruit. If we level the playing field for women, by dispelling the myth that maths ability relies on heritable traits, this may also help men.

What needs to change?

This Government is taking important steps to stimulate and encourage young people's and especially young women's aspirations to succeed in science, technology, engineering and maths – STEM subjects. To do so effectively, countermeasures need to start early. A child's first school teachers are almost always women, who act as powerful role models; US research shows some of these women seem to be 'infecting' their girl pupils with their own lack of confidence about maths.³

Cultural change needs to take place across society as a whole if we are to see significant gains in female participation. For a great majority of children, their very earliest educators are their mothers and fathers. To take the pressure off their daughters, fathers across society – based on their own faulty assumptions – may be passing on expectations to their daughters about being unable to achieve mathematical success.

3 Beilock et al, 2010, 'Female teachers' math anxiety affects girls' math achievement', *PNAS*, 2010 107: 1860–1863

Many mothers are transmitting the message that maths is to be feared, avoided or simply not worked at, and – on the grounds that their daughters will most likely be defeated from the outset – these mothers are unintentionally perpetuating a cycle of female underachievement that has distinct roots in our social history.

Where did the Fear Factor come from?

Fear is an umbrella word for feelings of alarm that can range from mild apprehension to anxiety and fright. A fear of maths was labelled 'Maths Anxiety' in America in the 1970s. For this report, I have dug out the roots of Maths Anxiety in order to enable us, as a society, to move beyond their influence. I link this irrational fear of maths to the historical and current perception that maths is an inherently male activity. Women feel they are encroaching on territory that is not really theirs by biological predisposition – but this is a highly gendered assumption: women can be just as good at maths as men. I lay the blame for this faulty assumption on historical patriarchy, by which I mean the system of social governance where every arena of power, and particularly the mainstream institutions of power, was overwhelmingly dominated by men.

Patriarchy was rooted in, and strongly reinforced by, the institution of religion, which set taboos around women's access to learning maths (and so science as well). The leading men of the day correctly recognised that these disciplines held the keys to understanding how the world worked. The theological underpinning to the social norm that men 'did' maths and women 'did not' would have made the concept of the mathematical woman seem unnatural and even taboo.

I looked through an anthropological lens at how such taboos can function and concluded that this taboo's powerful yet implicitly communicated message was that the female sex was defying the natural order by attempting to access the keys to truth, and the meaning of life contained within mathematics and science. 'Defying the natural order' is synonymous with entering highly dangerous territory, and associated with punishment and dire consequence. This would have had the desired effect on most women of keeping them well away from man's 'rightful domain'.

It is vital to bring about a shift in public attitudes so that people no longer see it as acceptable to be bad at maths.⁴

To further elucidate the role of patriarchy, I focus on the historical place of British women in society, particularly following the major social upheavals of the Industrial Revolution. I also chart how control over money increasingly became seen as exclusively belonging to a man's world. A few wives might have been involved in the management of the household or estate accounts,

⁴ Paterson E et al, 2010, *Count me in: improving numeracy in England*, London: New Philanthropy Capital, p31

but strategic financial concerns were not deemed to be within the proper domain of women. The effects of this attitude can still be felt today – it is still socially acceptable for a women to want to be financially looked after by men and, as a result, realistic for her to assume she may be able to get by in life with only a rudimentary understanding of maths and money.

I also draw on the history of women's education to reveal how even otherwise enlightened reformers adopted pseudo-scientific views towards maths and maths-based subjects, which held that the vast majority of girls were physically not equipped to master them. By accepting the premise that ability in this important subject was innate – and innately male – what we refer to as the Maths Myth was perpetuated and reinforced.

Dispelling the Maths Myth

The Maths Myth, which drives the fear factor for many women and girls, needs to be publicly identified as a remaining injustice of patriarchy; then it needs to be demolished. In order to achieve this I recommend the following:

1. A high profile campaign is needed specifically to counteract the Maths Myth. It should unambiguously and directly address the root cause of the negative and fearful attitudes of many girls and women to maths. It needs to be strongly endorsed by the Government and have broad-based financial and other support from it and a range of organisations with an interest in ensuring that Britain has the necessary skills base to be internationally competitive, and that women in this country are no longer at a disadvantage in STEM subjects and careers. A tightly-focused Commission needs to work with the Government to monitor the issue.
2. An early intervention approach is vital, to ensure that the next generation of school children are not exposed to faulty and gendered assumptions: teacher training curricula for primary and secondary schools need to include the origins and effects of the Maths Myth. (US research has shown that women training to be elementary school teachers are among the most 'Maths Anxious' of all college students.⁵)
3. Later intervention is needed to ensure that existing teaching staff are aware of the internalised bias that many of them have been working to, and how to address it. This will require a good evidence base to confirm the extent of the problem. For example, British research is needed to ascertain the extent to which primary school teachers – the vast majority of whom are female – are themselves anxious to some degree about maths.
4. Parenting programmes for parents of school-age children have an important role to play. Many of these encourage mothers and fathers not to project their own fears onto their children, and show them how to bring out each child's unique potential; programme content must explicitly mention the need to avoid passing on anxiety towards maths; assumptions about which sex is most likely to be able to master it; and any sense that there is a maths gene – which one sex may not have.

⁵ Beilock 2010, *op cit*

Introduction

Maths is a social justice issue: around one in five adults in the UK lack even basic numeracy skills, and the same proportion were not well-prepared at school to use maths for life.⁶ As a result they find it difficult to budget and make money stretch as far as possible; they feel stressed and insecure about money, regardless of their income, and they struggle to overcome barriers to progression in work. Yet it is culturally acceptable, especially for women, to say, 'I hate maths, I was never any good with numbers, and that's unlikely to change.'

For enormous swathes of our population, both adults and students, mathematics is a language they cannot speak.⁷

There is growing awareness that the relationship between females and maths is typically not a happy one, and that something needs to be done about it. This Government has come alongside industry to launch an important campaign, 'Your Life',⁸ to tackle signs in girls and young women making important choices at school, that they would prefer to avoid maths. Even though overall, girls outperform boys at school, closer inspection reveals that they lag behind when it comes this indispensable subject.

In terms of participation, even those who do very well at GCSE maths are less likely to take maths at A level, which sets the tone for broader participation in the important science, technology, engineering and maths (STEM) subjects: in 60 per cent of state schools, boys outnumber girls when progressing from GCSE to A level maths.⁹ 80 per cent of girls who achieve an A* grade in physics GCSE do not continue it to A level.¹⁰ This has a knock-on effect on what girls go on to do in further and higher education, and future careers.

6 BAE Systems poll, conducted by YouGov, questioned 2,016 adults between March 2 and 6 2013 and the National Numeracy survey, also conducted by YouGov, questioned 2,151 adults between February 27 and March 1 2013

7 Vorderman C, et al, 2011, *A world-class mathematics education for all our young people*, p3

8 See <http://yourlife.org.uk/>

9 Truss E, 'A gender gap that simply doesn't add up' *Daily Telegraph*, 8 December 2013

10 Dunn E et al. *Your Life: the formula for success*, 2014

This is also an indication of how confident women will be as they grow older about the functional end of maths – particularly about handling money, budgeting and financial planning. This is not to suggest that women are disinterested in handling money and managing family finances. Indeed, Department for Work and Pensions (DWP) research shows that, although women are not necessarily more financially confident or knowledgeable than their partners, women tend to have the greater influence, and frequently initiate decision-making processes concerning money.¹¹

While men in the DWP research consider that they play an important role at the final stage of a financial decision, historically men would have run the whole shooting match. This paper will show that men used to be far more dominant in money matters, and it will suggest that patriarchal attitudes in this area were very influential in the way women were educated. Keeping women away from maths also kept them away from understanding money.

Underlying assumptions or cultural facets, which treated women as being inherently less mathematically able, helped to consign women to a position of subordination and indeed, to their dependence on men. Although much has changed in terms of 'who does what' in British households and, on the whole, marriages are far more equal than they were in the past, a deep-seated lack of mathematical confidence remains in women, which holds many women back and makes them less effective in handling money.

Left or right?

Aren't men more likely to be 'left brain' and logical, therefore good at maths? Aren't women more 'right brain' and intuitive – therefore innately disadvantaged when it comes to maths?

A University of Utah American study, recently published in the online journal PLoS ONE,¹² debunks this as a myth, on the grounds that people are not *governed* by the right or the left side of brain. The researchers found that while different sides of the brain are responsible for certain skills and bodily processes, people do not have a dominant side.

In general, the left hemisphere is in charge of carrying out logical and precise mathematical computations and the right hemisphere is mainly responsible for face recognition, processing music, and rough mathematical estimations and comparisons. The researchers found no evidence that individuals use their left-brain network or right-brain network more often – or that men and women differ in the relative use of each side.

Without basic mathematical skills, and the confidence to use and build on them, women will continue to feel at a distinct disadvantage when managing money. For some women, this will mean that they find it harder to escape from poverty and dependence on welfare benefits, not least because of the important emphasis in welfare reform on work progression, which requires gaining new skills. Other women will feel they are obliged to be dependent on men to a degree that is dissonant with wider cultural values of gender equality.

¹¹ Department for Work and Pensions, 2012, *Household financial decision making: Qualitative research with couples*, London: DWP

¹² Nielsen JA, et al, 2013, 'An Evaluation of the Left-Brain vs. Right-Brain Hypothesis with Resting State Functional Connectivity Magnetic Resonance Imaging', *PLoS ONE* 8(8): e71275

While different sides of the brain are responsible for certain skills and bodily processes, people do not have a dominant side.¹³

One contributing reason to why women stay with an abusive partner is because they feel unable to stand on their own feet, financially. Coercive and controlling behaviour often includes the strategic restriction of the victim from money and financial decisions.¹⁴

Case study: How poor maths skills can make women financially poor

Margaret, aged 69, is in a wheelchair most of the time, but when she feels sufficiently confident she gets around with the aid of a stick. She has been on her own for about three years, after living with a violent and abusive husband for many years. When her grown-up son began to treat her badly, Margaret knew she had to make the break.

In this middle-class family, Margaret had been a teacher all of her working life, and when she took early retirement she was paid a lump sum that should have made it easy for her to stop work. However, this money went into the couple's joint bank account, which was a mystery to Margaret. For all she knows, there might still be some of that money left – enough to make her feel a bit more secure. Margaret now lives in local authority, sheltered housing and is dependent on welfare benefits.

The engagement of women with maths is clearly on the Government's radar. Relevant Government Departments – particularly Education and Business, Innovation and Skills – work with employers, trades unions and others, and are rightly concerned to be proactive and innovative in how they encourage more women into STEM subjects and careers. In order to meet the industrial and commercial needs of the nation and to be globally competitive, it is vital that Britain moves up international league tables for achievement in subjects that will lead to these maths-based careers. Such progress will be very hard to effect if nearly half the future workforce consider itself fundamentally ill-suited to these subjects. However, the fear of maths that exists in many girls and women – to a degree that may range from apprehension to near-panic – is rarely discussed, although it constitutes a massive barrier to the realisation of ambitions in this area.

Structure of report

This report suggests that women's fear of maths has historical, psychological, and anthropological roots that cannot be dismissed simply as innate differences in ability.

Chapter One explains why the development of mathematical skills that are sufficient to the challenges of the 21st century society and workplace must not be seen as something that ends at the age of 16 years, or when young people leave the education system. There is a

¹³ *Ibid*

¹⁴ Farmer E and Callan S, 2012, *Beyond Violence: breaking cycles of domestic abuse*, London: Centre for Social Justice

flawed perception and hope, especially among girls and young women, that the need to do maths ends when the school gates finally close behind them. To reach and sustain our country's economic competitiveness requires a much higher level of maths ability among the whole population, and the poor attainment of women is of particular concern.

Chapter Two emphasises the importance of confidence when children, young people and adults approach maths. Internationally respected research has exposed that it is differences in confidence, and not ability, that are determinative for the gender gap in maths attainment. The difference in self-efficacy or confidence levels between girls and boys is marked across the whole of the performance spectrum – not just among poor performers – and this has led respected organisations like the OECD (Organisation for Economic Co-operation and Development) to cite the importance of Maths Anxiety as a key factor in attainment in maths.

Maths Anxiety is markedly more prevalent among girls than boys and among women than men, as **Chapter Three** makes clear. This chapter links the irrational fear of maths to the historical and current perception that maths is an inherently male activity. Many women feel they are encroaching on territory that is not really theirs by biological predisposition – but this is a highly gendered assumption; it is based on socially ascribed perceptions of what it means to be male or female and not at all on biological realities. Women can be just as good at maths as men.

The origins of the underlying roots of these perceptions and the reasons why maths is perceived to be an innately male domain are exposed in **Chapter Four**. Historically, patriarchy was itself rooted and strongly reinforced in the institution of religion, which set up taboos around women's access to learning about maths and science. The leading men of the day correctly recognised that these subjects held the keys to understanding how the world worked. And they were not about to hand them over to their wives and daughters.

To further elucidate the role of patriarchy, **Chapter Five** focuses on the place of women in society, particularly following the major social upheavals of the Industrial Revolution; it reveals how control over money increasingly became seen as exclusively belonging to a man's world. A few wives might be involved in the management of the household or estate accounts, but strategic financial concerns were not deemed to be within the proper purview of women.

Chapter Six provides insights from a short, literature review on the history of women's education, particularly in the period before legislation that made secondary education universal, and with a specific focus on how reformers treated maths and maths-based subjects. The very scant material that could be found on girls' maths education suggests that in the main, girls simply did not 'do' maths or science.

Champions for women's education grappled with the issue but concluded that it was inefficient to teach this subject to girls because the vast majority of them were physically not equipped to master it. Unwittingly, by accepting the premise that ability in this important subject was innate – and innately male – they perpetuated and reinforced what we refer to as the Maths Myth.

Chapter Seven makes proposals to address the Maths Myth, because this underpins the fear factor that holds back so many women – and men – from fulfilling their potential in STEM subjects. We argue for the need to increase awareness among parents, to address the training and practice of teachers, and to challenge wider society through a broad-based public campaign.

In conclusion, if we are to see significant gains in female participation in maths then cultural change has to take place across society as a whole. For the vast majority of children, their earliest educators are their mothers and fathers. To take the pressure off their daughters, fathers across society may be passing on to them expectations about their inability to achieve mathematical success, which are based on the father's own faulty assumptions.

Where mothers are transmitting the message that maths is to be feared, avoided or simply not worked at (on the grounds that they will most likely be defeated from the outset) these mothers are unintentionally perpetuating a cycle of female underachievement that has distinct roots in our social history. Laying bare these roots will enable us, as a society, to move beyond their pernicious influence.

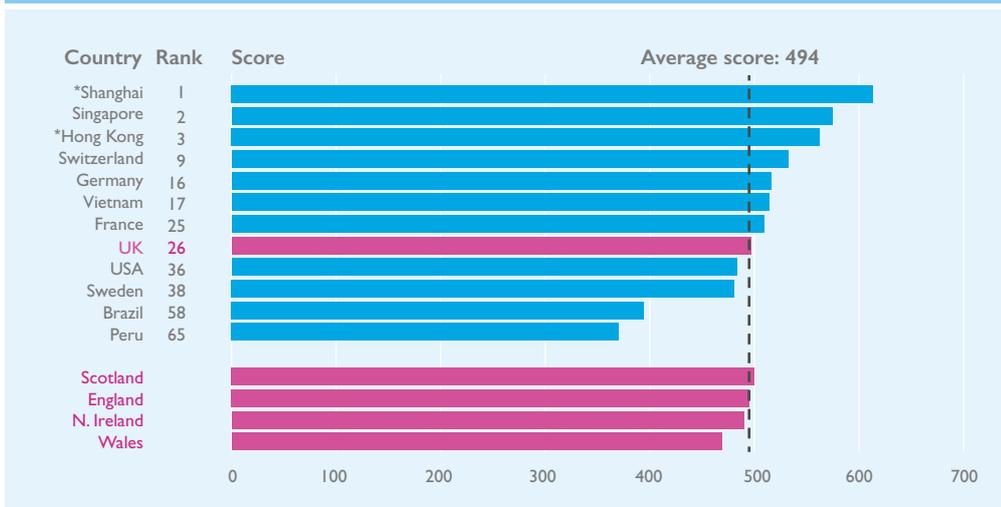
chapter one

Why maths and maths ability for women matter

1.1 Your country needs YOU to be able to do maths

According to the report commissioned from Carol Vorderman for the Conservative Party (while in Opposition), maths is a language where numbers are the sounds, syllables and words, 'but for enormous swathes of our population, both adults and students, it is a language they cannot speak.'¹⁵ The report warns that failure to address our low skills base in this area puts our nation's economic prosperity at risk, because other nations are performing considerably better than Britain. The graph is from the most recent Programme for International Student Assessment (PISA) tests carried out by the OECD (PISA 2012) and bears out the report's findings.¹⁶

Figure 1: Pisa maths scores for selected education systems



* China does not participate as a country, but is represented by cities such as Shanghai and Hong Kong
Source: OECD

¹⁵ Vorderman C, et al, 2011, *A world-class mathematics education for all our young people*, p3

¹⁶ Graph derived from <http://www.bbc.co.uk/news/education-25187997>

The unacceptably high number of British students failing to obtain a Grade C or above in maths and the disappointingly low number taking maths in some form beyond GCSE¹⁷ mean that universities and employers are often hampered by the low or underdeveloped maths ability relative to the demands of courses and the workplace.

As a result, too few teachers in Britain have good maths skills to pass onto future students. There is a shortage of specialist maths teachers: in 2014 a little over 20 per cent of maths lessons in years 7 to 13 were taught by teachers without a relevant qualification.¹⁸ So it would be unsurprising if what was being transmitted was a lack of confidence. At every level, too many children are underperforming: one in seven of 11 year olds in England left primary school unable to perform at the minimum satisfactory mathematical level for this stage¹⁹ and by age 16 many students fear and have little understanding of how maths works.

A recent survey found that 39 per cent of employers were concerned about their employees' basic numeracy skills while the cost to British industry of remedial classes for illiteracy and innumeracy is over £1 billion per year, and almost half of British firms surveyed run basic remedial training in English and Maths.²⁰

39 per cent of British employers surveyed were concerned about their employees' basic numeracy skills.²¹

One major barrier to tackling this skills gap is the widely held belief in the UK that many people are simply incapable of performing well in all things mathematical and therefore they should not attempt to improve their skills in this area. Although it seems reasonable to assume that there must be a range of mathematical ability across the population, only 5 per cent actually have dyscalculia.²² This is an identifiable disorder 'characterised by impairments in learning basic arithmetic facts, processing numerical magnitude and performing accurate and fluent calculations'.²³ Dyscalculia is not the result of a 'below par' education or a wider intellectual disability.

This disparity between the numbers of people who may genuinely be unable to perform mathematical tasks and those who are performing *as if* they were impaired, suggests that culture and expectations may be playing a decisive role, as well as possibly inadequate teaching. Indeed, according to Sir Peter Williams in his Review of primary school teaching of mathematics, published in 2008, 'The UK is still one of the few advanced nations where it is socially acceptable – fashionable even – to profess an inability to cope with maths.'²⁴

17 According to Vorderman et al 2011, op cit, nearly half of all students fail to obtain Grade C or above in Maths and only 15 per cent progress beyond GCSE

18 Department for Education, 2014, *Statistical First Release: School Workforce in England: November 2014* available at: <https://www.gov.uk/government/statistics/school-workforce-in-england-november-2014>

19 Department for Education, *Statistical First Release: National curriculum assessments at key stage 2 in England, 2014 (Revised)*, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/428838/SFR50_2014_Text.pdf

20 CBI and Pearson Education and Skills Survey, 2015

21 *Ibid*

22 British Dyslexia Association see <http://www.bdadyslexia.org.uk/dyslexic/dyscalculia>

23 *Ibid*

24 Williams P, 2008, Review of Mathematics Teaching in Early Years Settings and Primary Schools (Interim Report)

The UK is still one of the few advanced nations where it is socially acceptable – fashionable even – to profess an inability to cope with maths.²⁵

Other academics confirm that, even today, little has changed when it comes to this readiness to assume that difficulties in mastering maths cannot be overcome, and they are very concerned at the extent to which this is holding people back, especially those from poor backgrounds.

*We know that maths is a key predictor of later labour market success. I would like to see the badge of honour removed, 'I am not good at maths. Numbers are not my thing'. I would like to see that removed from things to be proud of.*²⁶

Those who fail to grasp maths at school can face an uphill struggle to obtain its vital foundational building blocks in an adult education setting – even if they realise how important maths is for future success – in a person's career or, more broadly, in other aspects of their life. Inability to perform simple calculations can make it very hard to stay within a family budget and debt-free, whatever one's income level (see box). Paradoxically the stigma, associated with the adult learning of basic skills that should have been mastered in school, undermines the adult's confidence to find and attend courses that could help to overcome what has often become their fear.²⁷

The link between poor maths skills and inadequate financial management skills

Although the prevailing culture dictates that being good at maths isn't cool or necessary, having money is deemed to be cool and necessary. For most people, to maintain a financially healthy position will require the ability to balance budgets and manage that money well, for which an adequate level of maths is essential.

Conversely, people who cannot manage their money are at far greater risk of falling into problem debt and poverty. While some people on very low incomes demonstrate exceptional money management skills and make their money stretch much further than those with far greater financial resources, tackling an inability to do maths needs to be part of a poverty alleviation strategy.²⁸

In summary, negative and defeatist assumptions about inherent mathematical ability will act against attempts to improve performance through better teaching. As one review concluded 'it is vital to bring about a shift in public attitudes, so that people no longer see it as acceptable to be bad at maths.'²⁹

25 Williams P, 2008

26 Uncorrected evidence taken before House of Lords Select Committee on Social Mobility, 8 July 2015, Session 2, available at <http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/social-mobility-committee/social-mobility/oral/18706.html>

27 National Audit Office, 2004, *Skills for Life: Improving adult literacy and numeracy* and National Audit Office, 2008, *Skills for Life: Progress in Improving Adult Literacy and Numeracy*

28 Centre for Social Justice, 2007, *Breakthrough Britain: Ending the costs of social breakdown*, London: CSJ and Centre for Social Justice, 2013, *Maxed Out: Serious personal debt in Britain*, London: CSJ

29 Paterson et al, 2010, *Count me in: improving numeracy in England*, London: New Philanthropy Capital, p31

1.2 #ThisGirlCan

Evidence suggests that unhelpful and fatalistic attitudes are even more pronounced among women and girls. Actual *fear* of maths is often an important underlying contributor to female reluctance to rise to the challenge of mastering the subject; it also appears to be more common among females than among boys and men, as I discuss in the next chapter. I suggest that frequently such a fear is masked by the underlying assumption – certainly in Britain – that maths is somehow unfeminine. The corollary of this is that if a girl or woman *cannot* do maths then this underlines her femininity. Yet shifts in other social attitudes are calling time on this conflation of poor maths ability with enhanced femininity, not least because it maintains many women in a disadvantaged position and so thwarts their ability to fulfil their potential.

One of the Government's key priorities is to inspire young women and girls to reach their potential, to take up science, technology, engineering and mathematics (STEM) subjects and compete with the best in the world for the top jobs.³⁰

1.3 Mind the gap

The assumption that women are simply less suited to maths means that many girls and women underestimate their ability to master mathematical subjects: they underperform at school and in further/higher education in related subjects; they enter the labour market with fewer of the skills that employers are looking for. Because of this, the increasing success in female education has not been followed by gains in employment. According to Andreas Schleicher, OECD Special Adviser on education, the study choices that girls are making do not lead to the best-paid occupations.³¹

To help explain this, the OECD describes the new gender gaps that are opening in education. PISA found that more 15-year-old boys underachieve in comparison with girls, 14 per cent of boys and 9 per cent of girls did not attain baseline proficiency in any of the three core subjects measured in PISA: reading, mathematics and science. Six out of ten of those not achieving baseline were boys.³² However, actual attainment in maths (and science) tests tells a different story.

British boys did better in the maths PISA tests than British girls by 12 percentage points – a little higher than the OECD average gap measured across 67 countries. In contrast, the gap between boys and girls in science tests is 13 percentage points, compared to the OECD average of just one percentage point.

30 Rt Hon Nicky Morgan MP, Secretary of State for Education and Minister for Women and Equalities, 'We've Made Great Strides on Women's Equality – But This Is No Time to Pat Each Other on the Back', *The Blog, HuffPost*, available at http://www.huffingtonpost.co.uk/nicky-morgan/gender-pay-gap_b_7799322.html

31 'UK Girls flop in science league', *Sunday Times*, 22 February 2015

32 OECD, 2015, *The ABC of Gender Equality in Education: Aptitude, Behaviour, Confidence*, PISA, OECD Publishing

While Britain seems to have a particular problem in encouraging girls to do well in science, there is no room for complacency when it comes to maths attainment: girls in some of the East Asian countries outperform British boys by the equivalent of several school years.

Maths ability is an important starting point for doing well in science and particularly in physics.³³ What are the reasons why we, as a nation, do not appear to have the right educational foundations for preparing women for STEM careers or even mathematical competence later in life? The OECD emphasise that education must take into account not only aptitude but also behaviour and confidence. The next three chapters look particularly at confidence: how girls' and women's fear of maths deeply undermines their self-confidence in maths and where the roots of that fear come from.

33 Norris E, 2012, *Solving the Maths problem: international perspectives on mathematics education*, London: RSA

chapter two

Why confidence about maths ability matters

2.1 Differences in confidence, not ability, are decisive

A growing body of international research, with data backed up from the OECD's PISA studies, highlights differences in confidence between males and females in the way they approach maths, and why this must be treated as a root cause of poor maths attainment, and more boys than girls continuing with STEM subjects post-16.

Self-efficacy is the belief of students that they can achieve mastery to the necessary level in an area of learning. It is hard to overestimate the difference that *self-efficacy* makes to attainment in a subject. On average across OECD countries, maths and science self-efficacy is associated with a difference of 49 score points in maths and 37 score points in science – the equivalent of between half and one additional year of school.³⁴

Self-confidence is... what enables high-achieving students to reach their potential and not choke under pressure. PISA reveals that self-efficacy – the extent to which students believe in their own ability to solve specific mathematics tasks [is] much more strongly associated with performance among high-achieving than low-achieving students; at every level of performance, girls tend to have much lower levels of self-efficacy... in mathematics and science.³⁵

This is why it is cause for concern that girls, in general, have lower levels of self-efficacy than boys in both maths and science and, given the foundational nature of maths, that the difference

³⁴ OECD, 2015, *The ABC of Gender Equality in Education: Aptitude, Behaviour, Confidence*, PISA, OECD Publishing

³⁵ OECD 2015, *op cit*, p31

is much wider in this subject than in science.³⁶ If poorer attainment and participation are to be addressed, understanding why girls tend to have less confidence in their maths abilities – even when their prowess should be in no doubt – is an important starting point.

Confidence seems to be shed rather than gained with age. When she was a minister in the Department for Education, Rt Hon Elizabeth Truss, MP stated, 'by the age of 14, girls have lost confidence in their maths ability... a generation of girls are nervous about maths and science.' She concluded, 'This is a matter of culture.'³⁷

Research supports her assertion that culture determines diversity in confidence and therefore attainment. Kane and Mertz' study on determinants of mathematics performance at all levels for both boys and girls concluded that gender equity and other socio cultural factors should be the primary focus of attention.³⁸

Men's versus women's confidence in maths

Psychology Today reported recently that:

One of the major financial houses recently canvassed high school students and asked how good they were about math and money. The boys said, 'We're pretty good.' The girls said, 'We're not very good.' In fact, they both knew the same amount about money; but their confidence levels were vastly different.

Moreover, when men make money in the stock market, they credit their own cleverness. When they lose money, they blame the incompetence of their advisors, or bad luck. When women make money in the market, they credit the cleverness of their advisors, good luck or even the stars. When they lose money, they blame themselves.³⁹

The Huffington Post similarly reported, 'Women Aren't Bad At Math, But New Study Suggests Both Genders Think They Are'. In this article, men and women employers alike revealed their prejudice against women for a perceived lack of mathematical ability. When the only information given to the employers was a photograph of the candidate, men were twice as likely to be hired for a job that requires simple maths, regardless of whether a man or woman was doing the hiring, as was reported in the *Proceedings of the National Academy of Sciences*.

The hiring bias did not disappear when candidates self-reported their ability on the task, in part because women tended to underestimate their ability while men tended to boast. And even when the employers received accurate information about the actual performance of the candidates, the bias did not fully disappear. The more prejudiced a person was, as measured by the Implicit Association Test, the less likely they were to correct their bias.⁴⁰

36 Pisa 2012, Tables 3.1b and 3.2b, cited in OECD 2015

37 Speech by then-Parliamentary Under Secretary of State for Education and Childcare, Rt Hon Elizabeth Truss MP, Institute of Physics, 11 December 2013

38 Kane JM and Mertz JE, 'Debunking Myths about Gender and Mathematics Performance', *Notices of the American Mathematical Society*, 2012, pp10–21

39 'Men, Women, and Money', *Psychology Today*, October 16, 2012 available at <http://www.psychologytoday.com/articles/199901/men-women-and-money>

40 'Women Aren't Bad At Math, But New Study Suggests Both Genders Think They Are' *Huff Post Science*, 3 November 2015, available at http://www.huffingtonpost.com/2014/03/11/women-bad-math-both-genders_n_4941952.html

So there is a belief that boys are born with an ability to do maths whereas girls are not, yet there is 'no biological reason for girls to do badly... there is simply no evidence from [the OECD's] research to support this', according to OECD Special Adviser on Education Policy, Andreas Schleicher.⁴¹ Other countries have far narrower gaps in boys' and girls' attainment in maths and, as stated earlier, girls in some countries are doing better than British boys to an impressive extent.⁴²

2.2 Do girls simply grow out of their enjoyment of maths?

Schleicher has also commented that 'aged 9 and 10, both girls and boys in the UK think science is really interesting; by age 15, girls in the UK think it is really boring.'⁴³ Beller and Gafni's research has shown that boys and girls at approximately nine years of age have similar maths skills but in their study, by age 13, boys' scores tended to be higher than girls in 17 out of 20 countries.⁴⁴

As there appears to be a link between disengagement and maths attainment, it is important to understand the reasons for which this disengagement takes place.

First, when maths and science are taught in such a way that they are perceived as detached activities – unrelated to any societal context that would give them meaning or relevance – this is off-putting for young girls who tend to engage with these subjects through personal and relational impact.⁴⁵ So there is an onus on secondary schools to inspire both sexes about the opportunities and occupations that will be opened up by sound maths skills.

Second, to address this will again necessitate being honest about the prevailing expectations and attitudes of careers for girls, and how they differ from those for boys. The effect of perceived gender differences in mathematical ability can be felt in the earliest years of education. US research suggests that female primary school teachers who teach maths anxiously and in a way that betrays their own belief that it is more of a masculine than a feminine activity, are inadvertently being realistic when they assume that girls are at a disadvantage.⁴⁶

The same research has shown that while boys seem impervious to any anxiety shown by their female teachers towards maths, girls seem to internalise their teacher's reticence for things mathematical, and adopt it as an appropriate gendered response. What can also be transferred to girls is the sense that maths is something to be fearful and anxious about. This can set up a vicious circle of maths-anxious primary teachers conveying their anxiety to girls, some of whom will grow up to become primary school teachers and so continue the cycle.⁴⁷ Maths Anxiety is a well-documented phenomenon, which will be discussed in the next chapter.

41 'British girls lag behind on science table: Gender divide among the biggest in the world as boys outperform by 13 per cent', *Daily Mail*, 22 February 2015

42 Shirley Conran's personal correspondence with Andreas Schleicher.

43 'British girls lag behind on science table', *Daily Mail*, 22 February 2015

44 Beller M and Gafni N, 1996, 'The 1991 International Assessment of Educational Progress in Mathematics and Sciences: The Gender Differences Perspective' *Journal of Educational Psychology* 88 (2): 365–77

45 Munn M (ed), 2011, *Unlocking Potential: Perspectives on Women in Science, Engineering and Technology*, London: The Smith Institute

46 Beilock et al, 2010, 'Female teachers' math anxiety affects girls' math achievement', *PNAS* 2010 107: 1860–1863

47 See Vorderman et al. 2011, *op cit*, p 11 for their description of the 'mathematics education circle' in the UK

Third, a neglected area for discussion lies in the extent to which women have often been socialised to feel the answer to their own inability to master maths lies in finding someone else to do the hard sums for them – especially when it comes to managing money. In this area, according to *Psychology Today*, ‘Women are raised to believe they won’t be good at it and, if they’re lucky, some man will take care of the details of money and investing.’⁴⁸

2.3 Dangerous assumptions

There is some statistical backing for this assertion, although it is a very mixed picture. Dr Catherine Hakim recently published a report which showed that the number of women in the UK who marry men with higher levels of education and income than their own has almost doubled since 1949, challenging feminist assumptions that women increasingly want to be financially independent. Dr Hakim’s research, which drew on an extensive review of existing studies from around the world, census data, and national surveys conducted in Britain and Spain, found similar patterns across much of Europe, the US and Australia.⁴⁹

The number of women in the UK who marry men with higher levels of education and income than their own has almost doubled since 1949, challenging feminist assumptions that women increasingly want to be financially independent.⁵⁰

Many couples, especially those with children, are financially interdependent, with both partners contributing to the family budget, perhaps at different levels; according to one survey, 41 per cent of women earn more than their partners.⁵¹ Women must not assume they need not worry about being able to manage their own money simply by acquiring the necessary mathematical skills. Such an assumption could be problematic in the future because the trend seems to be moving towards more women taking over the family finances, possibly because of the need to keep a tighter rein on expenditure.

Lloyds TSB research indicates that where women have traditionally maintained tight control of their family’s day-to-day household spending, and men have taken charge of major decisions on banking and financial planning, this situation appears to be changing.⁵² Now, women below the age of 45 are more likely to choose the family’s bank or building society (52 per cent of households); to take control of detailed future plans for savings (52 per cent); to pay day-to-day bills and keep track of spending (54 per cent).

48 ‘Men, Women, and Money’, *Psychology Today*, October 16, 2012, available at <https://www.psychologytoday.com/articles/199901/men-women-and-money>

49 Hakim C, 2011, *Feminist Myths and Magic: Medicine: flawed thinking behind calls for further equality legislation*, London: Centre for Policy Studies

50 *Ibid*

51 ‘Women now the main breadwinner in 41pc of homes’, *Daily Telegraph*, 18 July 2013, available at <http://www.telegraph.co.uk/finance/personalfinance/10188234/Women-now-the-main-breadwinner-in-41pc-of-homes.html>

52 Lloyds TSB, 2012, *Family Savings Report*

This picture is complicated slightly when we look at high versus low income families in Chapter Five. When there are significant funds to be managed, it is more likely that financial decisions will be male-dominated.

This greater level of women's involvement in managing family finances makes it even more important that educational efforts to narrow the gap between boys' and girls' mathematical attainment are backed by cultural change because there is no biological reason why one sex rather than the other should be less confident with maths – and money.

The next chapter explains why, in order to boost girls' and women's confidence, it is necessary to explore the deeper issue of the *fear* of maths that many women experience, but about which they are either unconscious or unconcerned – because our society treats such deep-seated anxiety as a natural part of being female.

chapter three

How do we know that women fear maths?

3.1 Introduction

In the last two chapters, I established that maths ability matters for both girls and boys, women and men, and that ignoring girls' poor educational attainment and lack of ambition for maths-based careers potentially limits their life chances and the nation's economic competitiveness. Moreover, the financial competency of individuals rests on their numeracy skills. Societal expectations have eroded previous norms about women being looked after by men, and increasingly women need to look to their own skills to ensure their financial wellbeing.

So it is important that women do not feel at an innate disadvantage, because this can undermine their confidence. The last chapter showed that international educationalists ascribe girls' poor maths attainment, relative to boys, in many countries, not to biological differences but to different levels of confidence in this subject.

Such experts go further, to state that girls also report greater anxiety towards maths than boys, in almost every country surveyed – *even if those girls are doing well*. In this chapter I describe Maths Anxiety and its effect on maths performance. I produce evidence that girls and women experience Maths Anxiety to a greater extent than males. The following two chapters will explain where that fear comes from, how it is reproduced in each generation and its historical roots.

3.2 What is Maths Anxiety?

Ashcraft defines it as 'a feeling of tension, apprehension or fear that interferes with math performance'⁵³ because it results in the avoidance by students of situations in which they are required to perform mathematical calculations. This avoidance obviously means that

53 Ashcraft MH, 2002, 'Math anxiety: Personal, educational, and cognitive consequences', *Directions in Psychological Science*, 11, 181–185

such students get less practice and exposure to maths, with the expected negative effect on competency.

Maths Anxiety is a very real phenomenon, measurable on rating scales, and it is not the same thing as not being good at maths. Brain scans show that the area of the brain that is triggered when someone experiences Maths Anxiety overlaps with the same region as that affected by bodily harm. Just thinking about solving a maths problem – not failing to do so – is perceived as a very real threat.

Maths Anxiety is a feeling of tension, apprehension or fear that interferes with math performance.⁵⁴

Maths Anxiety can be picked up in schools, especially if teaching is not of a high enough quality and instead betrays a lack of confidence in the subject overall or in particular areas such as fractions or long division, or basic algebra or geometry, which are foundational for future maths learning. Maths might be taught in a way that discourages experimentation and risk, particularly if it sends the strong message that there is only one right way to solve a problem.

Maths Anxiety can also be the result of something as simple as not learning the multiplication times tables before secondary school and then being in a classroom full of other students who can remember their tables. A student can feel innately inadequate and fearful of being embarrassed by not knowing something that they feel they should. Maths Anxiety can also be picked up from a parent whose negative or fearful perception of maths can 'rub off' on a child (see box below).

Case study: Negative and fearful attitudes towards maths hinder efforts to raise attainment

'Women are definitely more willing to admit they are not good at maths than men. We see it all the time in our school. In fact we feel our efforts to inspire girls that they can do maths are unintentionally being sabotaged by their mothers. They will not push their daughters but instead tell them how hard they found the subject at school and how much they disliked it. More than that, there is definitely a fear of maths. At parents' evening when they are told how they can help their children improve, they can be really quite concerned: "I don't have any understanding, I can't help." This is being passed onto their daughters. It's a real problem. In many cases it's really important that these children break out of cycles of disadvantage and this is not helping.'

School governor in a primary school in the North East of England, in conversation with the author

54 *Ibid*

3.2 The effect of Maths Anxiety

PISA data has established that Maths Anxiety is associated with a 34 point decrease in mathematical performance. To put such a decrease in context, this is the equivalent of being behind by almost one year of school.⁵⁵ This is not surprising, because Maths Anxiety manifests itself as a fear among students that classwork will be too difficult for them; they feel defeated before they have even started to approach a maths problem. As Maths Anxiety is more common in women than in men,⁵⁶ it is unsurprising that, on average and in most countries, female students' test scores are lower than those of men's, which comes through clearly in the PISA data, as described in Chapter one.

Even when girls and boys achieved the same grades, the former would be doing so with greater apprehension, dislike, tension, worry, frustration and fear in comparison with boys.⁵⁷

Devine et al's (2012) research led them to conclude that because maths is often viewed as a male subject, females are socialised into assuming they are mathematically incompetent. Even when girls and boys achieved the same grades, the girls would be doing so with greater apprehension, dislike, tension, worry, frustration and fear, in comparison with boys.⁵⁸ They concluded that without this anxiety, girls would be doing better than boys.

In summary, they and others argue that because maths is traditionally considered to be what men do, typically, the underlying assumption of women is that they are bound to be less suited to it. This means that many more girls than boys either do maths anxiously or they avoid it; as I have stated earlier, girls are far less likely to do Maths Post-16.

Trainee lawyer at big London law firm (who got an A for Maths at GCSE) describes how she feels when she is reading the financial details of a case:

I have to remind myself, 'I can do this'. You can feel bamboozled by the sight of big numbers and feel like giving up before you've even tried, if you don't feel very confident.

The next chapter takes an anthropological approach to understanding why maths is perceived as being innately male. Given what I say above, another way of putting this is, 'Why do women fear maths more consistently than men?' Where did this cultural facet come from? Why does it stubbornly persist despite all the modern encouragement for girls and women to succeed in education?

⁵⁵ OECD 2015, *op cit*

⁵⁶ Hembree R, 1990, 'The nature, effects and relief of mathematical anxiety', *Journal for Research in Mathematics Education*, 21:33–46

⁵⁷ Devine A, et al, 2012, 'Gender differences in mathematics anxiety and the relation to mathematics performance while controlling for test anxiety', *Behavioral and Brain Functions* 8–33

⁵⁸ *Ibid*

To answer these questions more fully, in later chapters I explore popular and historical literature to ascertain how girls were educated in the past, and how this was thought to prepare them appropriately for their roles as women.

chapter four

Why is maths perceived to be innately male?

4.1 Confidence and culture

The importance of confidence for the mastery of maths has already appeared in this report, as has the need to understand the countervailing force of maths anxiety which affects more girls and women than boys and men in a very wide range of countries. The Directorate for Education and Skills at the OECD reports that in almost all countries that participated in their Programme for International Student Assessment (PISA) 2012 girls were more anxious than boys about maths, and this affects their performance in tests.⁵⁹

Researchers have linked girls' higher levels of Maths Anxiety to the different ways that boys and girls are treated as they are growing up: 'because mathematics is traditionally viewed as a male domain, females may be socialised to think of themselves as mathematically incompetent.'⁶⁰ However they argue this 'sex-role socialisation' hypothesis is unlikely to be the full explanation, not least because the view that maths is a male domain is waning.

Because mathematics is traditionally viewed as a male domain, females may be socialised to think of themselves as mathematically incompetent.⁶¹

Certainly in the UK, considerable effort is being invested by the Government and others (particularly in the Your Life programme⁶²), educational and charitable organisations⁶³ and the

59 OECD, 2015, *op cit*

60 Devine A, et al, 2012, *op cit*

61 *Ibid*

62 See <http://yourlife.org.uk/>

63 Maths Action, Learning Skills Research and others.

media⁶⁴ to challenge the inaccurate view that males are inherently better at maths than girls. There is a strong emphasis throughout on the need for parents, grandparents and teachers to communicate to girls and young women that their maths ability is not limited by their sex.

However, in Britain, the perception that men's brains put them at an advantage over women in mathematical matters is very deeply entrenched in our culture: the underlying assumptions that drive values, attitudes and behaviour (see box below).

Culture is...

'... the set of attitudes, values, beliefs, and behaviours shared by a group of people, but different for each individual, communicated from one generation to the next.'⁶⁵

'Culture is a fuzzy set of basic assumptions and values, orientations to life, beliefs, policies, procedures and behavioural conventions that are shared by a group of people, and that influence (but do not determine) each member's behaviour and his/her interpretations of the 'meaning' of other people's behaviour.'⁶⁶

As the first description suggests, culture is transmitted across social history. I looked for clues in British social history which could help explain how maths came to be so closely associated with male prowess and female weakness. By laying bare these roots, the aim has been to challenge the naturalness of the association and to show that its origins lie not in biology but in patriarchy, by which I mean the system of social governance where every arena of power, and particularly the mainstream institutions of power, are overwhelmingly dominated by men.

4.2 Can maintained women safely avoid maths?

The other related cultural facet which helps to shore up the myth that women don't need maths is the 'maintained woman' ideal, which appears frequently throughout both contemporary society and history. Women are still more frequently associated with the phrase 'gold digger' than men and, in a less extreme vein, it is still far more socially acceptable for women to be more than half-serious about looking for a wealthy husband and so being able to give up work.

As Chapter Five will show in greater detail, there are clear historical antecedents to this view; authors Myrdal and Klein described how the lady of leisure was idealised, particularly in the nineteenth century where social values 'put parasitism of women at a premium. The task of an upper-middle-class wife was chiefly to be an ornament to her husband's home and a living testimony to his wealth.'⁶⁷

64 For example, the *Good Housekeeping* campaign, 'Maths is a feminist issue'.

65 Matsumoto D, 1996, *Culture and Psychology*. Pacific Grove, CA: Brooks/Cole, p16

66 Spencer-Oatey H, 2008, *Culturally Speaking: Culture, Communication and Politeness Theory*, 2nd edition. London: Continuum p3

67 Myrdal A and Klein V, 1956, *Women's Two Roles*, International Library of Sociology/Routledge, p5

The corollary of this ideal, in its contemporary form, is that the best future a woman could envisage for herself is one in which someone else, typically her marriage partner, ensures the financial wellbeing of the household *and* looks after the money. Girls with such a future in mind might very well doubt their need to grapple with the intellectual challenge of maths, especially if their sex is deemed to be at a fundamental disadvantage when it comes to mastery of the subject, as earlier chapters have described.

The 'Cinderella Complex' may be waning but it is still evident today. Not only does it crop up in popular culture⁶⁸ but primary research into secondary school girls' attitudes by Maths Action found distinct signs of it in 13–14 year olds (see box). Many females continue to see their or their daughters' economic success as being bound up with marrying, or otherwise depending, on male earning power and men's perceived superior financial acumen, instead of being dependent on their own ability to 'husband' their resources through a confident and well-informed approach to money and maths. (It is instructive that even as recently as the mid-1980s, about one in two adult women in Western societies thought it was a man's job to earn money and a woman's to look after the home and family. By 2006 that number had reduced to one in seven in the UK.)⁶⁹

The myth of the maintained woman

New Maths Action research found that many British girls in Year 9 (13 and 14 years old) still have a Cinderella Complex: secretly, they believe that they will get married before they are 21 to someone who will look after them financially for the rest of their life. But statistics show that, on average, a young woman may work for eleven years before she marries.⁷⁰ So in reality, many girls will marry *much* later than they expect, and even if they marry, they may need to be financially independent at some point in the future. The Centre for Social Justice has written extensively about the breakdown of couple relationships⁷¹ – 39 per cent of couples marrying today will divorce at some point in the future⁷² and four in ten cohabiting couples will have split up by their tenth anniversary.⁷³

As a result, 26 per cent of UK families are lone parent families⁷⁴ and 92 per cent of those are headed by a woman.⁷⁵ Moreover, a high court judge recently handed down a landmark ruling that divorcees with children aged over seven should work for their living and receive no spousal maintenance, and a Private Members Bill to reform divorce along the same lines as Lord Justice Pitchford indicated has been reintroduced in the House of Lords.⁷⁶ Women who have to manage on their own will need maths – either to earn to their full potential or to carefully control their own finances.

68 Maths Action research, 'What's it got to do with me?' Survey of 400 girls from Langley Park Girls' School, Year 9 (age 13–14) and Year 12 (age 16–17). Occasional articles still appear such as <http://www.sinuousmag.com/2011/01/the-cinderella-complex/>, citing use of the phrase popularised by Collette Dowling's (1981) book *The Cinderella Complex: Women's Hidden Fear of Independence*, Simon & Schuster

69 Wolf A, 2013, *The XX Factor: How working women are creating a new society*, Profile Books, p283

70 In 2011 the mean age at first marriage for women was 30.2 years: Office of National Statistics, 2015, *Population Estimates by Marital Status and Living Arrangements – England and Wales, 2002 to 2014*, London: ONS

71 Centre for Social Justice, 2013, *Fractured Families: Why stability matters*, London: CSJ

72 Benson points out that the more commonly quoted ONS figure of 42 per cent does not include ceremonies that took place overseas in the total number of marriages. (Benson H, 2013, *What is the Divorce rate?* Marriage Foundation)

73 Beaujouan E and Bhrolcháin M, 2011, 'Cohabitation and marriage in Britain since the 1970s' *Population Trends* 145

74 Office of National Statistics, *Statistical Bulletin: Families and Households*, 2012, London: ONS

75 Office of National Statistics, *Families and Households*, 2012, London: ONS

76 See details of Baroness Deech's Bill at <http://services.parliament.uk/bills/2015-16/divorce.html>

4.3 Elite women – different by default

Although the concept of women wishing to be financially dependent on men might seem alien, anachronistic and wholly unacceptable to the professional elite of today's society (both male and female), Professor Alison Wolf's recent work has highlighted how such women and the other 80 per cent of society lead divergent work and family lives.⁷⁷

So it is important not to read across from the underlying assumptions of gender equity – and particularly women's strong desire not to *need* to be financially dependent on men – that many in the professional elite live by, and unconsciously apply these desires to the rest of society. Politicians, policy makers, journalists and others must not assume that everyone thinks like they do – or has the same choices.

Indeed, in the introduction to *The XX Factor*, Wolf draws a distinction not just between elite and non-elite women in a developed society like the UK, but also between the choices of today's elite women and those of 'women throughout history'.⁷⁸ This suggests that the choices open to today's *non-elite* women may be more similar to those of 'women throughout history' and therefore the assumptions by which they live may also bear a closer resemblance to their ancestors than has previously been recognised. Wolf hints at this when she states that for every woman in a professional job there are four who lead *traditional* (her word but my emphasis) female lives.

With this in mind, I started a historical literature review with two interrelated research questions in mind. First, how were girls and women educated in the past in what would now be termed 'STEM' subjects but particularly maths; in particular, was there a difference between the syllabus they followed and that of their brothers? Second, although it is widely understood that, historically, girls and women were treated very differently to their male relatives and that female dependence on men was expected and encouraged, I wanted to look at contemporary literature for explicit references to women being kept away from financial decision-making beyond routine household management.

4.4 Using fear to keep women in the 'non-mathematician' category

It was my hypothesis that as women were educated for the roles they were expected to play, they were typically excluded from the powerful and influential arenas which included finance. The fear that women felt and still feel towards maths might have its roots in patriarchy's deliberate naturalisation of woman as non-mathematician. We now know that female brainpower is no less considerable than that of males; by situating that knowledge alongside a historically informed view of socially constructed impediments to gender equity, reinforced by education, my aim was not just to debunk, but more importantly, to *expose* the myth that maths is innately male.

⁷⁷ *Ibid*

⁷⁸ *Ibid*, p8

I suspected that even if educational practice was at the root of unequal access to maths, it was doubtful that it completely explained why *fear* of maths to some degree is particularly prevalent among British girls and women, especially after such care has been taken over several decades to overturn any pre-existing bias. It seemed important to look more deeply at the significant historical influence of religion on society in general and education in particular, not least because so many schools through the centuries were established by churches and maintained through endowments founded on religiously motivated charity.

By examining how patriarchy was promulgated through the all-pervading cultural institution of religion and the extent to which the concept of Mathematical Man was reinforced, it becomes apparent how effectively this was used as a tool to keep girls and women away from the culturally determined keys to power. An anthropological analysis of the influence of religion on the psychological and unconscious processes that can operate within society provides important clues to the origins of the fear that is the subject of this paper.

4.5 Patriarchy and religion

In many societies and religions, women typically not only held subordinate roles but were also restricted to those roles by strongly enforced social norms and even taboos. Obviously, there are clear exceptions in all religious traditions. Notable female theologians and leaders who have influenced Western culture include abbesses such as Hilda of Whitby in the seventh century, and Hildegard of Bergen in the twelfth century; fourteenth century theologian, Catherine of Sienna; sixteenth century mystic, Teresa of Avila; and philosopher Simone Weil in the 20th century.

According to the *Encyclopaedia Britannica*, taboo is defined as 'the prohibition of an action based on the belief that such behaviour is either too sacred and consecrated or too dangerous and accursed for ordinary individuals to undertake.' I applied an anthropological lens to the issue of 'taboo' to allow a better understanding of the effect of such 'irrational' concepts on a society, and the subconscious legacy these might bequeath to its more 'rational' descendants.

Human behaviour is not governed only by rational decision making. Societies often have shared values and standards of acceptable behaviour that members of the society are encouraged to follow. A culture or a society guides the behaviour and the thoughts of their members by agreed-upon expectations and rules. The list of behavioural guidelines is typically referred to as social norms and taboos: these norms and taboos have a huge effect on our lives.⁷⁹

79 Fershtman C et al. 2011, 'Taboos and Identity: Considering the Unthinkable' *American Economic Journal: Microeconomics* 3: 139–164, p139

With a gender taboo, danger and curse is associated with one gender (often but not always female) encroaching on the territory of what is deemed to belong rightfully to the other gender. While anthropological explanations tend to describe how taboos reinforce gender divisions, in order to maintain and explain the structure of society, sociological accounts emphasise the role that taboos play as a form of social control.

It is instructive to look at an example of a place where danger and curse are associated with the transgression of a gender taboo. Among many Amazonian tribes, women are punished by gang rape or even death, for viewing the sacred paraphernalia reserved for men.⁸⁰ In particular, in the Vaupés region of the Colombian and Brazilian northwest Amazon, women are strictly kept away from the Yurupary instruments – sacred trumpets and flutes – as well as the rituals and knowledge of mythology and shamanism associated with them. Women's exclusion from their society's most powerful symbols and the understanding of how life works, which is wrapped up in their meaning, keeps women in a subordinate position.

This extreme version of a gender taboo provides an important clue as to how women's historical exclusion from maths and science might have been maintained over past centuries as well as the legacy of fear and anxiety which remains today. First, it is important to realise the extent to which maths (and science and physics) were historically associated both with power and with the sacred, and to reiterate that the association of maths with power is as strong as ever. In short, those with access to mathematics also have access to the levers of power within society.

Women's exclusion from their society's most powerful symbols and the understanding of how life works, which is wrapped up in their meaning, keeps women in a subordinate position.

In her book, *Pythagoras' Trousers*, Margaret Wertheim describes how the public institutions of our society continue to uphold and promote the physicist's mathematical world-view and that both natural and social scientists increasingly explain how the world works by employing the language and concepts of mathematics.⁸¹ To return to the theme of earlier chapters, this is why today's politicians are so correctly insistent that STEM subjects have utility throughout life and should be studied for as long as is necessary in our education system.

What has not as yet been discussed is how religion and a mathematical understanding of the world became deeply intertwined many centuries ago, when mathematics was seen as a study of the divinely ordained rules governing the universe. Although history is littered with important exceptions of powerful female individuals and religious orders led by women, mainstream religion in the West was dominated by men.

80 Bamberger, J, *The Myth of Matriarchy: Why Men Rule in Primitive Society* available at http://radicalanthropologygroup.org/sites/default/files/pdf/class_text_052.pdf. See also *The Encyclopedia of Religion*, second edition, entry 'Yurupary' p9919

81 Wertheim M, 1997, *Pythagoras's Trousers: God, Physics, and the Gender War*, W.W. Norton & Company

That domination was reinforced and underwritten by the assumption that male brainpower and men's ability to understand how the world worked was innately superior, *by divine design* – and therefore maths belonged in a man's world.⁸²

For example, Wertheim describes how the strong link between Newtonianism and religion in eighteenth century England became a key factor in the perpetuation of a 'priestly' view of the scientist, and how such religious overtones made the 'new' maths and science opened up by Newton's discoveries inhospitable to women's involvement. England did not just head the international league table in science but also held the less auspicious prize of being the world leader, 'in denying women a place within the formal community of science'.⁸³

When Wertheim claims that 'the age-old link between physics and religion has set up powerful psychological and cultural resonances in our society that continue to serve as a barrier to women',⁸⁴ it does not seem fanciful to hypothesise that these resonances might have included anxiety and fear of maths, and so created a barrier that is particularly disempowering and hard to surmount. The theological underpinning to the social norm that men 'did' maths and women 'did not' would have made the concept of the mathematical women seem *unnatural* and even taboo. As stated earlier, danger and curse are associated with the transgression of gender taboos.

The age-old link between physics and religion has set up powerful psychological and cultural resonances in our society that continue to serve as a barrier to women.⁸⁵

A rare mathematical woman of the fourth century, Hypatia of Alexandria, endured a particularly brutal martyr's death when she refused to abandon the Neoplatonic movement and convert to Christianity. Although this has to be seen in the context of the wider backlash against Neoplatonism, it is likely that her death has been given a particularly noteworthy place in history because she was a woman who wrote pioneering mathematical texts.

History does not record that such atrocities befell Hypatia's successors, although it does pay tribute to the exemplars who took up her mantle of 'Mathematical Woman' throughout every century. Yet by looking through an anthropological lens at how taboos operate and are upheld, the viciousness of her murder takes on a more sinister perspective when seen alongside her prowess in maths, which was so unusual in her sex. The act sounded a subconscious warning to any women who might want to emulate her; the implication of this report is that its echoes can still be heard today.

82 In the fourteenth century for example, the medieval church had about 600 monastic institutions widely spread over Britain and interestingly one author describes how 'Among the monks appeared some of the best brains of the period, *often with a genius for finance*,' (my emphasis): Hartley D, 1979, *The Land of England*, Macdonald

83 Wertheim 1997, *op cit*, p133

84 *Ibid*, pxxv

85 *Ibid*

Similarly the dictates of religious orthodoxy would have had a powerful deterrent effect on the vast majority of female society. Given that at certain points in our society's past, the whiff of heresy or suspicion of witchcraft was sufficient grounds to imprison – or even execute – allegedly deviant individuals, it is reasonable to assume that women's religiously inspired exclusion from maths would have been implicitly hedged around with the fearful dread typically associated with taboo.

Quite simply, the taboo's powerful yet implicitly communicated message was that the female sex was defying God's natural order of life by attempting to access the keys to truth and the meaning of life that are contained within mathematics and science. 'Defying the natural order' is synonymous with entering highly dangerous territory, and associated with punishment and other dire consequence. This taboo would have had the desired effect on the majority of women by keeping them well away from man's 'rightful domain'.

England did not only head the international league table in science, but also held the less auspicious prize of being the world leader 'in denying women a place within the formal community of science'.⁸⁶

Unfortunately, it is very hard to dismiss fears that have been embedded at the level of deep culture, even when they begin to hinder the functioning of a society and clash with new values, as is today the case. These fears need to be unearthed to expose their lack of foundation in objective reality. The high prevalence of Maths Anxiety in the female sex can only be to the detriment of British society. To rebut the assumption that there is a biological underpinning to lower attainment in girls, it needs to be accompanied by an acknowledgement that there was, historically, a deliberate strategy to keep women away from developing prowess in maths and science.

The next two chapters examines how women were educated in British history, in order to provide evidence of this exclusion, and also to examine the ways in which females were, in the main, kept away from financial decision-making and control.

86 Wertheim 1997, *op cit*, p133

chapter five

Being female

5.1 Introduction

The last chapter argued that men's monopoly over maths was fundamental to their controlling the levers of power within society. The following two chapters reinforce this thesis. To introduce the content of each in reverse order, Chapter Six gives a brief overview of the history of female education and the place of maths within it, in England up to and a little beyond the Education Reform Acts of the late Ninetenth and early 20th century.

Chapter Six looks particularly at ways in which girls' schooling patterns and curricula differed to those of their brothers, and it necessarily pays more attention to education for higher class girls and young women. The greater focus on the upper levels of society shows that a) the education of poor men and women was a very patchy affair, at primary and secondary level, until the intentions of the reforming Education Acts had been fully realised and b) this is where so much of the power in society lies.

The pattern and content of girls' education closely mirrors what it was considered appropriate for females to know, and how they were prepared for their future roles within society, so this chapter sets the scene by looking more generally at the status of women. As this report links Maths Anxiety with many women's lack of financial confidence, it is particularly concerned with evidence suggesting that women were frequently excluded from financial decision-making, beyond routine household management. If women were socialised to believe their femaleness and femininity 'naturally' precluded them from playing a legitimate role in money matters, this would help to explain the enduring assumption that, in general, men are more suited to understanding money: no woman wanted to be considered 'unfeminine'. This dread of being considered 'unfeminine' acted as a real deterrent to ordinary women who were otherwise willing to breach long-established barriers.

As we shall see, Chapter Five also gives part of the explanation as to why, in the past, women's education might have de-prioritised mathematics, because it was not deemed to be relevant to the kind of life they were expected to lead. It is an important contention of this paper that we are still feeling the effects of this historical lack today, and not only in the lower participation of women in STEM subjects, as described previously.

Although the expectation that women will be dependent on men waned considerably over the second half of the 20th century, the acquisition of the scholastic and practical skills required for women to be self-sufficient when handling their money was not given equal priority: a recent survey found that 95 per cent of women surveyed had not been taught in school how to manage personal finances.⁸⁷ The idea that mathematics should be taught in a functional way only began to gain ground in our education system (for either sex) since the turn of this century.

5.2 But what about all the women who hold the purse-strings?

Obviously there are many contemporary, as well as historical, exceptions to the generalisation that women do not tend to 'do money'. Women occupy a range of roles, including those at very senior levels, in banking and other branches of the finance industry – although there has never yet been a British female Chancellor of the Exchequer or Governor of the Bank of England. In many homes, women would say they are the one who does the accounts and makes sure the family lives within its means. However, *managing* money is not the same as *controlling* money, as the box makes clear.

'Research on money in the household makes a crucial distinction, drawn from industrial sociology, between exercising power or strategic control over household finances and financial management as an executive function. While the former involves the freedom to make major financial decisions and how much should be spent on collective domestic expenditure as opposed to personal spending money, the latter involves organising money and making ends meet on a day to day basis, within the constraints set by broader strategic decisions.'

'Managing and controlling money should therefore be thought of as two separate functions in which managing money is only likely to become a source of power when income is high enough to enable real decisions to be made about how to spend money and when the person responsible for managing money is also able to exercise some degree of control over broader strategic decisions...'⁸⁸

Qualitative research suggests that in households where money is tight, women tend to control finances so that they can enjoy peace of mind by ensuring the bills get paid and the needs of the family are met.⁸⁹ While many couples say that financial decisions are made jointly, survey research has shown that female-dominated decisions are more prevalent in homes with the lowest incomes.

Managing money is only likely to become a source of power when income is high enough to enable real decisions to be made about how to spend money.⁹⁰

87 Survey of 2000 people in May 2014 for Maths Action by THINKJAM

88 Vogler C et al, 2008, 'Money, power and spending decisions in intimate relationships,' *The Sociological Review*, 56:1

89 Goode J et al, 1998, *Purse or Wallet?* London: Policy Studies Institute; Rake K and Jayatilaka G, 2002, *Home Truths*, London: Fawcett Society

90 Vogler et al 2008, *op cit*

However *male*-dominated decisions are more frequently made in those with the highest incomes, where people are not just doing their best to stay solvent by the end of the month but also have responsibility for a significant level of discretionary income.⁹¹ So if, for example, there are investment decisions to be made within a household, it is more likely that the man would take them. As outlined below, a historical glance back to see which sex tended to control money, reveals that this contemporary pattern is consistent with the broad contours of the past.

5.3 The place of girls and women in the scheme of things

As stated earlier, the historical reasons that females received a very different education to their brothers become clearer when we consider attitudes towards women in general. While there is very limited space here to unpack a vast body of literature on the subject, the dominance of patriarchal attitudes is the indispensable starting point.

Kent, for example, explains how, during the seventeenth century, patriarchy was ingrained in the social and cultural structures of the day, and informed a broad range of culturally accepted standards.⁹² The assigned position of leadership of men and the typically subordinate, domestic role of women were supported by an array of institutions ranging from the natural sciences, to philosophy and politics, and these assumptions were also underpinned by religious authority and attitudes towards the family unit.⁹³ This produced a cultural system that laid the foundations for many assumptions about the innate strengths and weaknesses of both sexes.

Men's assigned position of leadership and women's typically subordinate, domestic role were supported by an array of institutions ranging from the natural sciences, to philosophy and politics and underpinned by religious authority...⁹⁴

As stated in the last chapter, within contemporary Britain, these facts have had significant repercussions for women and girls' engagement with mathematics. It is important to understand how women came to be trapped in a domestic mould, as this shaped historical expectations for the appropriate education of the female elite, which were starkly divergent from those concerning their male relatives.

5.3.1 Keeping it in the family

During the seventeenth century, the domestic household setting was the primary location for economic transactions, and these were principally carried out by men *and* women within the working and growing 'middle-ing' artisan classes. Kent notes, 'whether it be a farm or an

91 *Ibid*

92 Kent S, 1999, *Gender and Power in Britain, 1640–1900*, London: Routledge

93 *Ibid*; Davidoff L and Hall C, 1987, *Family Fortunes: Men and women of the English middle class 1780–1850*, London: Hutchinson

94 *Ibid*

artisanal workshop, work and family could not be separated from one another. The family economy characteristic of early modern society depended on the labour of all members of the household; marriage was above all an economic partnership.⁹⁵

This partnership was because the men and women of a family were bound together – usually within the nuclear family unit – primarily for economic survival; with the men working in the family field or workshop, women were in charge of all the household affairs. A woman's domestic duties included the management of whatever household cash income the family might raise, typically from the selling of whatever goods it could produce, such as fruits and vegetables or items made within the home workshop.⁹⁶

Families living and working within both an urban and a rural setting functioned on this basis, as did the gentry and aristocratic families. Women's involvement in economic management was typically cooperative with their male counterparts, in a concerted effort to maintain the family's fixed economic and social assets.⁹⁷

In her book on the first female pioneers of women's education, Jane Robinson paints a picture of the medieval and early Tudor period in England as one which bustled with businesswomen, tradeswomen and female estate managers.⁹⁸ Similarly, Trevelyan describes how the wife of the lord of the manor was often her husband's loyal lieutenant, who stood in for him when he left to fight for his king. Trevelyan also notes that on all levels of society, the organisation of the feeding and clothing of a family was a big administrative task for the wife, requiring forethought as well as action.⁹⁹

5.3.2 A creeping separateness and an evident asymmetry

The advance of capitalism took the form of the agricultural and industrial revolutions of the eighteenth and nineteenth century; this meant that, in the lower classes, the management of many small family-run businesses became unsustainable in the face of the growth of private business.¹⁰⁰ Consequently, this form of economic expansion resulted in substantial financial success among many from the emerging middle and established upper class families who managed estates, mills and factories.¹⁰¹

By the Victorian era, this economic process had led to the emergence of two separate spheres – the feminine home space and the masculine workspace. When the family unit lost its status as the primary site of economic production, wealthier women (those who were not forced into the factories or into doing piecework at home for large employers) remained within the

95 Kent 1999, *op cit*, p8

96 Erikson A, 2010, 'Marital status and economic activity: interpreting spinsters, wives, and widows in pre-census population listings,' *The Cambridge Group for the History of Population and Social Structure*

97 Kent 1999, *op cit*

98 Robinson J, 2010, *Bluestockings: The Remarkable Story of the First Women to Fight for an Education*, Penguin

99 Trevelyan GM, 1942, *Illustrated English social history volume 1*, Longmans, Green and co, pp66–7

100 Shaw-Taylor L (No date) 'The rise of agrarian capitalism and the decline of family farming in England'. *The Cambridge Group for the History of Population and Social Structure*; Bermingham A, 1997, 'Introduction: The Consumption of Culture', in Bermingham A and Brewer J (eds.) *The Consumption of Culture: 1600–1800*, Abingdon: Routledge, p1–22 p7; Higgs E, 1987, 'Women, Occupations and Work in the Nineteenth Century Censuses'. *History Workshop Journal*, 23(1), 59–80

101 Kent 1999, *op cit*

domestic setting and focused on its management. To do this well took considerable skill and a Victorian lady was expected to be a firm manager.¹⁰²

So by the beginning of the nineteenth century, women's orbit had moved away from the economic sphere which, as a consequence, became male-dominated.¹⁰³ This domination was further reinforced by particular cultural features of the time, such as the male practice of discussing business in their clubs which, before mass train travel, might have required a long and tough journey from the country to London.¹⁰⁴ By this time, learning and ingenuity were considered to be assets in men, but flaws in women who should 'under no circumstances... ever admit to intellectual curiosity.'¹⁰⁵

The concept of the lady of leisure increasingly became idealised; it spread further down society and became associated both with upward social mobility and femininity, as mentioned in Chapter Four and expanded below. Those who wanted to climb up the social ladder had to conform to this concept as well as to many other conventions, with the result that the ornamental importance of women increased (see box).

Apeing their betters

In the nineteenth century, as a result of the Industrial Revolution, the middle class grew rapidly. Factory owners, transporters, wholesalers, retailers and others who had the resourcefulness to exploit the opportunities presented, were able to make quite a lot of money fairly quickly. These 'nouveaux riches' were determined to gatecrash the upper levels of society, which required adopting the manners and lifestyle of what was called 'the Quality' or the Gentry. So the nouveaux riches copied what they observed to be aristocratic behaviour, and purchased the outward signs of, for example, 'a lady', but often without understanding the reasoning behind upper class behaviour, which usually only comes with being born and bred in this culture. The elite they tried to emulate, spitefully referred to this behaviour as 'apeing their betters'.

In a later era, this is well-illustrated by John Betjeman's cruelly funny poem *How to get on in Society*, in every line of which the nouveau riche woman betrays her lowly origins while trying to adopt the trappings of a higher class.¹⁰⁶

*Phone for the fish-knives, Norman
As Cook is a little unnerved;
You kiddies have crumpled the serviettes
And I must have things daintily served.*

In a gentleman's home it was considered vulgar to discuss money. Expenditure was controlled by the head of the household who was usually a man, and behind the scenes, meticulous accounts were kept, which might have been overseen by the lady of the house but not necessarily. However, to a nouveau riche woman pressing her nose up to the glass of this very different social world, 'ladies' seemed to have very little to do with money – except for their dress allowance, which might even have been

102 Hayward E, 1998, *Upstairs and Downstairs: Life in an English country house*, Pitkin Guides

103 Beaujot A, 2012, *Victorian Fashion Accessories*, London: Berg p1; Kent, 1999, *op cit*, p28; Foyster E, 2005, *Marital Violence: An English Family History, 1660–1857*, Cambridge: Cambridge University Press, p10

104 Hayward 1998, *op cit*

105 Robinson 2010, *op cit*, p10

106 Betjeman J, 1958, *Collected Poems*, London: John Murray, p203

set by their fathers as part of their dowry. Therefore it appears that no great knowledge of maths and money was needed by a woman, and indeed a lack of knowledge of maths might have sent the desired signal that she was well-bred.

There are plenty of references to this in the literature of the day. Elizabeth Gaskell's *Cranford*, for example, first published in 1851 and set 20 years earlier, describes a small-town society of ladies of reduced means – impoverished gentlefolk – born from 1770 onwards, so typically before the sweeping social changes made by the Industrial Revolution. Nearly all the considered decisions of these ladies related to money or class, and they all kept up a pretence not of being short of money, but of practising 'elegant economy'.

The narrator wrote that, 'We none of us spoke of money because that subject savoured of commerce and trade, and though some of us might be poor, we were all aristocratic.' The Misses Barker were financially comfortable but not entirely accepted by Cranford society as ladies, because the two sisters had been upper indoor servants, and had set up their milliner's shop with savings from their time as ladies' maids. However, it was accepted that the Barker place in the pecking order was above that of a farmer's wife. 'They would not sell their caps and ribbons to anyone without a pedigree. Many a farmer's wife or daughter turned away huffed... [The Misses Barker] only aped their betters in having nothing to do with the class immediately below theirs.'¹⁰⁷

Even though another character, Miss Matty, kept account books and locked them in her desk, when her bank failed and her financial adviser 'a capital man of business' explained her situation, the female narrator lengthily describes the ladies' humorous, female inability to understand anything of finance.

In summary, within the upper and middle echelons of Victorian society the idea firmly took hold that a woman who did not need to think about money was a 'lady'. In other words, a hallmark of social success was an insouciance towards and ignorance of the money and maths behind the financial security on which their status depended. Little was to change in this middle-class attitude until the time of the First World War.

Again there were notable exceptions: Florence Nightingale, the outstanding female icon of the late Victorian era, is best known for her insistence that nurses were trained for their duties in the Crimean War (1853–1856). She was also an accomplished mathematician who further battled against disease by using statistics to reform the Indian Health Service remotely, from her apartment in London.

By insisting that nurses were trained, Miss Nightingale opened the door to the concept that women should also be trained for other professions. The seed of an idea was planted and began to gain some acceptance; upper and middle class women, especially those who were unmarried, should be able to support themselves and make a contribution to society.¹⁰⁸ However, this was far from being a mainstream view, even after the First World War, as the next section makes clear:

Typically, for women who married in the Victorian era, there are many hints in literature and in the law, that they had very little financial or other freedom. Although Henrik Ibsen (1828–1906) was writing from a Norwegian perspective, the stage dialogue between Nora and her husband, Torvald, in *A Doll's House* (1879) would still have shocked a London

¹⁰⁷ Gaskell E, *Cranford*, 1944, London: JM Dent and sons (Last reprint) pp107–108

¹⁰⁸ Robinson, 2009, *op cit*; Trevelyan GM, 1942, *Illustrated English social history volume 4*, Longmans, Green and Co

audience by its honesty, and also by the accuracy of its commentary on the status of a well-born, married woman in British society:

Nora said,

I was simply transferred from papa's hands into yours. You arranged everything according to your own tasks and so I got the same tastes as you – or else I pretended to.

Further down the social pecking order, in *The Mayor of Casterbridge*, (published 1886) Hardy's eponymous main character, in a drunken rage, sells his wife and child to a passing sailor. His wife stays with the sailor for many years because she feels that he has bought a right in her and she has a duty to him, which highlights many women's acceptance of their chattel status. Should it be assumed that Hardy was merely using a literary device, James Brown's book on six hundred years of life in an English village, *Gamlingay*, finds evidence of wife sales held in the eighteenth and nineteenth century.¹⁰⁹

Before the Married Women's Property Act, passed in 1882, all the belongings and wealth of a woman automatically passed to her husband upon marriage, with the result that a wife who died before her husband had no need to make a will because any property she owned at her marriage had become the property of her husband.¹¹⁰ The Act, according to Trevelyan, 'released the wife, if she had money of her own from economic bondage to her husband'¹¹¹ (my emphasis, to highlight that this would have applied to only a tiny percentage of English women).

Despite this Act, Victorian marriage held many elements of unfairness for women, although for the great majority it represented their only chance of security, of having children and of attaining a respectable social status. This situation was to change very slowly and, arguably, a 1950s marriage was disconcertingly similar in many regards, as shall be seen.

5.3.3 Constructions of femininity

Certainly in the Victorian and Edwardian eras, financial survival for many women rested on being married and therefore 'kept' by a man, so being attractive to the opposite sex was very important: this meant complying with socially proscribed notions of femininity. Virginia Nicolson's book on female singlehood following the First World War (when competition to 'secure' a husband from the severely depleted stock of marriageable men was particularly intense) reveals how norms surrounding femininity – which still included being dependent on men – endured even after the massive social upheaval that the war brought in its wake.

Nicholson summed these up as follows: 'Wives must be younger, shorter and stupider than their husbands.'¹¹² Of course, many women refused to conform to such normative prescriptions, including the acclaimed writer, Vera Brittain, whose best-known book, *Testament of Youth*, became the 1979 television series and a recent film about her life; both follow Vera's

¹⁰⁹ Brown J, 1989, *Gamlingay: Six hundred years of life in an English village*, Cassell

¹¹⁰ Purvis 1991, *op cit*

¹¹¹ Trevelyan GM, 1942, *Illustrated English Social History*, volume 4, Longmans, Green and Co p91

¹¹² Nicolson V, 2008, *Singled Out*, Penguin, p64

life, as a battlefield nursing aide and, after the First World War ended, as a journalist and active pacifist, as progress changed the social landscape for women.

Even before the tumultuous events of the First World War, Vera wrote, 'It feels sad to be a woman, men seem to have so much more choice as to what they are intended for'.¹¹³ Marriage and motherhood were the sum total of her parents' ambitions for Vera. Secret study and a determination to go to Oxford set her at odds with her parents 'who had been brought up by their own forebears to regard young women as perpetually at the disposal of husbands and fathers.'¹¹⁴

However, in order for even the well-educated and highly talented Vera Brittain to live as a single woman by her pen, she needed an allowance from her father – in much the same way as the unmarried Jane Austen and her eighteenth century single heroines were also dependent on male relatives. In giving money to Vera for this purpose, her parents were quite enlightened for their time. They realised that after nursing at the battlefield in war-torn France, and then taking up her place at Oxford University when hostilities had ceased, Vera was not going to be able to settle back into her parents' home, in the way an unmarried daughter was still expected to. As Vera writes, 'my return to a position of subservient dependence at home would be intolerable both for them and for me'.¹¹⁵

But that insight for both parties had come partly through Vera's experience of her parents requiring exactly that subservience from her during the war. They had been struggling to cope with a lack of servants and the privations of life at home, and the socially acceptable response in such circumstances was to insist that their unmarried daughter return to help domestically, although she was carrying out vital war work; Vera's father reminded her that it was 'her duty'.

The lack of autonomy experienced by most single women rested on the fact that those who could not depend on a husband were forced to rely for financial and material support on their father, brothers, uncles or other male relative. Conforming to feminine norms was vital if a woman wanted to obtain the key to the front door of her own home and to have children. 'Knowing about science or mathematics did not enhance the featherbrain image these girls so carefully cultivated. It was essential not to frighten men off.'¹¹⁶

Knowing about science or mathematics did not enhance the featherbrain image these girls so carefully cultivated. It was essential not to frighten men off.¹¹⁷

Virginia Nicolson's later book on marriage in the 1950s makes it clear that these norms endured well into the mid 20th century and explain the tenacity of the 'smaller, younger and stupider' wife motif and its relevance for women's education.¹¹⁸

¹¹³ *Ibid* p31

¹¹⁴ Brittain V, 1980, *Testament of Youth*, London: Gollancz, p261 (3rd edn, first published 1933)

¹¹⁵ *Ibid*, p536

¹¹⁶ Nicolson 2008, *op cit*, p11

¹¹⁷ *Ibid*

¹¹⁸ Nicolson V, 2015, *Perfect Wives in Ideal Homes: The Story of Women in the 1950s*, Viking

The lyrics of a popular song from the late 1940s musical, *Annie Get Your Gun*, illustrates the 'smaller' aspect; in Irving Berlin's song 'The girl I call my own' '... will wear satins and laces and smell of cologne... a doll I can carry, the girl that I marry must be' (my emphasis). Similarly, the renowned film producer Nora Ephron who was a girl in the 1950s later wrote, 'I wanted more than anything to be something I will never be – feminine, and feminine in the worst way. Submissive. Dependent. Soft-spoken. Coquettish. I was no good at all at any of it, no good at being a girl; on the other hand I am not half bad at being a woman.'¹¹⁹

When newspaper *Agony Aunt Marjorie Proops* took a sample of husbands' preferences, she found the majority were emphatically opposed to being married to a brainy (university graduate) woman. Understandably, many women perceived that spending one's youth getting highly educated would be incompatible with being feminine and attractive to the opposite sex.¹²⁰

Research on women who went to university¹²¹ found that once women married – and especially once they had children – over half of them became entirely dependent on their husband's earnings; although only 15 per cent did not expect to work again in the future no data exists on those who were able to realise an ambition to pick up the threads of career again.

A doll I can carry, the girl that I marry must be.¹²²

Any female incursion into male-dominated spheres of work was likely to be met with veiled if not outright derision: Nicolson recounts the 'jovial tone' of newscasters describing women doing work typically done by men, and she interprets this humour as a device used to neutralise the threat that such activity represented. Girls also self-excluded from certain professions because of perceptions of what was and wasn't feminine. '[They] thought that in engineering their fingernails would be broken, their stockings would be laddered, their hair would be covered in grease and their faces would be black with smuts.'¹²³

Finally, women were fortunate if they were even allowed to train for such professions. Radio 4's *Farming Today* programme recently carried a personal testimony from a former land-girl, who had been so inspired by her experiences during the Second World War that she went on to study agriculture at university. However she describes the palpable reluctance to teach women about animal husbandry, 'because male lecturers feared embarrassment'; this meant that a degree in agriculture could still leave women graduates lacking in essential knowledge and at a disadvantage alongside their male peers when – and if – they obtained posts in the farming industry.¹²⁴

¹¹⁹ Ephron N, 2013, *The Most of Nora Ephron*, Knopf Publishing Group, p111

¹²⁰ Nicolson 2015, *op cit*

¹²¹ Hubback J, 1957, *Wives who went to College*, Heinemann (see Nicolson V, *op cit*, p190)

¹²² Irving Berlin's 'The girl I call my own' (from *Annie Get Your Gun*)

¹²³ Nicolson 2015, *op cit*, pp273–4

¹²⁴ Radio 4, *Farming Today*, 2 January 2015

5.3.4 Medical collusion with the femininity construct

To return to the link between femininity and women's reluctance to study seriously in general and to exert themselves to do maths in particular, this was reinforced by the medical profession and pseudoscientific opinion. Mathematics was considered too hard for women, or at least for the average woman; indeed the nineteenth century philosopher and sociologist, Herbert Spencer believed that female intellectual evolution had stopped at a stage before that of a man, in order to preserve vital organs for childbirth,¹²⁵ and the average female brain was thought to be 150g lighter than that of a man.¹²⁶

Professor Amanda Vickery recounts how, when women were enrolling for the first time at a British university in 1869 (in tiny numbers: the first vanguard was just five women), respectable medical opinion held that intellectual activity would disrupt a woman's menstrual cycle and might even destroy her fertility. Women's colleges were established against a backdrop of genuine concern that studying would warp or 'unsex' girl students.¹²⁷

Young women were told that if they studied too hard, they risked being unable to have children because their wombs would wither and die;¹²⁸ this further compounded the culturally transmitted message that learning made a girl unattractive to men and so reduced her all-important marriage prospects. There were even doubts in the minds of *female* educationalists as to whether they would have sufficient 'energy', as shall be shown in the next chapter.

5.4 Women's exclusion from power

In summary, it is hard to overstate the extent to which, historically, innate male superiority and female inferiority was taken for granted, and how it shaped social, emotional and political life. Indeed, Vickery firmly situates the early 20th century suffragette cause in this context: women were considered to lack both the intellect and education to have the vote, but then the male establishment had always restricted the access of women to proper education. This view of women's suitability to take an equal place in society had served to lock in patriarchal power structures that gave men – rich and poor – complete legal, political and physical control over the opposite sex for many centuries.

For Vickery, men did not want their supremacy threatened and they wanted women to remain subservient. They certainly did not want *interference* at either a personal or a political level. Equal status for women's education was therefore a deeply contested issue and a key battleground in which the status quo needed to be overturned. The next chapter gives an overview of women's education as it was going through its most significant period of reform, to give an impression of the magnitude of the task facing those who championed change – and where they hesitated when it came to charging the gates that led to the world of maths.

¹²⁵ See 'Women's access to higher education: An overview (1860–1948)' at <http://herstoria.com/?p=535>

¹²⁶ Robinson 2010, *op cit*

¹²⁷ 'Suffragettes Forever! The story of women's power,' BBC documentary aired 4th and 11th March 2015

¹²⁸ Robinson 2010, *op cit*

chapter six

Women's education in history and the place of maths within it

6.1 Introduction

This chapter does not attempt to provide a detailed chronology or exhaustive history of advances in English education for women and girls, not least because several of these already exist in excellent books on the subject, or web-based resources.¹²⁹ So this chapter aims to draw together some key threads from these publications, to paint a sketch of a culturally-determined approach to female education; in the main this reproduces, for one generation of girls after another, the assumption that a rigorous intellectual training was not appropriate for their development, or necessary for their future lives. Given this starting point, it is hardly surprising that maths lagged well behind other subjects in being added to a girls' curricula because it was considered to be particularly difficult and beyond both their understanding and the boundaries of what was acceptable for them to learn.

Prior to the late nineteenth century, the works of respected authors of social history contain so little proof of female education that this is strongly suggestive of its general lack.

I shall start with four broad observations. First, in the literature review conducted, there is a general consensus that the lack of formal education for girls seems to have been raised as an issue in the late eighteenth century;¹³⁰ prior to this, the works of respected authors of social history contain so little proof of female education that this is strongly suggestive of its general

¹²⁹ See for example Purvis, 1991, *op cit* and IOE Archives Subject Guide No 7, available at: [http://www.ioe.ac.uk/services/documents/SG7_Women_and_education_web_\(Oct_2009\).pdf](http://www.ioe.ac.uk/services/documents/SG7_Women_and_education_web_(Oct_2009).pdf)

¹³⁰ Brown R, 2011, Education of girls 1800–1870: revised version available at <http://richardjohnbr.blogspot.co.uk/2011/02/educating-girls-1800-1870-revised.html>

lack.¹³¹ For example, the sections in Trevelyan's *Illustrated Social History*, Volume 1, on fifteenth century education, concerned only boys' education, where he reveals that 'the poor' who benefited from schools founded by rich merchants were not those from the labouring classes but for those in the lower middle class, the sons of yeomen, burghers and the 'small gentry'.

Similarly in Volume 2, Trevelyan describes the Elizabethan grammar school as the typical unit of English education and explains that, 'A gentleman would finish his education at one of the universities and he usually learned Latin, some Greek and a varying measure of mathematical and philosophical acquirements'. Trevelyan also tells us that, 'The mass of people were illiterate or half-taught to read by village dames'.¹³²

This information is relevant because of the second observation which concerns the strongly class-based nature of British education for both sexes, in comparison, for example, with the United States. A public school system based on a common education for all its (white) citizens was being instituted in the US by the 1830s,¹³³ whereas England's education system was at that point – and enduringly – divided not just by gender but also according to its class structure. Gillard points out that three national education commissions in the second half of the nineteenth century – and the legislation which took up their recommendations – reinforced these divisions by focusing their work on provision for a particular social class.¹³⁴

Girls' education, to the extent that it even existed, depended greatly on their class: secondary education was largely unavailable to working class girls in the nineteenth century although better-off girls were taught at home by often ill-educated governesses¹³⁵ or attended small academies and private secondary girls' schools. Certainly there were only a dozen public secondary schools for girls recorded in the 1864 Schools Enquiry Commission for England and Wales.¹³⁶

My third observation concerns the nineteenth century general idea of suitable education. As Purvis explains in her history of women's education in England, the prevailing idea was that it should fit children for the position in life which they were meant to occupy.¹³⁷ So, given what was said in the previous chapter, it is not particularly surprising that girls were less well educated than boys. Hadow observes, 'In general it may safely be said that the traditional education for girls up to about 1845 accentuated the differences between the sexes'.¹³⁸ It was not considered necessary for girls to be able to do more, academically, than master the three Rs and develop domestic skills, such as sewing.¹³⁹

131 I am grateful to Shirley Conran for her diligent review of over 50 books of British social history and key novels of the period which provide useful informal background information to the norms of the day.

132 Trevelyan GM, 1942, *Illustrated English social history volume 1*, London: Longmans Green and Co, p41

133 Gillard D, 2011, *Education in England: A Brief History of our Schools*, available at <http://www.educationengland.org.uk/history/index.html>

134 The Clarendon Report of 1864, the Taunton Report of 1868 and the Newcastle Report of 1861 focused on the elite (the nine 'great' public schools), the middle classes and the masses respectively, with finer gradations within the middle classes provided for in a system of separate schools by Taunton.

135 Hayward E, 1998, *Upstairs and Downstairs: Life in an English country house*, Pitkin Guides

136 IOE Archives Subject Guide No 7, *op cit*

137 Purvis J, 1991, *A history of women's education in England*. Milton Keynes: Open University Press

138 The Hadow Report, 1923, *Differentiation of the Curriculum for Boys and Girls Respectively in Secondary Schools* p23, available at <http://www.educationengland.org.uk/documents/hadow1923/hadow1923.html>

139 Brown 2011, *op cit*

During this century, for those on middle and upper incomes, the home setting was seen as the school intended by Nature for a girl, hence the employment of governesses to educate girls, although their brothers went away to school. Mastering accomplishments that would attract a husband was considered to be an indispensable priority.¹⁴⁰ Similarly, many people held the view that girls from poorer households should be only be taught what was useful for their future – domestic labour.

This view was still apparent after the First World War, when a Government enquiry was set up to look into the effects of women being employed on war work, on the Domestic Service Problem. This enquiry called upon Local Education Authorities to set up domestic service schools, to train girls between the ages of 14–16. The recommendation was that they spend two thirds of their time on domestic subjects and the remainders on general education, including elementary hygiene and care of the body: obviously, this left very little time to master maths.

Whatever social class girls came from, the official view was that the education they received should keep them in their subordinate place in the social order, rather than provide a runway out of it; this view was diligently upheld by many of their husbands and fathers,¹⁴¹ which brings me to my fourth broad point.

Many people blame a patriarchal culture for the inferior education that English women received until fairly recently. However, that same patriarchal culture dictated the attitudes of men. It is important not to accuse all those husbands and fathers of maliciously holding back their wives and daughters. The opportunities women would have enjoyed if the underlying assumptions that society lived by had, instead, been supportive of gender equality, would obviously have been very different. Given their situation, many male relatives must have felt they were doing their best for the women in their lives, towards whom they would probably have felt strongly protective instincts.

Successful women whose education was not encouraged by their highly educated, male relatives...

Baroness Anne Jenkin vividly remembers that her father, the grandson of the Nobel Prize winning physicist, Lord Rayleigh, had no ambition for her education and would tell her 'Be good sweet maid, and let who will be clever'. She told me, 'He wasn't sexist, he was just a man of his time.' And she did not go to university. 'But it is somewhat ironic that my father's other grandfather, Sir Willoughby Dickinson, introduced the first Bill in the House of Commons for women's suffrage; and his daughter – my grandmother – was Mimi Davidson, who was the only Conservative woman elected in 1945.'¹⁴²

¹⁴⁰ Purvis 1991, *op cit*

¹⁴¹ Purvis 1991 *op cit*

¹⁴² Private conversation with the author

... and mothers did not argue for their daughters' equal treatment

Jessica Mitford, in her book about her extraordinary and influential family, reveals how her mother personally oversaw the education of her six daughters, and taught them herself until they were eight or nine. 'Thereafter we entered the schoolroom, presided over by a fast-moving series of governesses.' Although elsewhere in the 1920s, the fight for equal education may have raged, 'no hint of these controversies reached us... [her only brother] Tom of course, had been sent away to school at the age of eight and thence to Eton; but my mother felt that school for girls was unnecessary, probably harmful and certainly too expensive.'¹⁴³

Mitford describes how she and some of her sisters 'longed passionately to go to school. The warm, bright vision of... learning all sorts of fascinating things, dominated my thoughts for years. But no argument would move my mother on this point. The older children, with the exception of Pam, had all in turn begged to go... "I want to go to university when I grow up," I insisted.'¹⁴⁴ The answer always came back that when Jessica was grown up she could do so, yet there was no recognition that without the same quality of education as her brother had received, the university doors were unlikely to open for her.

Instead, her mother was firmly wedded to the idea that education should prepare women to run their own home well and serve their community and country according to their husband's station in life. Therefore simple arithmetic, rather than maths, would suffice. For a girl, marriage 'provided the satisfying and constructive framework upon which a life and future could be built.'¹⁴⁵

The behaviour of social actors may or may not be determined by the structural constraints of their society because the same actors may or may not have the power to act independently, so may not necessarily be to blame if they collude in structural inequalities. Leaving aside well-rehearsed arguments about such tensions between structure and agency, we can say that some men were sufficiently enlightened, for their time, to educate their daughters properly: that is, with the same rigour and in the same subjects as their sons.

The corollary of this is that the vast majority of men went with the tide of opinion that to so educate girls was highly inappropriate. The evidence presented here suggests that this approach had an enduring and profoundly negative effect on females. To remedy this problem requires the recognition by today's men that the greater prevalence of Maths Anxiety in girls and women, than in boys and men, may well be a remnant of patriarchy. As such, to address it will require a similar intolerance to its perpetuation as majority opinion demonstrates towards violence against women and girls – or any other manifestation of male oppression.

The next section looks more closely at a particularly important period for the growth and development of female education and examines how well the teaching of maths fared while the rest of female education was being reformed because, as Purvis points out at the beginning of her book on the history of women's education, 'the present is the product of the past'.¹⁴⁶

¹⁴³ Mitford J, 1960, *Hons and Rebels*, Weidenfeld and Nicolson, p17; other authors also report the view that educating daughters was a waste of time: see Murray V, 1998, *High Society: a social history of the Regency Period, 1788–1830*, Penguin, p237

¹⁴⁴ Mitford 1960, *op cit*, p34

¹⁴⁵ *Ibid*, p99

¹⁴⁶ Purvis 1991, *op cit*, pxiv

As I have argued elsewhere, however forceful and persuasive the rhetoric and emphasis of current and fairly recent initiatives to increase female participation in STEM subjects, these are at odds with the deeply-rooted assumptions that many in society live by. Understanding and acknowledging the enduring power of these cultural facets, and the fear associated with them – requires the exposure of these roots, which are discernible in the literature of the day and the social history of the period.

6.2 The education of girls: from its earliest manifestations to the end of the nineteenth century

Although women could sometimes obtain an education by entering a religious order, outside the walls of convents it appears there was no system of formal female education until the late sixteenth century by which point – and only occasionally – personal tutors were engaged by enlightened and prosperous fathers.¹⁴⁷ The entrepreneurial medieval and Tudor women described in the last chapter had picked up enough literacy and numeracy for their needs within the family.¹⁴⁸

The seventeenth century saw the beginning of girls' schools in England; some were run by religious orders (without the need for girls to become members) and other schools were run by charities or private providers. Whatever form the curriculum took, it usually differed greatly to that of boys. Maths gets no mention and there seemed to be little variety beyond a staple diet of sewing or embroidery, reading and writing.

6.2.1 Bathsua Makin takes on all-comers against women's education

Early voices of dissent against this educational apartheid were beginning to be heard – and they laid the blame at the door of the male sex. Bathsua Makin who lived from around 1600 to 1676 was a rare and exceptionally good female classicist who had been taught in her father's school and who, in spite of her own many children, founded schools for girls and for boys. In 1673, Bathsua published *Essay to Revive the Antient Education of Gentlewomen* to spell out why girls' education was so poor, and to rebut orthodox opinion which was against improvement. In her essay, Bathsua referred scathingly to the overwhelming force marshalled against her thesis as 'men's Lust, Pride and Pleasure; especially those that desire to keep them ignorant to be tyrannized over'.¹⁴⁹

Robinson itemises the reasons proffered in Bathsua's *Essay* for not investing in women's minds, and focusing almost exclusively on their femininity, particularly their appearance and prowess on the dance floor. Interestingly, Makin does not wholly dismiss the merits of needlework and looking 'comely and decent'; she did not reject so-called feminine pursuits but urged that they be supplemented.

¹⁴⁷ Robinson 2010, *op cit*

¹⁴⁸ *Ibid*

¹⁴⁹ See Bathsua Makin's *Essay* and rebuttal to objections to it at: <http://digital.library.upenn.edu/women/makin/education/education.html>

First, Makin deals with the accepted wisdom that no one will want to marry an educated woman because she will show a man up for his ignorance. She attacks the double standard of men wanting an education for themselves but not for their wives, as well as their short-sightedness in not doing what they can to ensure their own children will be born to mothers able to teach them.

Second, the fear that education would make women vain was swatted away by pointing out that the deeper their understanding, the less likely they were to be smug and self-satisfied. Moreover, 'women, like men, can be clever and humble, wise and virtuous.' Third – and fascinating for the insights it brings of the period – as women cannot hold public office, what is the point educating them? If they are educated, answered Makin, they will influence society through their husbands.

Fourth, what will happen to the domestic front if the minds of women are consumed with what they have learned? Again, it was argued, men hold down jobs in spite of all the knowledge they have crammed into their heads through education. Fifth, some girls might not want to learn –but again, 'show me a schoolboy who does'.¹⁵⁰

Finally, how will the school system cope? No problem there; Makin had the blueprint for reform, and her essay finished with an advertisement for her school in Tottenham High Cross in London. Her school gave girls a far more extensive educational grounding than anything else that was available. As well as the basic principles of religion, needlework, some dancing and musical appreciation, culinary skills and writing, girls also learned book-keeping skills – early signs of a functional approach to maths – modern and ancient languages, astronomy, geography and philosophy.

Men's Lust, Pride and Pleasure; especially those that desire to keep [women] ignorant to be tyrannized over.¹⁵¹

6.2.2 Women's education – finally on the agenda

The truly reforming potential of any idea is only realised when it is scaled up, and this did not happen to women's education, although it began to receive significant public attention: Trevelyan records that in the eighteenth century,

*'The want of education in the sex was discussed as an admitted fact, one side defending it as necessary in order to keep wives in due subjection, while the other side, led by the chief literary men of the day, ascribed the frivolity and the gambling habits of ladies of fashion to an upbringing which debarred them from more serious interests.'*¹⁵²

¹⁵⁰ Robinson 2010, p10 *op cit*

¹⁵¹ See Bathsua Makin's Essay and rebuttal to objections to it at: <http://digital.library.upenn.edu/women/makin/education/education.html>

¹⁵² Trevelyan GM, 1942, *Illustrated English social history volume 3*, London: Longmans Green and Co, p19

Yet at the end of that century, Mary Wollstonecraft still had to plead for women's minds to be taken seriously, for the good of society. Her seminal book, *Vindication of the Rights of Woman*, published in 1792 (after an earlier book, *Thoughts on the Education of Daughters*) has been seen as the beginning of the campaign to secure good education for girls and to link the issue with broader feminist thinking.¹⁵³ *Vindication* argued that if women's minds were properly developed, their souls would prosper too, as would those of men. Indeed, unless the moral fibre of women was improved through education, 'the virtue of man will be worm-eaten by the insect whom he keeps under his feet'.¹⁵⁴

6.2.3 Governing the governesses

Half a century later, a movement for better education for girls and women began, with the foundation of the Governesses Benevolent Institution in 1843; this aimed to provide a system of examinations and certificates for governesses, and it was sorely needed. In 1851, there was a sizeable workforce of 25,000 governesses in England, the vast majority of whom would have had no proper teacher training; often, they were barely educated themselves, had very little security of tenure and certainly no pension.¹⁵⁵

The secondary education of girls was very ill provided for. They were sacrificed to pay for the expensive education of their brothers.¹⁵⁶

Queen's College in Harley St opened in 1848 and this was where the leaders of the movement, such as Rev FD Maurice, adopted the traditional boys' curriculum and started to teach it to women. The list of subjects published in 1849 is: English, French, Latin, Italian, History, Geography, Natural Philosophy, Methods of Teaching, Theology, Vocal Music Harmony, Fine Arts and Mathematics.¹⁵⁷

That slender vanguard of girls who received instruction in all those subjects would have had a far better education than many girls growing up in the social elite. Harcup describes how some girls learned only reading, writing, Scripture and embroidery, and had no formal grounding in literature, science (which I assume included mathematics) or politics.

Moreover girls were rarely given instruction to prepare them to be able to do anything practical for themselves. Harcup gives an intriguing account of the daughter of a Scottish duke who had no idea how to sew a button on her father's coat, and was taught how to do this by one of Queen Victoria's daughters, who married her brother.¹⁵⁸

¹⁵³ Brown 2011, *op cit* and Robinson 2010, *op cit*

¹⁵⁴ Robinson 2010, p9–10 *op cit*

¹⁵⁵ Gillard 2011, *op cit*, Brown 2011, *op cit*

¹⁵⁶ Trevelyan GM, 1942, *Illustrated English social history volume 4*, Longmans, Green and Co p58

¹⁵⁷ Gillard 2011, *op cit*

¹⁵⁸ Harcup A, 1982, *Children of the Great Country Houses*, Sidgwick and Jackson Ltd, p59

6.2.4 Second rate secondary education

Around the middle of the century, 'the secondary education of girls was very ill provided for. They were sacrificed to pay for the expensive education of their brothers.'¹⁵⁹ In 1851, female literacy rates stood at only 55 per cent compared to nearly 70 per cent for males.¹⁶⁰ The 1868 Taunton Commission was concerned because there were only 13 girls' secondary schools in the whole of England and 'the picture brought before us of the state of Middle Class Female Education is, on the whole, unfavourable... there is a want of thoroughness and foundation; want of system; slovenliness and showy superficiality; inattention to rudiments; undue time given to accomplishments, and those not taught intelligently or in any scientific manner...' In such contexts, mathematical skills were unlikely to be well taught.

Disappointingly, the Commission created by the Endowed Schools Act, which followed the Taunton Report, was charged in legislation with extending the benefits of educational endowments to girls only 'as far as conveniently may be.' It was left to other educational reformers in the remaining decades of the nineteenth century to take up the cudgels for the women's cause. For example, in 1871 the National Union for the Improvement of the Education of Women of all Classes was founded to champion the foundation of affordable day schools for girls, and improve the status and training of women teachers.

40 years later, the rightful status of maths in girls' education could still not be taken for granted. Even the most ardent champions of education for girls, such as Sara Burstall (who studied maths at Girton College and become Headmistress of Manchester High School for Girls), were uncertain as to the merits of the mainstream teaching of maths to girls. In 1912 Burstall voiced her concern that teaching maths to girls took too much effort for too little return: 'We ought to recognise that the average girl has a natural disability for Mathematics. One cause may be that she has less vital energy to spare...'¹⁶¹ This reflects pseudoscientific views referred to earlier, which assumed that strenuous 'brain work' would divert energy from women's reproductive systems.

We ought to recognise that the average girl has a natural disability for Mathematics. One cause may be that she has less vital energy to spare.¹⁶²

6.2.5 The effect of unreformed attitudes towards maths

Unsurprisingly, the lives and attitudes of women emerging from that period demonstrate that Sarah Burstall's statement was a self-fulfilling prophecy. The literature review highlighted the extent to which attitudes to young women, money and maths had remained largely unchanged

¹⁵⁹ Trevelyan 1942, volume 4, *op cit*, p58

¹⁶⁰ Brown 2011, *op cit*

¹⁶¹ See 'Women's access to higher education: An overview (1860–1948)' at: <http://herstoria.com/?p=535>

¹⁶² *Ibid*

by 1930 when EM (Elizabeth) Delafield published her *Diary of a Provincial Lady*.¹⁶³ Elizabeth was born in 1890, 'came out' into society as a debutante in 1909 and became a nursing aide – a VAD – shortly after war broke out in 1914.

Later, Elizabeth settled down to a happily married, middle-class life in Devon and wrote over 30 books, so she was an accomplished woman, and her diary is an early recorded example of a woman juggling husband, children and a career. Her diary starts in late 1920s Britain and, with the quintessentially British penchant for self-deprecation, it is full of cheerful disclosures about her housewifely imperfections, her passion for hats and the endless bewilderment of her and her friends by their bank statements and overdrafts. Thousands of middle-class readers identified with her life and laughed in recognition.

What becomes clear is that Elizabeth, and countless others like her, could not balance their chequebooks or read their own bank statements, and only knew they had completely depleted their accounts when the bank manager wrote to inform them. Elizabeth wrote of evenings spent 'trying to reconcile grave discrepancy between account book, counterfoils of chequebook and rather unsympathetically worded communication from the Bank.'¹⁶⁴

This was not just a minor blip, a difficulty she was able to overcome in early married life, but something that dogged her and her friends for at least a decade and showed no signs of improving. In 1940 when Britain was again at war, she writes to her friend, Felicity, and enquires about the unfortunate state of her overdraft. We hear subsequently, that Felicity's bank account is still a mystery to her and that, very strangely, whenever she pays anything into her bank, the overdraft *never* gets any smaller.

Felicity's brother had explained it, but still she couldn't understand it... Elizabeth wrote,

*it was just that Felicity hasn't got that kind of a mind... Sympathise with her once more, admit – what she has known perfectly well since long-ago schooldays – that I haven't got that kind of mind either, and enquire what Veronica feels about it all... Veronica thinks it's dreadful and most depressing, and wouldn't it cheer us both up to go out shopping?*¹⁶⁵

It is likely that these women received the best education available for their sex at the time yet the seed was sown, from the outset, that for women in general – certainly for these three in particular – maths and maths-related skills to make their lives work, were somehow beyond their reach. It is clearly not considered shameful for Delafield to admit her inability, and there is no suggestion that remedial action should be taken, just a resigned and cheerful acceptance of the indisputable fact that women's minds are disadvantaged when it comes to being able to master maths.

¹⁶³ Delafield EM, 1930, *Diary of a Provincial Lady*, Penguin

¹⁶⁴ *Ibid*, p74

¹⁶⁵ *Ibid* p531

6.3 Has anything really changed?

When I ask my own highly-educated women friends who are not mathematicians, if they fear maths, they almost always go into full disclosure mode. One successful professional who won a first class degree from Oxbridge, told me how much she hates doing her tax return because she doesn't feel 'very at home' with figures. Another, a seasoned parliamentarian, said that when she retires she wants to do a maths course because she didn't like feeling so bemused by it all.

Perhaps most poignantly, when an older friend who had been comfortably off and a towering figure in the community was suddenly widowed, she appeared palpably insecure when it came to spending any money, even though her husband had left her a large sum of money – 'Jerry used to do all our finances, I can't get my head around it, perhaps one day I will have the energy.'

Today, many older women in this position, living on their own after their husband has died, feel incapable of understanding of their finances and unsure of where they stand. Long after the grief of losing their partner has begun to fade a little, these women still feel – just as sharply – the loss of having a man around who could do the money and make them feel 'taken care of'.

6.4 Conclusion

There have been notable exceptions,¹⁶⁶ but from a historical perspective the education that women received in this country did not equip them to fulfil their potential in maths or to understand money, to the extent that they feel confident and able to manage their financial affairs well.

As stated in an earlier chapter, international statistics demonstrate that there is no gap between the performance of girls and boys in maths in other OECD countries. The PISA findings and new research on how the brain works, profoundly challenge assumptions that differences between men's and women's brains necessarily translate into differences in maths ability. It is time for a more concerted approach to tackling Maths Anxiety, particularly in girls and women and this is the focus of the final chapter.

¹⁶⁶ Such as Philippa Fawcett of Newnham College who beat the top male student in the Cambridge mathematics tripos in 1890 but was not, because of her sex, eligible to receive a degree; Augusta Ada Byron King, Countess of Lovelace and daughter of Lord Byron, who is remembered as the first female computer programmer; and of course Florence Nightingale who has already been mentioned.

chapter seven

Attacking the Maths Myth that drives the Fear Factor

The thesis of this report is that, to put it bluntly, the British male establishment kept women away from learning maths and science because it perceived such a strategy would enable men to maintain their hold on the keys to understanding how the world worked and so keep women in a subservient position.

It is my view that the taboos which were hedged around the learning of maths (and science) by the religious systems of the time, were deeply patriarchal, as was the rest of society, and are at the root of the far greater prevalence today of the fear of maths in females than in males. Taboos engender and rely on fear to maintain the boundary they were set up to protect. The purpose of these taboos was to retain male monopoly on power. While much has changed in society to improve gender equality, the enduring effect of the Maths Taboo has been to undermine women's confidence in their ability to master STEM subjects and so also to fulfil their potential.

While many of the injustices of patriarchy have been identified and addressed, this is not one of them. It would be wrong to airbrush it out of our social history or sweep it under the carpet on the grounds that everyone is aware of it and society has moved on; neither of these are the case. As long as the cultural roots of girls' poorer performance in maths than boys, which leads to unequal participation in the workplace, remain unacknowledged, many mothers will continue, inadvertently, to pass on their fear of maths to their daughters, as will many female primary school teachers.

The Maths Myth is an artefact of a past age – although it still has powerful resonances in today's society; the majority of men will have a keen interest in consigning it properly to history.

As a consequence, many fathers will hold back from encouraging their daughters to believe that their attainment in maths can be boosted in the same way as in any other subject, due to these fathers' deep-seated worry that they might be pushing against an innate female weakness and so being too demanding. As good maths results in school exams can increase a daughter's eventual salary by £5,000 a year, it is doubtful that fathers will mind being disabused of the faulty assumptions that many of them are likely to hold.

As I inferred in the last chapter, what is not sought is a collective apology from men, because this approach is an artefact of a past age – although it still has powerful resonances in today's society; the majority of men will have a keen interest in consigning it properly to history. However, it needs to be acknowledged that in order to do so a change in the mindset and expectations of many men – and women – will be required.

As would be the case with any other sexist misconception, the myth that maths ability is an inherited trait, and one that boys are more likely to inherit than girls, needs to be publicly and carefully attacked and demolished. Institutions have a particularly important role to play because they represent the interests both of women and of a high-skilled economy.

So employers' organisations, trades unions and higher education institutions have enormous influence. Also, Oxford and Cambridge universities have, historically, both been particularly responsible for resisting the equal access of women to all learning, including maths. These institutions are all well-placed to set the record straight, and help reshape national expectations. Further research is greatly needed in this area.

This would be an excellent cause for individual parliamentarians to champion, and for the scrutiny of parliamentary committees and other public bodies. What is also needed is a visible, hard-hitting Government-backed campaign focused on this particular cause, which complements the excellent work of the youth-focused 'Your Life', which is part of the Equalities agenda.

Recommendations to dispel the Maths Myth

1. A high profile campaign is needed specifically to counteract the Maths Myth. This campaign, which would complement and reinforce 'Your Life', should unambiguously and directly address the root cause of disturbingly negative and fearful attitudes of many girls and women to maths. It needs to be strongly endorsed by the Government and have broad-based financial and other support from it and a range of organisations with an interest in ensuring that Britain has the necessary skills base to be internationally competitive, and that women in this country are no longer at a disadvantage in STEM subjects and careers.

A tightly-focused Commission needs to work with the Government to monitor the issue until it no longer exists.

The involvement of a successful advertising agency may be essential, one which is known for understanding women's anxieties and lack of self confidence, as well as the need to make the message appealing and unarguable to men. I also recommend the involvement of a small group of famous and respected men, particularly those from popular culture, sport and global philanthropy: women need male champions to convince men.

It is surely reasonable to expect a financial contribution from the Equalities budget and funds might also be raised from business and philanthropic sponsorship. This matter affects the whole of British society and all of society will benefit if this bias is eradicated. As such the issue falls within the remit of corporate social responsibility (CSR) and is consistent with many trusts' and foundations' charitable objects.

2. An early intervention approach would ensure that the next generation of secondary school children are not exposed to faulty and gendered assumptions. Teacher training curricula for primary and secondary schools need to include the origins and effects of the Maths Myth. (US research has shown that women training to be elementary school teachers are among the most 'maths anxious' of all college students.¹⁶⁷)
3. Later intervention is also needed to ensure that existing teaching staff are aware of the internalised bias that many have been working to, and know how to address this bias. This will require a good evidence base to confirm the extent of the problem. For example, British research is needed to ascertain the extent to which primary school teachers – the vast majority of whom are female – are themselves anxious about maths.
4. Many parenting programmes for school-age children encourage mothers and fathers not to project their own fears onto their children, and show them how to bring out each child's unique potential; such programmes must explicitly mention the need to avoid passing on any anxiety towards maths, or assumptions about which sex is most likely to be able to master maths, and any sense that there is a maths gene – which they may not have.

¹⁶⁷ Beilock 2010, *op cit*

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