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Girls and mathematics

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GIRLS AND MATHEMATICS.

By

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A Master's Dissertation submitted in partial fulfilment of the requirements for the award of the degree of M.Sc. in Mathematical Education of the Loughborough University of Technology, January 1988.

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ABSTRACT.

In this dissertation I address the issues related to why girls perform badly in mathematics. I investigate whether there is any real disadvantage that may have a genetic or biological cause. I hold that while there is some evidence for this, that in fact social factors have a much greater influence on the issue.

My main argument hinges on the fact that mathematics has a "male" image and that girls and women are not willing to identify themselves with the opposite sex as this might indicate some flaw in their femininity. I examine the notion of femininity in some detail and come to the conclusion that it is a limiting and power-sapping ideal constructed largely by men. My first hypothesis is that women are willing to conform to the feminine stereotype because the crossing of sex-boundaries is abhorred by our society.

My second hypothesis goes some way to explaining why little attempt is being made to change the situation. Because of the Sex Discrimination Act and women's lib women believe that they have achieved equality and so feel that there is no need for action. I claim that this attitude is not only unfounded, but is dangerous because it leads to complacency.

I spend one chapter discussing the attitudes of pupils and discover that stereotypes still exist and in a manner which can only be detrimental to girls' progress.

Finally I attempt to consider what can be done to solve the problem by considering both specific and general solutions.

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DECLARATION.

This dissertation is entirely my own work.

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CHAPTER 1.

STATISTICAL EVIDENCE OF THE DISPARITY IN THE ACHIEVEMENT OF BOYS AND GIRLS IN MATHEMATICS.

In this chapter I will discuss the evidence offered by The Royal Society and The Institute of Mathematics and its Applications in their 1986 report on Girls and Mathematics. It begins with an analysis of examination results at 16 and 18. (See fig.1a in Appendix)

Note that there is reasonable parity between the sexes in terms of numbers entered for CSE examinations, but that each year more candidates take English than Mathematics. (See fig.1b)

Here the split between the sexes begins to appear. Boys dominate the Mathematics entries, yet girls are more likely to be entered for English than boys. The predominance of girls sitting English Literature is particularly noticeable. (See fig. 1c)

The split is now completely obvious. Although an increasing number of girls sit 'A' level Mathematics, the proportion does not at all mirror the sex-split in the population as a whole. Girls are seen to be increasingly dominating in English. It is interesting to note that for

the first time in 1984 Mathematics was taken by more candidates than English.

An analysis by sex of the grades obtained in each of these three examinations is highly illuminating. (See figs. 2a, 2b, 2c.)

At CSE the girls dominate at Grade 1 level in Mathematics, but at grades 4 and 5 in Arithmetic. I would suggest, following Scott-Hodges (in Burton, 1986) that girls are less likely than boys to be entered for 'O' level. This then accounts for the fact that girls are awarded more grade 1's. These girls should not have been entered for this examination at all, and they consequently distort the data. They would probably have obtained an 'O' level had they been entered for it, rather than its CSE equivalent. At the other extreme, it is noticeable that girls dominate at the bottom end of the low-status Arithmetic examination.

At 'O' level the girls have the upper hand only in the fail grades. The greatest disparity is at grade A level. Again, in both Additional Mathematics and Commercial and Statistical Mathematics the worst ratio of girls to boys is at grade A.

At 'A' level the girls are least likely to be awarded a grade A, whatever combination of mathematical subjects they

take. The majority of the girls' grades are bunched around the C,D,E mark.

At school level then, it is quite clear that girls are not only less likely to study Mathematics than boys, but they are also much less likely to do well.

The situation post-school is equally interesting.(See figs. 4 and 5).

Whatever the subject, women achieve fewer firsts than men, but only in Mathematics do they gain the majority of the pass degrees. Men have by this stage even excelled in English, that traditionally female subject, by gaining more firsts than women.

This data has implications for mathematics teaching in schools. If few women study it in the first place, there are consequently going to be fewer top class women mathematicians in schools. This then only serves to perpetuate the myth that women are no good at mathematics. In reality, however, because teaching is seen as a woman's occupation, many more women than men choose to enter it. However, many of those women who teach mathematics are not well qualified in the subject, or, worse still, dislike or are afraid of the subject. 77.2% of primary school teachers —

and 45.4% of secondary school teachers are women. The next table then becomes extremely important in the light of these figures. (See fig.6).

There are proportionally many more women than men on scales 1 and 2. All the senior posts in schools are dominated by men. Thus Heads of Mathematics departments are likely to be men, whereas the classroom teachers of the subject are likely to be women. Even when women do hold senior posts such as Senior Teacher or Deputy Head they are likely to be responsible for traditionally "feminine" areas such as pastoral matters or girls' welfare.

Girls and women are therefore seen to opt out of studying Mathematics as the level increases. They do worse than their male counterparts at all levels. Is this because males are in fact better at mathematics than females, or is there some other explanation? It is clear that a difference in achievement does not necessarily imply a difference in ability, though the latter is often measured in terms of the former. I shall now look at the evidence available for a difference in attitude between the sexes, as this may account to some extent for the difference in performance.

CHAPTER 2.

ATTITUDINAL EVIDENCE OF THE DISPARITY IN BOYS' AND GIRLS' ACHIEVEMENT IN MATHEMATICS.

In 1978, 1979 and 1980 the APU made surveys of the mathematical development of both primary and secondary school pupils. They tried to address the problem of the difference in attitude between boys and girls at both of these stages of their education. They also examined the question of performance, and noted that the boys performed better than the girls generally, with boys and girls being roughly in the ratio 3:2 in the top 10% of the ability range. In particular, boys were better at problems concerning measure, rate and ratio, whilst initially anyway, girls performed better at computation and algebra. However, by the end of the secondary years, boys were out-performing girls in all areas of mathematics.

Fundamental to my explanation of the difference in performance between girls and boys is the change in attitude of girls at around the time of puberty. This seems to be

borne out by the APU results. My reasons for this hypothesis will be discussed in detail later. In the primary school boys and girls had similar attitudes to mathematics, with the girls being only marginally more negative than the boys. There was little difference between the sexes' enjoyment of mathematics, and in their attitudes to its importance. However, the boys showed more confidence than the girls, and expected to be able to produce accurate work.

In the primary school girls adopt a passive, conformist approach. The able ones assume the role of sub-teacher (Walden and Walkerdine, 1985, in Burton, 1986). They help the other pupils and so assume some of the teacher's authority. Because they are keen to please they learn to think and act in certain ways which are found to be acceptable to the teacher. Pask has identified two different types of thinker - the serialist and the holist. The serialist likes to proceed in a linear manner from certainty to certainty. They are not willing to accept a high level of uncertainty, and do not look very far ahead. The holist on the other hand aims to achieve overall understanding, and is willing to accept uncertainty at the level of specifics. The holist tends to be more versatile and intuitive and is generally regarded to be the "better" thinker.

The teaching in primary schools tends to promote serialist modes of thought - it is structured and follows set procedures. That it is like this is due to at least two reasons. Firstly, it is much easier to teach mathematics like this. Secondly, and more importantly, primary school teachers are generally neither able nor confident mathematicians. As we have already seen, they are also generally women. Their fear is dissipated somewhat by adopting serialist ways of teaching - to proceed in an ordered mannner offers some degree of security. Scott-Hodges (in Burton, 1986) argues that girls adopt a serialist mode of thinking in order to please and identify with the teacher. Their upbringing has taught them to aim to please other people. (A full discussion of this factor appears in chapter 6). But, in doing this, they are unknowingly lessening their chances of becoming truly inventive mathematicians. On the other hand, because boys are willing to challenge the authority of the teacher, they are more likely to reject the serialist approach and may develop as holist thinkers. I am well aware of several (female) teachers who, being insecure of their own grasp of mathematics, attempt to put down or deride any form of individual thinking. It is much easier for them to say "No, that's not how you do it" than it is to consider an original approach. It is likely that far from curbing a boy's inquisitiveness this approach only reinforces his desire to think for himself. Thus the gap widens between boys and

girls, possibly irretrievably.

Girls' increasing unease with mathematics could, I maintain, be largely blamed on primary school teachers. Society's stereotypes of women being poor at mathematics are only reinforced when the child is taught by a woman who herself harbours all the traditionally held anxieties about the subject.

By the time the girl reaches secondary school she has had any natural liking for mathematics destroyed by her desire to please the teacher and imitate her attitudes.

In the secondary school the differences in attitude become vast and crippling to the girl's ability to make progress. Girls now expect to find mathematics difficult and only attribute any success they may have to either hard work or to luck. Girls fail to see that mathematics will be useful to them once they leave school, and often feel that they are wasting their time studying it. They may also become resentful and angry at having to study a "useless" subject. They do not value the subject. It is not for them - it is for the boys.

Licht and Dweck (1983) did some research in which 200 sixth grade students were asked questions aimed at investigating their attitudes to mathematics, reading and

language arts. Mathematics was seen as a subject where one had to be intelligent in order to do well, whereas the children agreed that one could do equally well in the other areas without being intelligent. In the classroom two thirds of all negative feedback for boys was non-intellectual (e.g. for conduct). Teachers were eight times more likely to attribute boys' failure to lack of effort than they were a girl's. Thus girls tend to enter situations of intellectual achievement with lower expectations of success than boys as they are criticized more for intellectual failings, and given less credit for success when they do actually succeed. Licht and Dweck (ibid) thus claim that girls eventually come to avoid situations of possible failure, since the failure is seen by their teachers to be a reflection of their true intellectual ability. The boys have no such problems - their failure is usually seen to be due to less important and remediable factors such as lack of effort. When the boy fails all is not lost; but when the girl fails that is the end of the matter, she is simply not good enough.

We are beginning to reach the crux of the matter. Mathematics is a "male" subject and thus even if not inaccessible to the girls, then certainly undesirable and inappropriate as an area for study. Girls are caught in a double-bind. They are taught to be "feminine" and fear recrimination and abuse if they are not, yet they are also

taught to work hard and please their teachers. They suffer the dilemma of having to choose between gender and intellectuality (Walden and Walkerdine, 1981). Horner (1968) suggests that girls shun mathematics because of the implications for their sexuality. There is seemingly an unreconcilable gap between being good at mathematics and being feminine. Success in mathematics is generally defined in terms which are taken to have "masculine" overtones - logical, competitive, brilliant, intuitive, independent etc. In order to be good at mathematics the girl must not only break the serialist mould, but she must also be willing to accept the disdain of her peers. Most girls are not willing to take such a risk in this unbelievably sensitive field. Attitudes in the highly-charged domain of femininity will be discussed in chapter 7 .

The next chapter gives a brief survey of the history of girls' education. It shows that throughout history society has always held that women's education is unnecessary. Even today, there is a tendency to trivialise women's attempts to achieve educational parity with men.

CHAPTER 3.

THE HISTORY OF GIRLS EDUCATION.

In order to explain and understand the problems involved in girls' mathematical education mentioned in the last chapter it will be necessary to have an overview of the history of girls' education. If one wishes to change and improve the position of girls and women it can only be attempted if one has a deep and all-embracing appreciation of the attitudes and prejudices formed a long time ago, and firmly adhered to ever since.

Before the widespread introduction of school education there were several women who made notable contributions in the fields of mathematics and sciences. From Hypatia in Greek times to Emmy Noether and Grace Hopper this century, women have made valuable yet little-appreciated contributions to mathematical understanding. Why have they been so invisible? Barnes, Plaister and Thomas (1984) are quoted in Burton (1986) offering many suggestions. I shall consider some of these now.

Firstly, education, and in particular, mathematics education, was not generally available to women. Those women who did express a desire to study mathematics laid themselves open to accusations of masculinity or

eccentricity. It was not considered appropriate or normal for a woman to want to study this subject.

Secondly, and related to the above, such women faced tremendous opposition from their families. It was considered perfectly acceptable to use the most extreme measures to prevent one's daughters from serious study. Sophie Germain's parents resorted to depriving her of heat, light and clothing in an attempt to prevent her pursuing her interest in mathematics. Sophie however, overcame this and went on to become an excellent mathematical physicist, devising the theory of the vibration of elastic surfaces.

Thirdly, even if the desire to study was not extinguished early, women were not allowed to enter universities until relatively recent times, so they found it difficult to pursue their interests at a high level. Some went to extraordinary lengths to get the materials they wanted, by borrowing notes or even, in the case of Sonya Kovalevsky, by making a marriage of convenience to further her studies. It is notable that most of the women who became successful mathematicians had access to mathematical ideas through families or close friends.

Fourthly, and perhaps most obvious of all, those women who had children were presented with further difficulties as child-rearing had to be fitted in with their studies.

Despite changes in attitude to women's education today, this is still a major hindrance. Women are still seen as having the main responsibility for looking after the children, and often see a career as conflicting with motherhood.

Finally, and another factor which still holds true today, these women had little faith in their own abilities to produce valid and original mathematics. Many of the most famous women mathematicians spent much of their time simply translating the work of their male counterparts.

Despite the passage of time some of these factors are still barriers to the mathematical progress of girls today, as mentioned in the last paragraphs. The pressures are no longer so formal - girls do in fact have equal access to education, but the informal pressures are still intense.

Now I will turn to a discussion of what happened after the 1870 Education Act which made schooling available to all children up to the age of ten years. Surely this would begin to resolve the inequalities, particularly after 1880 when education up to age ten became compulsory for all. However, it very soon becomes apparent that while education was to be provided for boys and girls alike, it was not to be the same education for both sexes.

In 1926 the Hadow Report emphasised women's place in

the home- This report stressed that women were bored with housework simply because they were not doing it efficiently and because it was not regarded as a skilled occupation. It was the school's job to ensure that girls were properly prepared to take up their roles as effective and happy housewives.

The Crowther Report of 1959 recommended that since the main prospect for lower ability girls was marriage, time should be given over in school to their education as wives and mothers. The implication here is that the "less able" are to be excluded from participating in any of the useful occupations.

Again, as late as 1963, the Newsom Report advised that below-average girls should be given an education in "the wider aspects of home-making, and in the skills that will reduce the element of domestic drudgery."

It is obvious that whilst the issue of girls' education was being addressed, the old prejudices remained. Women were traditionally child rearers and homemakers, so those girls who proved themselves to be non-academic were forced to maintain that tradition. Non-academic boys, on the other hand, fared much better. They were prepared for supporting themselves and their (dependent) wives by learning practical skills which would enable them to find paid work.

Byrne (1975) made a survey of school resources during the period 1945 - 1965. He discovered that in single-sex schools girls had £75.30 per head, and boys £87.80. This was due to the fact that boys schools tended to be better equipped with craft and science facilities. Girls were expected to study "their" science, biology, in converted classrooms.

Thus the scene is set for an examination of the prejudices related to girls' position in society. We have seen that they perform badly and feature less and less as the level of difficulty increases. They also have an increasingly negative attitude to mathematics. It is also clear that they have in the past been discouraged from engaging in intellectual pursuits. I will now examine all the evidence which can be brought to bear on the problem. I begin by looking for evidence of a real cognitive superiority in boys, then I consider at length the effects on both boys and girls of their upbringing. This latter discussion leads me into an analysis of the idea of femininity and the need to preserve this artificial manifestation of biological femaleness.

CHAPTER 4.

ARE BOYS NATURALLY BETTER AT MATHEMATICS?

In their 1974 classic Maccoby and Jacklin attempt to discover whether there are any cognitive differences between boys and girls which would account for their differing performances.

They noted from research that girls invariably perform better than boys up to the age of about eleven. One possible hypothesis is that the rate of physical growth may account for intellectual development as girls are generally bigger than boys up to age eleven, at which age the boys suddenly start to grow rapidly. Bayley (1956), however, dismissed this argument, saying that no evidence could be found for the correlation of intellectual and physical development.

Bayley and Schaefer (1964) argue that environment affects the behaviour and intellectual functioning in boys, whereas in girls it appears that intellectual functioning is largely genetically determined. However, no other studies have corroborated this, so it is unwise to accept it unreservedly.

A fact which is accepted by most researchers is that

while boys do in general reach a higher level in mathematics, there is also greater variability - they are likely to predominate at both extremes of the ability range.

A second fact which is well established is that boys have better spatial ability than girls. They can visualise the three-dimensional object from a two-dimensional sketch, they can move objects around in their mind's eye, they have a better intuitive understanding of geometry. [Stafford (1961) argues that if the genetic determiner for spatial ability were recessive and carried on the X chromosome, then girls, with two X chromosome, would be relatively unlikely to receive the two recessives necessary for that trait to manifest itself. Thus boys are more likely to inherit spatial ability than girls.] This could be a very strong argument to support the thesis that boys are naturally better at mathematics than girls, as spatial ability is vital in most areas of the subject.

Fennema (1983), however, argues that inferior spatial visualization skills alone cannot explain the differences in attainment. So whilst she sees mathematics as a cognitive endeavour, she does not hold that sex-related differences can be explained simply and solely by looking in the cognitive domain.

There also seems to be some hormonal link with spatial

ability. In tests of spatial ability boys with a masculine body type had lower scores. Girls with masculine body type, on the other hand, had higher scores than other girls. However, this suggestion remains unverified until further work on hormones is done.

A second physical fact which has a bearing on the issue is that in girls the left hemisphere of the brain develops earlier than in boys. Buffery and Gray (1972) claim that the left hemisphere is responsible for dealing with verbal matters, whereas the right hemisphere is essential in spatial modes of thought. It could be argued that girls come to use and rely on that area of thought which developed first, whereas in boys this early specialization does not occur and the right hemisphere is given longer to develop. McGuinness (1976), however, has criticized the lateralization hypothesis on the grounds that many skills in which there is no male superiority are also located in the non-dominant hemisphere (e.g. singing ability).

It is possible then that there is some real and fundamental disadvantage in being female. However, I will maintain that real though this may be, the girl is further disadvantaged by her upbringing, and the differences are accentuated and amplified - boys may in fact be better, but they are also brought up to be better. I will also argue that the converse of this is true - that girls are brought

up to be worse.

CHAPTER 5.

ARE BOYS BROUGHT UP TO BE BETTER THAN GIRLS?

Let us assume then that boys have a slight advantage over girls in that their spatial ability is better. This is in fact very important as most areas of mathematics require the ability to visualize shapes, spot patterns and relationships, imagine transformations etc. Even advanced areas of mathematics are susceptible to visual interpretation - the study of calculus, groups and much of mechanics, to name but a few, all require a fairly well developed spatial ability. To lack spatial sense is a serious handicap. Let us also assume that the initial difference between boys and girls is not vast, as the research seems to indicate, why then do boys do better? The main reason lies elsewhere than in their spatial good fortune.

Sharma and Meighan (1980) demonstrate that performance in mathematics is helped by studying Science and / or Technology subjects. Since boys are by tradition more likely to study these subjects, their mathematics is improved incommensurately against the girls. However, their study also showed that when girls studied Physics at

'O' level they performed better in mathematics than their male counterparts who also studied Physics. On the surface this is important, but I feel that the explanation is a simple one. Since Physics is regarded as the "male" subject par excellence, only the very best girls are likely to study it. Thus one would expect them to perform better than the boys who often study mathematics whatever their ability.

Bing (1963) found that spatial ability improved in children given freedom and independence. Brandis and Henderson (1970) discovered that independence is a trait more encouraged in boys than in girls. This was particularly so in middle-class families. Thus the natural division between boys and girls is widened.

Parents have an enormous influence on their children. The Tall Trees experiment described by Alison Kelly et al (in Burton, 1986) shows that parents have fairly egalitarian views about the education of their children, and profess to agree with the view that girls should and do have equal opportunities in education and employment. However, the questionnaire results showed that while most parents adopt in public a non-sexist stance, their unguarded sayings give lie to their true attitudes. They say that it would be perfectly acceptable for their child to take a job associated with the opposite sex,

but they simply do not see it happening. Children are very adept at receiving unspoken messages, and thus come to see their parent's prejudices and stereotyped views quite clearly beneath the thin veil of overt sexism. Boys and girls are intended to be good at different things.

At school the boys dominate and demand the teacher's time (Binns, in Burton, 1986). They expect, and are allowed to have, more than their fair share of resources such as computers. They dominate the verbal space in classroom discussions. Even teachers who are aware of the problem find it impossible to share their time equally between the two sexes. This factor is even more worrying when one considers the results of research done by Casserly (1975) - girls who did well in mathematics reported positive teacher influence as being the cause of their success. The implications for teachers are all too obvious - we have to find some way of giving more of our time and attention to girls, even though they do not demand it as the boys do. This, unfortunately, is not such a simple thing to do, yet it must be attempted.

In the classroom the boy comes to realise that he is a member of a privileged group, and will try to reinforce sex differences by being as unlike the girl as possible (Mahoney, 1983). He might see the girls in his class simply as a source of the pens and other equipment that he needs.

Mathematics is a "male" domain and the boy asserts himself within it. "Mathematics is part of the 90% of the world's resources owned by men and they guard it well (Spender, in Burton, 1986).

Even the toys boys play with serve to widen the gap. Many boys' toys are constructional or mechanical. In playing with them the boy cannot help but improve his grasp of spatial relationships. Girls do not as often come into contact with such toys, and their natural limitation is not remedied.

In most areas of endeavour one is willing to work in order to gain skills in something one considers to be important or useful. Boys quickly pick up society's message that mathematics is their subject. They are also taught that their future will contain a career in which mathematics will be a useful if not invaluable tool. For boys there is consequently some purpose to the study of mathematics.

Boys are expected to be better at mathematics, and the prophecy is fulfilled and they turn out better. Rosenthal and Jacobson (1968) deliberately misinformed teacher about the abilities pupils had displayed in tests. Months later the pupils were actually performing according to the original false reports. Thus teacher expectation is an

extremely powerful influence on pupil performance.

Stamp (1979) points out that certain personality traits are important for success in mathematics . These are responsibility, independence, low impulsivity, reflectiveness, aggression and boldness. Nearly all of these would generally be characterized as "male" traits.

The boy thus develops, or has developed in him, the sort of personality which is conducive to success in mathematics.

Oakley (1983) holds that sex-related differences in achievement can be explained in terms of affective variables such as confidence and perceptions of usefulness.

Because boys feel "at home" with mathematics, and expect to be good at it, they have a more confident approach to it than girls. She points out that in research confidence was almost as highly correlated to achievement as were the cognitive variables of verbal ability and spatial visualization.

Even examinations seem to favour boys - they perform better on multiple-choice tests, and many examination questions are placed in "male" contexts. (Murphy, 1978).

Thus it is that the underlying assumption in society that males are better than females at mathematics is perpetuated by differential treatment of the two sexes.

The path to success for boys is relatively smooth, and they are aided by the positive attitudes of parents, teachers and society as a whole. They are working from a position of strength.

Marland (1983) claims that schools actually make boys and girls more different than society would otherwise do. "Schools act as amplifiers for society's stereotypes". If this were true, and work clearly needs to be done in this area then it has implications for all of us engaged in the education system.

This attitude pervades Western culture, yet is not to be found worldwide. Murdoch (1937) surveyed 224 preliterate societies and found that all had rules about which activities are suitable for males and which for females. However, these activities were not consistent from society to society. Again, Margaret Mead (1935) found three primitive societies which displayed differing and divergent sex-roles. In one the ideal adult was seen to be gentle, passive and caring, the opposite to what is generally to be found in Western cultures. In a second, both sexes approximated to a traditional Western "male" ideal; and in a third the sex-roles were reversed. Thus the roles that are forced upon us and seem to be part of some pre-ordained natural law are in actual fact variable from culture to culture.

I shall, in the next chapter, examine the converse of this position. Not only that boys are brought up to be better but, to further exaggerate the differences, girls are brought up to be worse than boys - they are actually encouraged to underachieve.

CHAPTER 6.

ARE GIRLS BROUGHT UP TO BE WORSE?

Throughout history it seems that girls and women have been educationally disadvantaged, but especially in those areas seen to be the domain of men. Dale Spender's poem is an eloquent statement of the position:

History tells me
That it is not so long since languages
Were considered very important.
Anyone who wanted to get on in the world
Needed languages as an entry
qualification
For this was how you sorted out those who were capable
From those who were not.

Girls, it seems,
Were not.
They were "naturally"
Not very good at languages
When languages were required
For leaders.

Today

It is maths and the sciences
Which are considered very important
For those who want to get on in a technological world
Maths and science are the entry qualifications
Which sort those who are capable
From those who are not.

Girls, it seems
Are not.
They are "naturally"
Not very good at maths and science
While these are required
Of leaders.

Of course,
I could resign myself to accept
That girls are inferior
If it were not for one inconsistency.
Today when languages are not needed,
When they are not used to sort out those who are capable
From those who are not,
Girls have come to be "naturally" good at languages.

Have they progressed so far
In such a short time,
I ask myself?
Are they but one century

Behind?

In the twenty-first century,
Will they become
Very good at maths and science?

Possibly,
As long as maths and science
Are not required
As entry qualifications!

It is not that girls have changed so much
In the last 100 years
It is that the entry qualifications have changed.

Tomorrow,
If weaving and cake-making
Are considered very important
And those who want to get on in the world
Need them as an entry qualification
Because they sort those who are capable
From those who are not
Girls, it seems
Will not.
They will "naturally"
Not be very good at weaving and cake making
When they are required for leaders.

It's a very convenient argument
It's very clever of those who control the entry
qualifications
To be able to control nature as well.
For we can chase our own tails
And spend years
Testing girls for their inadequacies
We will not find them,
For we are looking in the wrong place.
The underachievement lies not in the girls,
But in those who do not wish to accept them,
As equals.

It is quite clear from this that Spender sees the problem
of girls' inadequacies in mathematics and science as
having little to do with the girls themselves. It is rather
to do with man's conception of the world, and what
qualifications and skills are essential if one is to
succeed. Women are not excluded from being good at
something - so long as it is not in an area that is
considered important or useful. It is as though the men
not only define the rules of the game, but also move the
goalposts whenever it suits them.

Thus it would seem from all this that women do not
succeed at mathematics because they are excluded from this

domain by men. It is because the solution to female oppression lies in male hands that there is a problem at all, yet even so we might wonder why women do not fight back; why do they give in so easily? The answer to this is subtle and many-faceted, and begins at the moment of birth.

The new-born baby girl may be immediately at a disadvantage as her parents may have wanted and hoped for a boy. Tradition is so strong and deeply-embedded that boys are seen as naturally superior to, and thus more desirable than, girls. The parents may thus first have to come to terms with feelings of disappointment and possibly failure - they see themselves as having to make do with second-best. Of course this is a gross oversimplification of the situation. Not all parents will feel this way, and most of those who initially wanted a boy quickly come to love and appreciate their daughter.

Moments after the child is delivered it begins to experience sex-stereotyping. It may be wrapped in a pink or blue blanket. A screaming boy may be congratulated on being a "hearty little fellow" and a girls may be praised for her looks or her cuteness. The child's sex is vital to its future identity - people do not know how to treat a child until they are sure of its gender. Once the sex is revealed one can sit back and rely on well-worn sayings and

attitudes. There is nothing more unnerving than not knowing the sex of a child - most of what we say is heavily influenced by gender attitudes. When an unknown toddler acts aggressively we do not know whether to praise it for being a "proper little boy" or admonish it for being "unfeminine" unless we know whether it is a boy or a girl.

Kessler and McKenna (1978) claim that until we know someone's gender we cannot begin to make sense of their behaviour.

Joyce Nicholson (1975) has pointed out that psychologists cannot delineate exactly what parts inherited characteristics and upbringing have in defining gender divisions. It would seem on the surface that aggression, dirtiness and noisiness are male traits. However, some girls are also noisy and aggressive, and some boys are peaceable and quiet. So not all boys have certain character traits inborn, and despite their parents' best efforts to the contrary, not all girls can be brought up as passive little angels. Thus neither nature nor nurture alone is sufficient to explain the matter. It would seem that we are born with certain types of personality or dispositions, and have a propensity to act in certain ways. However, it is not true to say that some traits are masculine and some feminine, it is just that some types of behaviour are encouraged in boys and discouraged in

girls, and vice versa why some children fail or refuse to act in these prespecified ways is an interesting question.

It may be that the pressure brought to bear is not sufficiently oppressive to adapt behaviour, or it may be that the child can see no point in adopting sex-stereotyped behaviour patterns. Whatever the reasons for young children, nearly all children whose behaviour is seen to be inappropriate to their sex will adapt it as they enter puberty. Nicholson (ibid) argues that this is because sex and sex-differences suddenly become a reality, the most important thing in the child's life.

Oakley (1972) says that adolescence signifies the change from learning adult gender roles to performing them. Those who do not manage to conform successfully to the stereotypes are for the first time in their lives the objects of real ridicule.

The role that the girls has to conform to is neatly summed up by Simone de Beauvoir (1972): "To be feminine is to reveal oneself as impotent, futile, passive and docile."

Tremendous pressure is brought to bear from all quarters. If girls do not want to become wives and mothers they are considered "peculiar,unsatisfies,unfulfilled" (Nicholson,ibid). There is something wrong with them.

They have broken the most revered of rules, and it is not only distasteful, but also dangerous to do so. The young woman finds that she has to deal not only with the physical changes in her body, but is also urged to conform to restrictive stereotypes. Teenage magazines only compound the problem. Not only do they stress highly stereotyped images, but they continually undermine the girl's confidence in her looks and her body - she must strive to be something she is not. Suddenly she must concentrate on being attractive to the opposite sex. Wanting to be good at schoolwork is now positively discouraged - girls are undesirable to boys if they are better than them in any important areas.

The girl is made to feel guilty if she cannot or does not want to conform to the stereotypes. Whyld (1983) says "Socialization is a very subtle process which induces us to view our behaviour as natural, and stops us from seeing any alternative to it."

In time the girl may find herself a mate and marry. Yet even this, the goal of her life, turns out to be an unwise move. She has achieved the glittering prize, yet it turns out to be counterfeit. On the whole marriage for a woman consumes her whole life. Even if she works outside the home she is still often expected to cook and clean unaided. Her work outside the home is not taken seriously

- in 1979 women's weekly earnings were equivalent to only 63.6% of men's. For men, on the other hand, marriage is only a part of their life. He also has his work, which is seen as the main purpose of his life. It is accorded great status as he sees himself as the breadwinner, the supporter of his family.

Sociological and psychological surveys discussed by Dr J. Bernard in "The Future of Marriage" (1973) points to the truth of the matter. In general, marriage is good for men but bad for women. Married men live longer than their unmarried counterparts, they are more affluent and consider themselves happier. Married women, however, are more likely to be depressed, unhappy and poorer than their unmarried sisters.

The push towards marriage is then a very important factor in the girl's life. It prevents her from performing well in her schoolwork for two reasons: firstly, her newly-found or newly-enforced esteem for the male prevents her from wanting to be better than him; and secondly, if her future lies in marriage then there is little point in acquiring academic qualifications.

Teachers too have lower expectations of their female pupils. Research has shown that they will mark work down if they believe a girl has produced it. They do

not believe that girls can be truly intelligent, but give them credit for such factors as neatness and hard work.

It is hardly surprising that the girls begin to perform only up to the levels expected of them.

So from the moment of birth the girl is brought up to be different from the boy. She is expected to be quiet, conformist and non-aggressive. Academic success is acceptable so long as it can be attributed to hard work. She learns that the boys in her class are accorded superior status in that they are given disproportionate access to resources and teacher time.

Once she enters puberty her fate is sealed. She must conform to the feminine ideal or face the horror and displeasure of her parents and her peers. So the answer to the question posed at the beginning of this chapter seems to run along these lines - the girl or woman does not fight back because to do so is to deny her femininity, and this is seen to be the essence of the woman. Without it she is nothing. I will now look in more detail at the issues and implications involved in the notion of "femininity".

CHAPTER 7.

FEMININITY.

Failure to be feminine is the most profound failure of all - it has terrifying implications. But what is femininity, and why is it so vital that it be preserved at all costs? Susan Brownmiller (1986) suggests an answer to the first question: "Femininity, in essence, is a romantic sentiment, a nostalgic tradition of imposed limitations." Mere biological femaleness is only a very small part of the picture. This is backed up by Oakley (1972) who points out that "If gender has a biological source of any kind, then culture makes it invisible." That is, gender differences do not simply mirror sex differences.

Women are expected to be acquiescent and unambitious, yet, as Brownmiller points out, the paradox of femininity is that it has a strong competitive side - one must always seek to be more and more feminine. Women have to compete against each other for the men, who are sometimes seen as a valuable and rare resource.

The woman must constantly compromise in order to be feminine - if she is not willing to do so then she must be willing to abandon her desire to be seen as a complete

woman. To be feminine one must be, to some extent, vulnerable, desire protection, be romantic, non-competitive and "nice". Men like feminine women because they help them enhance their own masculinity. A woman who refuses to be vulnerable or compliant threatens men, so the men retaliate by attacking women where it hurts most - by questioning their sexuality.

To be feminine is to subjugate oneself to the male. Why do women wear uncomfortable clothes and shoes, why do they try to mould their bodies to some preordained shape if not to achieve some highly desirable end? Men are by tradition superior, and seek to maintain it by desiring women to spend their time hindering themselves. Long or elaborately styled hair is difficult to look after and keep clean, yet it is considered very feminine to have such hair - it also hinders the woman, puts her at a disadvantage. Earlier this century having short hair was outrageous in a woman, because it was seen to make her masculine. The male-imposed standards deemed that short hair in a woman was unacceptable. However, the double standards involved in this seem to have gone unnoticed - men shave their faces and so look more like women, yet this is entirely acceptable. What is sauce for the gander is not sauce for the goose.

The shape of one's body is rigidly controlled by gender. If one is female then one must conform to the shape

currently in vogue. If this means wearing tight, restrictive and uncomfortable clothes, then so be it. If it involves endless dieting or expensive massage or dangerous pills, this is entirely acceptable in the search for the perfect female form. Men often judge a woman by her body, and by how close she comes to the ideal. Men, on the other hand, do not have to go to any such lengths to seem desirable - they are desirable simply by virtue of being men. It is frowned upon for men to be too obsessed by their appearance. It brings into question one's sexuality if one is too worried, or not worried enough, about one's appearance, depending on whether one is male or female. The contradiction implied by these double standards does not appear to be problematic to most people. Consistency is not essential when comparing attitudes to men and women. Women must be constantly fighting their natural appearance, men are allowed to accept theirs, whatever it is, as not needing any improvement. Whoever heard of a woman being complimented on her rugged looks?

One possible explanation as to why women were, and still are, expected to spend a lot of time and effort adorning themselves has to do with class. Before modern times only women belonging to the higher social classes would have the time and money to dress themselves in the required manner. The very fact that clothes were cumbersome and required help in putting them on (especially the tight

laced corsets) was an added recommendation, as it pointed to the fact that the woman could afford such help. The men of the same class did not have to go to such ridiculous lengths - they had their careers, their shooting, their fine horses and cars to show the world which class they belonged to.

The obsession with clothes, hair, skin and mannerisms all handicap the woman, deprive her of the time and energy she might otherwise use on more worthwhile pursuits. Yet in fact, a lack of ambition and purpose is the most feminine of all traits. Femininity demands that women show their dislike of important issues. As Brownmiller (1986) puts it "Knowledge is power, and lack of it is charmingly feminine."

Yet why is it that women have always been seen as somewhat frivolous entities, with little of any importance to contribute to the world? From the earliest stories women were always second class citizens. Eve was fashioned from the rib of Adam, she was his helpmate, and she was ultimately his downfall. In most cultures women, weakened by frequent childbirth, were not strong enough to do the important work of hunting for food. Whoever fed the group was accorded great status. So the men gained the upper hand early and have never relinquished their control. Women were kept content by looking always to improve their appearance, and thus please the men - is it not human nature to want to

please those who have the power? Yet the more they asserted their femininity, the less able were they to look beyond it to the world of ideas and work. The Church too has ensured that women are not allowed any ambition outside the home. The Virgin Mary is extolled as the paragon of all feminine virtues - she is simple, humble and compassionate, but most of all she is chaste. To be a loving mother without having experienced the reality of sex seems to be the pinnacle of femininity. It is an almost fairy-tale vision of innocence and purity.

The other side of the coin is almost disturbing. If one fails to adhere to the image, if one is ambitious without tempering it with some feminine frivolities, then the weight of opinion falls on the hapless woman. Not to be seen to make any concessions to femininity is a guarantee of failure - it is totally unacceptable to be a successful woman if one is not also a traditionally "feminine" woman. The latter, in a way, excuses the former. The success will be tolerated provided that there is no doubt that the woman is first and foremost feminine.

I would claim then that by early childhood girls are much further behind boys in mathematical achievement than any initial cognitive disadvantage could explain. This is a view shared by Fennema (1983). I also maintain that the real fall-off in attainment occurs at about the start of puberty

when society's messages about sex-differences suddenly make sense and become real and frightening. Announcing one's femininity to the world then becomes an all - important task. It begins to consume all of the girls's time.

Oakley (1972) reports of a male patient reared as a female who went for help when male secondary sex characteristics began to develop. He was diagnosed as male, and converted his gender identity from female to male. His schoolwork improved, particularly his mathematics, at which he began to excel. It is clear from this that his performance at school had not been determined by his ability, but by his understanding of the sex-appropriate modes of behaviour determined by society.

At this stage it may seem that I have overstressed my case. Surely men are not as dominant nor women as submissive as I have made out? But that is the very point, and why it is so dangerous to ignore it. Because men have held the power for so long they no longer have to actively demand respect - tradition ensures that they get it without a struggle. Thus women and girls may not seem nor feel oppressed, and yet still, possibly almost subconsciously, hold all the traditional beliefs about the sexes.

In order to discover whether this, my second hypothesis, is correct, I did a small survey with some

pupils currently in school. The girls I spoke to considered that they were equal with the boys in academic attainment. The boys, too, did not feel that they dominated the girls in any way, nor did they think that they were treated differently by their teachers. However, the results of my research indicate deep-seated differences in attitude. I turn now to a discussion of the investigation and its results.

CHAPTER 8.

RESULTS OF RESEARCH DONE IN SCHOOLS.

Having come to the conclusion that somehow the influence of men has a great bearing on the present discussion I felt uneasy as it was not apparent in daily life that that women felt that this power affected them. However, I soon came to realise that this was in fact why the situation was so serious. The power-submission relationship between men and women is so deeply entrenched that it has a life of its own. Both sexes accept and fulfil their roles without even realising that they are doing so. My small and consequently biased survey attempts to uncover some of the prejudices related to girls and mathematics held by students in schools at the moment.

My method consisted of getting all the pupils interviewed to write down or comment upon the appearance, behaviour, attitudes etc. of each of the following four people:

- (1) a boy who is good at mathematics
- (2) a girl who is good at mathematics

(3) a male mathematics teacher

(4) a female mathematics teacher

I asked the pupils to try not to describe any particular individuals fitting these descriptions, but to try to generalise from all their experiences, or simply to write what they felt, even if they did not draw their descriptions from real experiences.

I chose these attributes (appearance, behaviour etc) because I thought that they would throw the most light on the issue. I intentionally hoped that the figures described would be much larger than life, for I assumed that this would highlight and amplify the stereotypical views held by the pupils.

The groups interviewed consisted of my own fourth year top set in a mixed 13 - 18 comprehensive upper school. I also visited an 11 - 18 girls'school and interviewed both first and sixth form pupils. Both schools are in fairly large towns in Northamptonshire.

I shall first discuss comments made by the mixed group of high ability fourth years. Where I quote a list of qualities which they ascribed to the imaginary person, I give it in descending order of use by the pupils.

The boys in this group made the following comments about the boy who is good at mathematics: he would get on with his work, he would not mess around in class, he would have brown, greasy hair, and he would wear Clark's shoes! He would wear grey socks and carry a briefcase. I do not know of a single boy in the school who comes anywhere near to answering to this description, yet the views were held by many.

The girls in the mixed group gave some very different descriptions of the boy who is good at mathematics. He would often think that the teacher was wrong, he would be fairly disruptive, he would be smart and fashionable. Although his work might be neat and logical, some mentioned that it would be scruffy, and the working would not be shown.

The most notable differences in the perceptions of the boys and girls was that the boys all thought that the imaginary boy would be well-behaved, whereas the girls almost without exception commented on his probable disruptive and arrogant behaviour. Some of the girls gave the boy the benefit of the doubt by saying that he was disruptive because he was so far ahead of the class and was bored.

In reality, in this particular class, the boys who were

good at mathematics were closer to the girls' descriptions than the boys'. Why are the boys so wrong about themselves? Could it be that they identify doing well at one's school subjects with being conformist, hence their somewhat childish comments about clothes and footwear? The girls, on the other hand, appear to associate ability at mathematics with a certain flair and confidence - hence their remarks about the boy's attitudes to the teacher.

On analyzing the comments made on the girl who was good at mathematics it was again noticeable that the answers I received were differentiated by sex. The boys replied that she would be neat in her work, hardworking, unpopular, and would spend more time on presentation than was necessary. She would be fairly ugly and would always wear the correct school uniform.

The girls thought that she would be quiet in lessons, would often think that she had done the question wrong, and would be willing to help others with their difficulties. She would probably be good at other subjects as well as mathematics. She would not be very pretty and she would be unpopular. She would work hard and revise well for her examinations. She would listen hard to explanations and would ask questions when she did not understand. One pupil mentioned that she would be clever because of her parents (no elaboration given), and one girl mentioned that she would

want a good job when she left school.

Here the imaginary girl is allowed to be good at mathematics because she is also good at other subjects - it is not so surprising. But her ability seems to be dependent on her neatness and willingness to work hard. She has no great faith in herself. The girls in the survey seem to be offering excuses for the girl's achievement in mathematics. None of them put it down simply to high ability or flair in this field. It is instructive to compare the girls' comments on both the imaginary boy and the imaginary girl. The boy comes over as very confident and popular; the girl as a shy and retiring workhorse. For both sexes this girl's looks featured quite high on their lists, and both made negative comments. It is as though by daring to enter the male domain of mathematics, the pupils imagine her as sexless.

The first year girls in the all-girls school had slightly different views. Of the boy who was good at mathematics, they commented that he would be unpopular, would be picked on and would wear glasses and unfashionable clothes. A minority of these girls mentioned that he would be a big-head and a show-off, these girls said that he would not do his homework, but this did not matter as he had no need to do it. They thought that he would tell others when they were wrong. When I asked these girls if they thought

anyone in their school might become a famous mathematician they said no. However, they said that if they were in a boys' school this might be more likely because the boys are "brainier than the girls".

The comments on the girl who was good at mathematics were similar to the fourth year girls' remarks. They said that she would work hard and would be happy to help others. They mentioned her appearance less than the girls in the mixed class, and when they did it was not in such negative terms.

Overall I think that there are two main differences of opinion regarding the boy and the girl who are good at mathematics. The boys think that they behave better than the girls think, and the younger girls in the single-sex school do not make so many comments about appearance. It would seem that the boys tolerate, or even do not notice, bad behaviour from their peers. The older girls nearly all mentioned that the boy exhibited some form of disruptive behaviour. The reason for this may be that by this age the boys have come to dominate in most areas of school life, and are so used to acting in a bold and confident manner that they do not realise when this becomes disruptive behaviour. However, surprisingly, in reality most of the cleverer boys AND girls in the mixed group are occasionally disruptive. This brings me to my next hypothesis - that while girls are

generally more anxious about their mathematics than boys are, this does not seem to have such a profound effect on the very able girl. They do not seem to worry excessively about what society says about girls and mathematics. They are well-balanced and seem to be accepted by their peers. It may be that the conflict of gender and intellectuality does not affect all girls, or it may be that these able girls have won the respect of their peers in other areas of school life, and this respect is automatically carried into the mathematics classroom.

The comments on appearance are very interesting. It is quite clearly the case for all to see that the top sets are not peopled by ugly, bespectacled eggheads. Yet the pupils still have a stereotyped view of those who are good at mathematics. How does it come about and why does it remain in spite of all the evidence to the contrary? The solution seems to lie in the traditionally male image projected onto mathematics. In order to be good at this subject one must be clever, logical, analytical and have some natural intuition for the subject. These qualities are generally accepted to be masculine; they are also commonly associated with an unflamboyant personality and appearance. Thus the boy who is good at mathematics is unfashionable and boring. But the girl who is good at mathematics thereby possesses "masculine" qualities, and so is seen to be incapable of being traditionally "feminine". Thus she is said to be ugly

and a poor dresser, failing in the two most important female domains. The stereotypes exist because of the labels put on mathematics, they are not in the least undermined by the fact that few people seem to satisfy them. The stereotyped view is not derived from experience or observation - it is generated by tradition and prejudice.

I come now to the comments made by the small group of sixth form girls in the girls' school. They study Mathematics 'A' level with boys from the local boys' school.

Their comments may appear at first glance to contradict what I have said above, yet in fact I think that what they say is simply a variation on a common theme.

None of these girls commented on the appearance of the girl who was good at mathematics. They were all agreed that there was no one particular type. However, one girl did say that a girl who was good at Physics would have straight hair and would wear round glasses. This was, she explained, because Physics was a harder subject than Mathematics, and the girl would have to be cleverer. It is clear that this girl at least identified "cleverness" with a lack of the usually accepted feminine appearance.

The girls were agreed in their description of the girl who was good at mathematics - she would be of high ability, and she would be confident enough to point out mistakes to

the teacher, although she would do it in a friendly way. If she had been a boy she would have acted in a more superior way when pointing out mistakes - "boys are more conditioned to being good at maths". She would be prepared to help others. She would have natural ability. She would get on very well with her peers.

The boy who was good at mathematics would be superior and smug about his abilities, but also "ever so nice". He would be over-nice to compensate for being good at mathematics. He would be far more competitive than a girl, and would be unwilling to help others. The girls commented that boys who were good at mathematics were very good, they were very far above the rest. One girl said that boys are generally better at mathematics than girls. The girls would look up to the boy and would not expect to beat him in examinations. Girls would have to work harder. When asked if there was any stigma attached to doing mathematics at 'A' level or at university I was told no, it was a perfectly acceptable thing to do.

These comments demonstrate that by this age these girls are not swayed by the stereotypes relating to appearance as much as the younger pupils were, but they seem very convinced of the fact that while it is acceptable for girls to study mathematics, boys are "naturally" better. It is clear that the boys are actually performing better than the girls, but that the girls put this down to innate,

natural ability without considering whether it could be a result of differentiated upbringing.

I turn now to a discussion of pupils' attitudes to teachers of mathematics. I will omit any discussion of the sixth form girls' comments as it was clear that one of their teachers was not liked, and this seemed to cloud their judgements.

The younger girls at the single-sex school had fairly well-defined perceptions of the male and female mathematics teacher. On the whole they thought that women were more helpful and more sensitive to the needs of the class. Many mentioned that she was good at mathematics, but many also said that she was not very strict or had problems controlling the class. The male teacher was perceived as being older, smartly dressed and generally very strict. He was seen as being a good teacher in that he kept good order and made the class work hard. Some mentioned that he would shout a lot, and might be "a bit of a drip". Almost without exception these younger girls mentioned that he would be very good at mathematics. Only one pupil said that the male was "not so brainy as a woman". Overall, these girls seemed to have little preference.

The older pupils in the mixed school produced more exaggerated pictures. The girls thought that the female

would be well-dressed, have a cheerful personality, be helpful, and able to explain difficult ideas well. Some said she would be very good at mathematics, though several mentioned that she would not be as good as the male teacher.

Overall, the woman came over as friendly, caring and a good teacher.

The girls' views on the male teacher were equally strong. He would dress in a suit but would still manage to look scruffy. He might be tall and would probably have a beard. He would probably be unpopular with his pupils, due to the fact that he had a very high opinion of himself. Many mentioned that he might not be very willing to help, and he might be impatient. Several said that while he may be good at mathematics he would not be able to explain very well. The girls seemed to have fairly negative images of this imaginary male mathematics teacher.

The boys in the mixed school had fairly negative images of both teachers. The male teachers described by them were almost all along these lines: old, bald, wearing glasses, wearing a suit, tall, unfashionable, very strict, somewhat moody and unwilling to help. (Remember that all such lists are given in descending order of importance to the pupils). A considerable number of the boys used the word "boring" when describing this imaginary male teacher. Many said that he would set a lot of work. One boy said that he would

either be an absolute dictator or be totally unable to control the class. Overall, the male teacher came over as being competent, if boring and humourless.

The boys' images of the imaginary female mathematics teacher were remarkably similar to those of the girls. Most said that she would be smart, helpful to pupils, fairly strict but not very good at her subject. Only two of the boys said that she would be very good at her subject. One boy said that she would dislike the boys in her class. One rather outspoken individual wrote:

"... all the men teachers are yuk and bossy. Only women who are stupid become maths teachers. They are not as clever as men."

In addition to the above descriptions I asked the pupils in the mixed group to write down why they thought women did not feature heavily in the world of mathematics. Here are some of their replies.

"Women are still regarded as the weaker sex and do not have enough confidence" (Boy)

"Men have always been on top, so women up until now haven't had a chance" (Boy)

"Women are too busy having babies... they lack the intelligence needed to succeed at higher levels of maths... it's not socially acceptable for women to study maths at university" (Boy)

"The women don't get to the top because they're not good enough" (Boy)

"(women) are discouraged by their own family, expected to do girlish things... men don't like women cleverer than them" (Girl)

"everything you hear about is done by men, women aren't recognised" (Girl)

"male maths teachers...believe in boys more so making them seem better" (Girl)

These comments seem to me to describe the stereotyped views held by current pupils in a rather extreme form. However, I think that the nature of the questions probably led pupils to make stronger and more outrageous remarks than they would under less artificial conditions. This, however, is not necessarily a bad thing as it highlights the issues. Thus we see that sex-stereotyping is alive and kicking in the minds of our pupils.

During the lessons when we did the survey and then discussed the results the boys tended to look upon the exercise as a bit of a waste of time. It was certainly the case that they would have liked to make a joke of the matter, had they been allowed to. The girls seemed to be interested and serious about it. Taking the attitudes to the exercise and the comments made as a whole it seems that many of the boys feel there is no need to even discuss the matter. The girls showed that they feel inferior to the boys, yet they seem willing to accept that this is just one of the facts of life; they do not seem to believe that it has anything to do with sexist prejudice.

CHAPTER 9.

SUMMARY AND CONCLUSIONS.

In this survey of girls and mathematics several facts have come to light. I also hold three hypotheses related to the issue. I shall begin by reiterating the facts, and then I shall examine to what extent I believe my hypotheses to be tenable.

THE FACTS.

(1) BOYS HAVE A BETTER SPATIAL SENSE THAN GIRLS.

It seems that this is a genetically determined factor, and gives boys an immediate and innate advantage over girls.

However, it is vital to note that whilst there are more boys than girls with this ability, some girls do have it. It would seem that it is not a matter of degree; it is not that boys have MORE ability in this field, but just that they are MORE LIKELY to have it.

(2) BOYS AND GIRLS ARE BROUGHT UP DIFFERENTLY.

Throughout history men have had the upper hand. Even today, boys and men are expected to be clever, adventurous, creative, aggressive and generally superior. Few people challenge the right of boys and men to assume superiority in most important areas of life. Men seem to be responsible for defining what is important. They then adopt ownership of these areas. Traditional femininity is a restrictive mode of being - it trivialises women.

(3) GIRLS DO NOT PERFORM WELL AT MATHEMATICS AFTER PUBERTY.

Up to the age of about eleven girls are better than boys in tests of verbal reasoning, English and arithmetic. From this age onwards their achievement and participation in mathematics declines rapidly.

(4) MOST MATHEMATICS TEACHERS TREAT BOYS AND GIRLS DIFFERENTLY.

Teachers praise girls for neatness and conformity, for being quiet and well-behaved, for being hardworking. Boys, on the other hand, are commonly expected to be better at mathematics. They are praised for being clever, for having natural flair and understanding. They are not expected to have to work so hard. Research has shown that teachers discriminate against girls when deciding which students will sit 'O' level examinations, and when marking pupils' work

and tests. There is much evidence in all aspects of education to show that pupils will fulfill the prophecies made about them. Because of this girls will tend to underachieve relative to the boys as this is what is expected to happen.

THE HYPOTHESES.

(1) THAT GIRLS START TO UNDERACHIEVE AT MATHEMATICS AT THE TIME OF PUBERTY BECAUSE OF THE IMPLICATIONS FOR THEIR SEXUALITY.

At puberty boys and girls come to realise the prominence of sexuality in adult life. Girls become aware that mathematics is a "male" subject, and since they do not wish to be seen to have any male characteristics they avoid being good at it. They fear success because it may imply masculinity. At this age the differences between the sexes are all-important to the young man or woman. Not to emphasise one's biological maleness or femaleness is seen as the ultimate failure as it leaves the door open to accusations of being "queer", one of the most serious and hurtful jibes at this age.

If tradition and upbringing did not play a large part in determining attitudes then one would expect more female

mathematicians. If spatial ability alone were the deciding factor the ratio of women to men in engineering and allied fields would be in the region of 2:3. In actual fact it is more like 1:100. Some other factors must be coming into play to account for this huge deviation. I claim that it is traditional sex-stereotyping, and in particular the fears imposed on boys and girls alike of the consequences of crossing the very well-defined boundaries of their sex. This has more serious implications for the girls as it is the men who delineate the boundaries.

(2) DUE TO FACTORS SUCH AS WOMEN'S LIB AND THE EQUAL OPPORTUNITIES ACT WOMEN NOW BELIEVE THAT THEY ARE FREE AND EQUAL. THIS IS A COMPLACENT AND DANGEROUS VIEW.

Few would disagree that girls today are more confident and less anxious than they were even ten or fifteen years ago. Certainly, the girls I teach now seem more positive than I or my colleagues were at their age. Women and women's rights have enjoyed a high-profile position in the intervening period, and this has resulted in girls and women becoming more aware of the possibilities open to them. However, except for in small numbers of cases, women have not capitalized on these opportunities and remain second-class citizens without even realising it. This complacency is dangerous - not being seen to want to be equal means that one will not be equal. My research showed

that girls think that boys are better than them, and accept that they will probably have a lower-status career than the boys. The girls seem to accept equality with the boys in the "Same But Different" sort of sense. What they do not realise is that where there are differences they are ones which militate against them. They are willing to accept that they are not as good as the boys at mathematics, but do not realise that this means that many highly-paid careers are thus closed to them. They believe in equality in marriage, but find themselves making all the concessions. The equality that they believe in does not in fact exist-but they are satisfied with their lot because they think that it does.

(3) THE PRESSURES DO NOT SEEM TO AFFECT HIGH-ABILITY GIRLS TO THE SAME EXTENT AS OTHER GIRLS.

From my own experience in schools I have noticed that girls at the very top of the ability range do not seem to worry to the same extent about conforming to stereotypes. I have no real explanation for this other than to suggest that such girls may see through the male posturing and carry on regardless. I emphasise however, that this is only true at the very top of the ability range.

This view is contradicted by Crandall (1969), and Stipek and Hoffman (1980) who suggest that it is the

brightest girls who experience the greatest degree of helplessness. Because of their "achievement orientation" (Licht and Dweck, 1983) or their unwillingness to engage in activities in which they feel they might fail, it is these high-ability girls who are most likely to underachieve, because in a sense they have most to lose.

CHAPTER 10.

RECOMMENDATIONS FOR THE FUTURE.

In the last chapter I pointed to several facts which pertain to the problem of why girls do not perform well at mathematics. I also suggested three hypotheses, two of which, the first and last, I feel go a long way to explaining why the problem has such a tenacious hold. Given this foundation one can begin to point to changes in practice and more general recommendations that might go at least some way to remedying the problem. I shall consider the problem in two sections: (1) particular and precise changes which should be made; and (2) a discussion of general and large-scale changes in philosophy. I believe that by a combination of the two we can go a very long way towards lessening the gap between boys and girls.

(1) RECOMMENDATIONS FOR CHANGE.

I shall begin by discussing the Royal Society's conclusions and recommendations. They address groups which they consider to be influential separately, but begin by making the general observation that Cockcroft says that it is vital to make girls aware from an early age that

mathematics is a qualification that is vital for entry into many careers. Hilary Shuard, in Cockcroft (1982) says that girls should be made as aware of the importance of mathematics in their future lives as boys are. I shall now comment upon the recommendations given to particular individuals and groups.

(a) SECONDARY SCHOOL TEACHERS OF MATHEMATICS.

The Royal Society notes that APU results show that by secondary school age girls are beginning to perform less well at mathematics than boys. They note that the "masculine" image of the subject causes girls to "react and begin to associate success in mathematics with an undermining of their femininity". Teachers make things worse by treating pupils according to their sex. The Royal Society makes thirteen specific recommendations. These advise teachers to try to be aware of their prejudices, and try not to expect more of boys than of girls. They suggest encouraging pupils in all aspects of mathematics, not just those in which boys traditionally excel. They should avoid making sex-stereotyped comments and giving praise for different qualities. They must ensure that all pupils have equal access to resources. They should encourage all pupils to consider taking mathematics into higher education. And finally, they should try to make sure that women teachers of the subject participate in INSET courses, and thus come to

be confident of their own grasp of the subject, if they are not so already.

(b) EXAMINATION BOARDS.

It has been shown that girls perform badly on multiple-choice tests. They also respond badly to failure, and are more likely than boys to give up when faced with a problem they are finding difficult. Girls have been brought up to be less competitive than boys, so the whole system of examinations distresses them more than it does boys. The Royal Society suggests that more continual assessment might help to redress the balance - it is to be welcomed that the GCSE is using this mode of assessment increasingly. The Royal Society makes specific recommendations to the examination boards: use assessments which are not gender biased. Try not to use stereotyped situations for questions. Use continuous assessment as much as possible. Promote "girls-friendly" syllabuses.

(c) EDUCATIONAL PUBLISHERS.

It is noted that by secondary age reference to girls and women in mathematics textbooks are severely diminished. Where they do feature they are often in "caring" or supportive roles. They are only very rarely shown in active or decision-making situations. Girls at this age are very

sensitive to society's messages - this should not be further compounded by seeing women in passive roles in textbooks. It has been pointed out to me that even the new SMP 11-16 material is guilty of this. The booklets are fine, but the books, intended for older pupils, are said to be still sex-biased. This is, obviously, unverified at present as not all the books are in print, yet it must surely be a cause for concern in this popular and up-to-date course. The Royal Society offers its suggestions to publishers: use illustrations which show girls and women using and enjoying mathematics. Balance references to the sexes and ensure that girls are presented with positive female role models in their textbooks.

(d) PARENTS.

Parents have an immense influence on their children's attitudes to mathematics. The children will tend to look to their same-sex parent as a model for their behaviour. The Royal Society stresses that parents should not expect differences in performance in their boys and girls. They should encourage their children to mimic both parents, not just the same-sex one. They should encourage their sons and daughters to be aware of women who have successful careers. They should not allow their children to play with sex-stereotyped toys, nor should they encourage differing types of behaviour in boys and girls. Finally, they should try to promote the importance and value of mathematics to

both sexes.

(2) CHANGES IN PHILOSOPHY.

The suggestions I shall make in this section spring largely from my hypothesis that (a) girls do not do well in mathematics because of the implications for their sexuality, and (b) girls and women think that they have achieved sex-equality and this makes them complacent. I shall consider ways that these problems may be approached, though I make few specific recommendations as to how they can be solved. This area is more general and does not lend itself to fixed solutions.

Firstly, then, I shall consider the proposition that girls do not want to do well in mathematics because of the implications for their sexuality, that they fear success in mathematics. (Horner, 1972). The "male" image of mathematics is perpetuated by parents, teachers, relatives, employers, the media etc. Besides following the specific recommendations given in the previous section, society must make an attempt to stop seeing all issues in gender terms. The qualities that are associated with being good at mathematics must be de-sexed. Being weak and passive must no longer be seen to be desirable in a woman. Girls and women should be expected to want a career, not simply to sit back and wait for marriage. Women do not have to give up

their femininity, it is just that femininity must be redefined. Women must learn not to make concessions, must not desire traditional femininity which cripples their individuality and their ability to succeed. It is still a man's world, but women do not have to pander to this by making themselves weak and ineffectual.

Now I come to my second hypothesis - that women think that they have achieved equality so they are complacent and accepting. In fact, they have achieved equality only in theory, the practice is very different.

Let me consider Isaacson's paper "Are Girls Really Free To Choose?" (in Burton, 1986). She gives a philosophical analysis of the way in which girls are "free" to choose, and argues that they are in fact more constrained than we might believe. She distinguishes two types of freedom. "Negative freedom" is the absence of any deliberate intervention into areas in which I might want to act. Thus girls are free, in the negative sense, to choose to study Physics. That Child Care happens to be in the same option block does not affect this negative freedom. Isaacson argues that while girls do seemingly have freedom of choice when it comes to options, in fact they will always tend to choose in a stereotyped manner. This happens simply because they have absorbed society's messages about gender.

"Positive freedom", on the other hand, is to do with "being my own person". My freedom to choose my own career is an example of it. However, girls' negative freedom to choose to study or not to study Physics may conflict with their positive freedom to choose their own career. Their positive choices are restricted by the lack of real freedom they have in other areas. The Sex Discrimination Act (1975) gave only negative freedoms. It did nothing to remove the existing prejudices which limit women's freedom of choice. Isaacson says that the removal of constraints while being necessary, is not sufficient to ensure freedom. Her solution would be to work in an evolutionary way to a more humane picture of mathematics, while simultaneously aiming to break down gender stereotyping of behaviour and career aspirations.

A similar view is held by David Craig (1987). There are, he maintains, two different concepts related to equality of opportunity. The "weak" concept is simply associated with access, whilst the "strong" concept is associated with a concern for equality of outcome. So while in most schools girls are equal in the weak sense, they are only sometimes equal in the strong sense. We must be prepared to look not only at what we offer our pupils, but at what happens in the end. If the end-product shows differentiation by sex, then something must be done to attempt to change this situation.

This then is the sense in which women have attained freedom and equality - they have it in theory, but they are prevented from exercising it by society's expectations and constraints.

Until women start to look about them and realise that there is still discrimination against them no progress will be made. In the end it comes down to women themselves being willing to pursue a battle they believe is worth winning. At present I am not sure whether they want to win it.

Walkerdine (in Wilkinson, 1986) points out that it is women in their roles as mothers and teachers who have been "placed as guardians of an order from which it is difficult to escape.". She argues "If you are told that you are totally responsible for the nature of the child, and with it, therefore, the possibility of freedom, of democracy - how much guilt and pain is involved in resisting such a notion?". She claims that woman's position is insupportable because of the contradictions they must come to terms with in bringing up the little girl to be "passive" and "good" - qualities she may not at all want to encourage. Women have the responsibility for bringing up children to suit the male image of the world - that they do this is ridiculous.

But here, it now appears, is part of the solution. If

women were to realise the conflicts and contradictions implicit in the way they perpetuate the accepted order, they would be in the perfect position to change and mould attitudes. Only when mothers and teachers start to react against sex-stereotypes will any real freedom be achieved. But best of all, such changes would be deep-seated and real because of the immense influence that women have over young children. If this were to happen, and the "male" label were to be removed from mathematics, a whole generation of girls would, for the first time, have equal access to the subject as the boys.

Until such time as this radical change takes place we must content ourselves with the recommendations made by The Royal Society. These will create a different atmosphere around mathematics, and begin in a small way to remove the "male" image. In the end it is this which causes the problems.

At this point some time ago I finished this dissertation, feeling that while my conclusions were not simple nor easy to implement, they did at least offer some chance of changing current practice. Since then, however, I have read an article in the T.E.S. reporting on some research done in this field by Pat Mahoney of Goldsmith's College. When she began her work some six years ago she arrived at conclusions similar to mine. They were, she

felt, if not easy to implement, then at least straightforward. Since that time, and after further research she now realises that "My naivety had been monumental". The problem is not simply that girls are "marginalized from classroom talk, physical space, high status jobs and from large parts of the male-orientated curriculum" but that they find themselves victims of sexual violence and harrassment. She reports an incident where three boys were responsible for a sexual assault on a younger girl. Their punishment was to be suspended for one week, after which time they returned to the school as heroes. Much verbal abuse takes place in schools, with girls becoming used to it to the point of sensitization and acceptance. Mahoney's solutions now are more complicated, and consider the possibility of offering girls-only rooms in schools. Most of all, though, she suggests that male teachers should play their part in changing boys attitudes - although very often it is the male teachers who are the perpetrators of much of the abuse and innuendo.

My own experience over the past few weeks would tend to support this. I have had the opportunity to observe mathematics classes in a variety of schools in the Manchester and Cheshire areas. In all of these the domination by the boys was extremely evident, but its form was aggressive and vindictive. In one school I watched a male pupil going round the room asking for a pencil

sharpener - he asked only girls, and when he was not given what he wanted he made remarks such as "slag" or touched the girl in an unwarranted fashion. The girls seemed to accept this sexual harrassment and mumbled complaints to their neighbours - not one told the teacher or became angry with the boy. This was not an isolated incident - I have seen many such examples where boys have treated girls in this way and expected to do so without admonishment or retaliation.

In the light of this the problem begins to take on a sinister air. Until people become aware of this aspect of the issue no progress can be made. I would urge that all teachers look to their own classrooms to see if this sort of thing is going on - and if it is to stamp it out with the greatest of urgency. I became very angry when I saw what was happening in the incident mentioned above, hopefully more people will become angry and incensed at this amazingly cavalier attitude. Once the anger turns into action things will begin to change.

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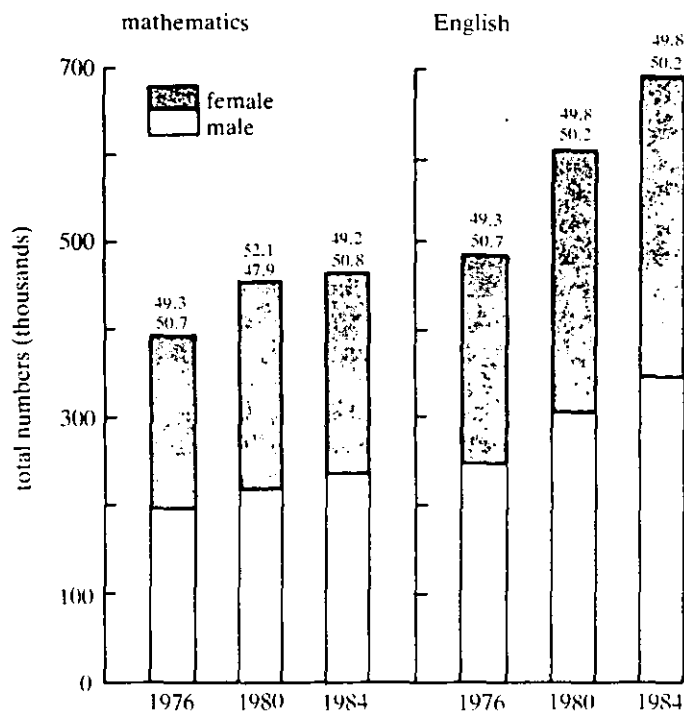


FIGURE 1a. Total numbers entering C.S.E. examinations (English and Welsh examination boards) in summer 1976, 1980 and 1984, by gender. The school population in England and Wales in 1985 at 15+ was boys 392 980, girls 377 539. The percentage of males and females entering examinations each year is marked on the bars. In all figures the top percentage figure applies to the top section of the bar, the lower percentage figure to the lower section of the bar.

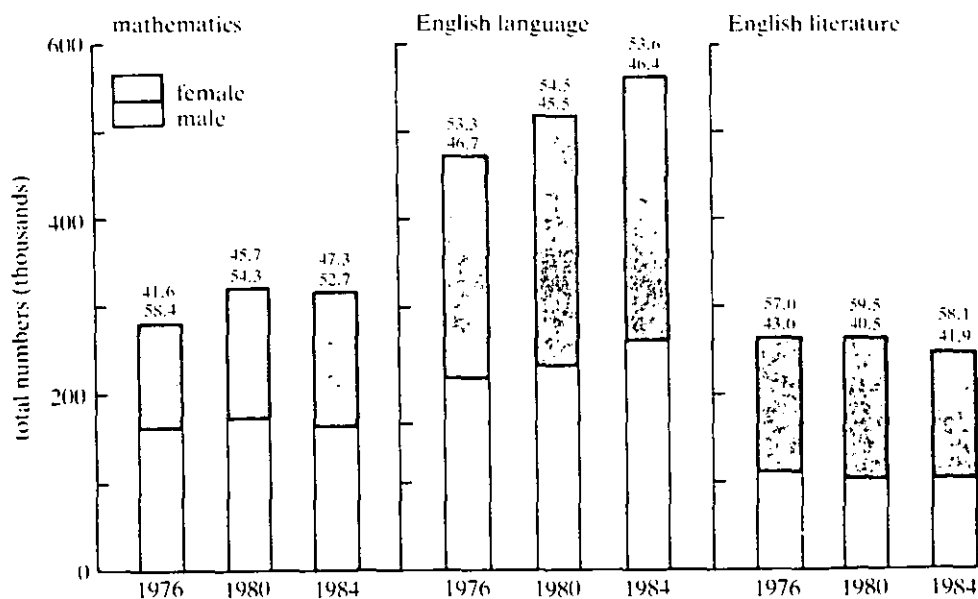


FIGURE 1b. Total numbers entering G.C.E. O-level examinations (English and Welsh examination boards) in summer 1976, 1980 and 1984, by gender. The school population in England and Wales in 1985 at 15+ was boys 392 980, girls 377 539. The percentage of males and females entering examinations each year is marked on the bars.

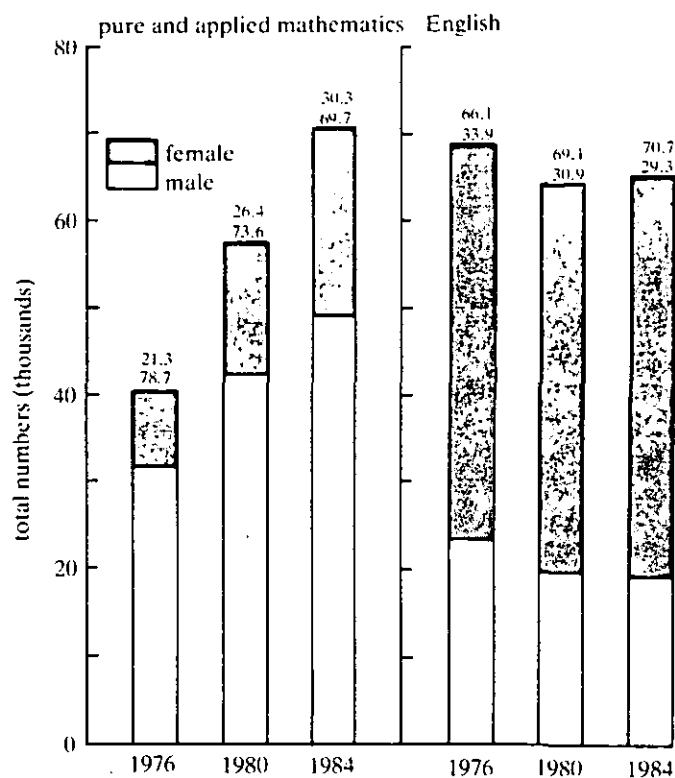


FIGURE 1c. Total numbers entering G.C.E. A-level examinations (English and Welsh examination boards) in summer 1976, 1980 and 1984, by gender. The school population in England and Wales in 1985 at 17+ was boys 79 476, girls 78 566. The percentage of males and females entering examinations each year is marked on the bars.

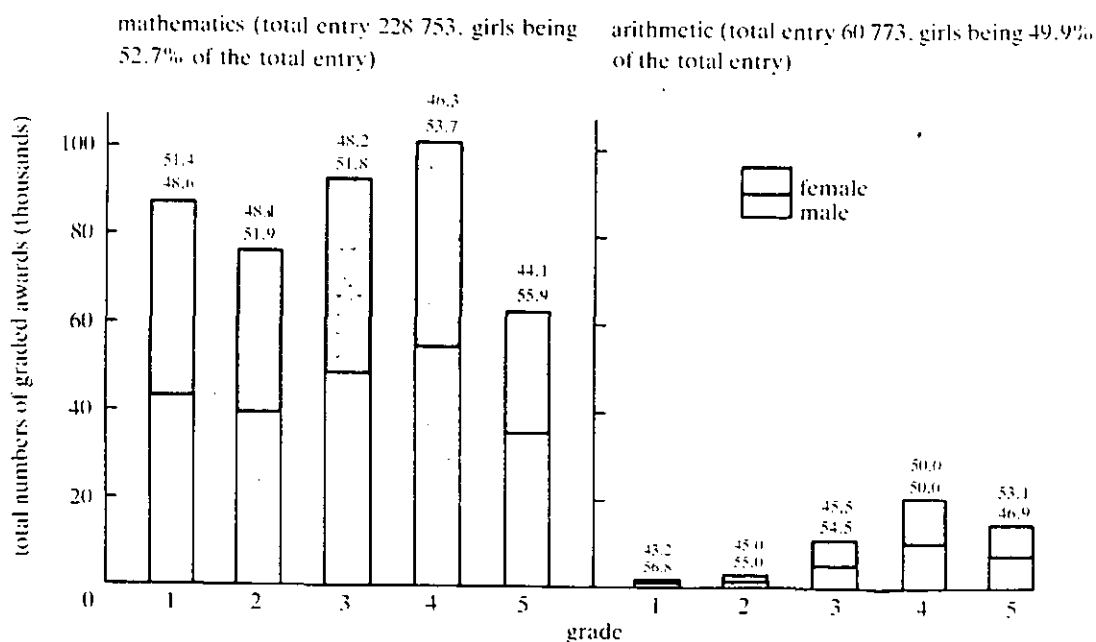


FIGURE 2a. C.S.E. examinations achieved by grade and gender in summer 1984 (English and Welsh examination boards including Welsh common syllabus entries). The school population in England and Wales in 1985 at 15+ was boys 392 980, girls 377 539. The percentage of males and females awarded each grade is marked on the bars.

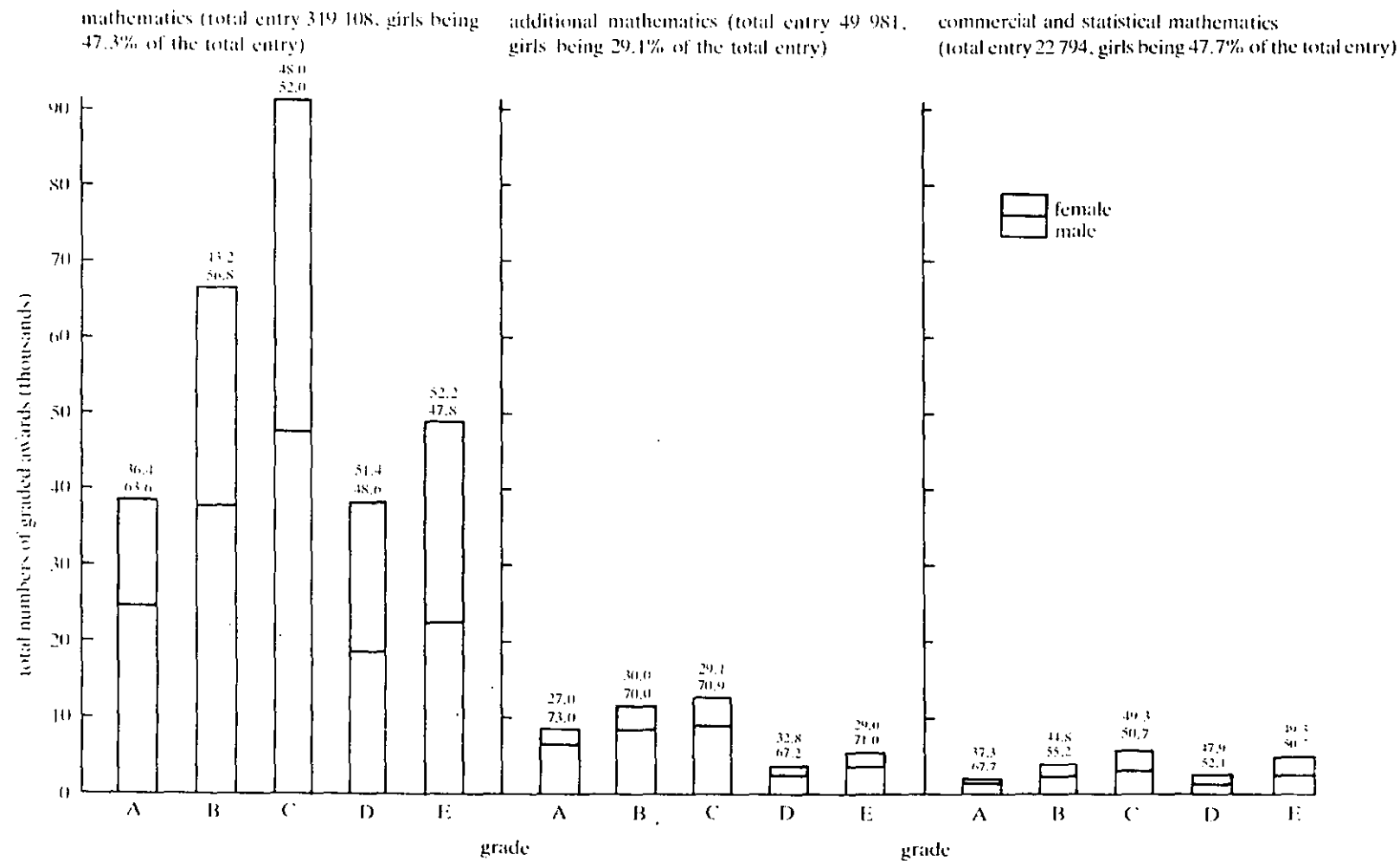


FIGURE 2b. G.C.E. O-level examinations achieved by grade and gender in summer 1984 (English and Welsh examination boards including Welsh common syllabus entries). The school population in England and Wales in 1985 at 15+ was boys 392 980, girls 377 539. The percentage of males and females awarded each grade is marked on the bars.

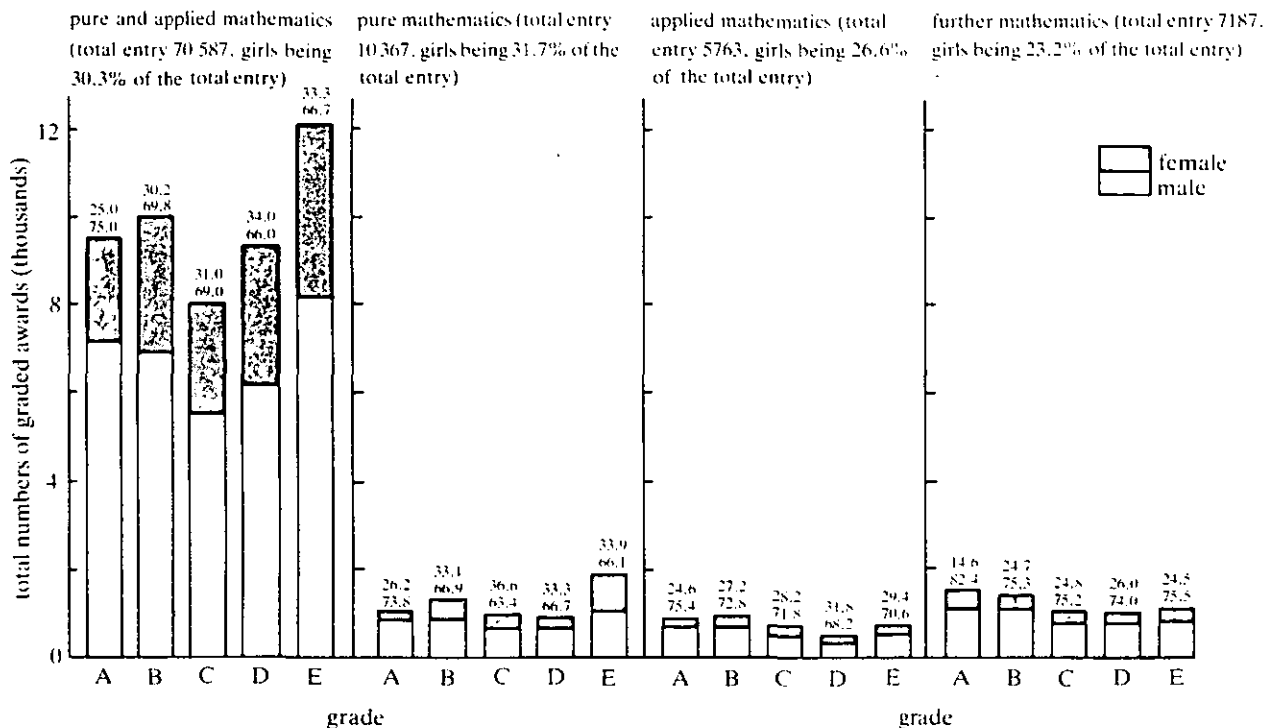


FIGURE 2c. G.C.E. A-level examinations achieved by grade and gender in summer 1984 (English and Welsh examination boards including Welsh common syllabus entries). The school population in England and Wales in 1985 at 17+ was boys 79 476, girls 78 566. The percentage of males and females awarded each grade is marked on the bars.

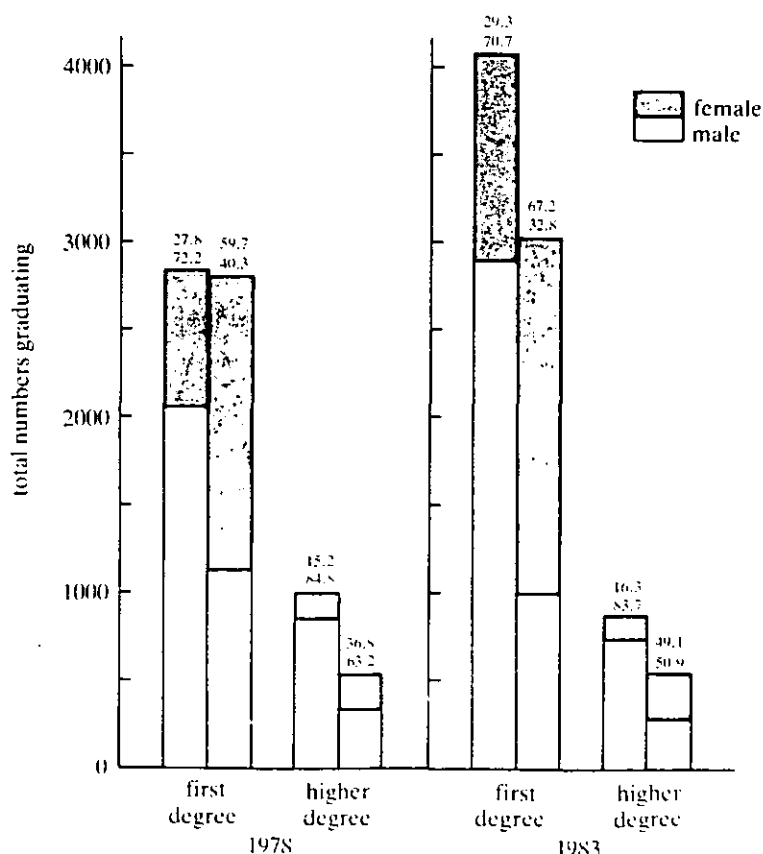


FIGURE 4. Total numbers of degrees obtained in Great Britain in 1978 and 1983. The percentage of males and females obtaining degrees is marked on bars. The figures for mathematics are on the left-hand bars, those for English on the right.

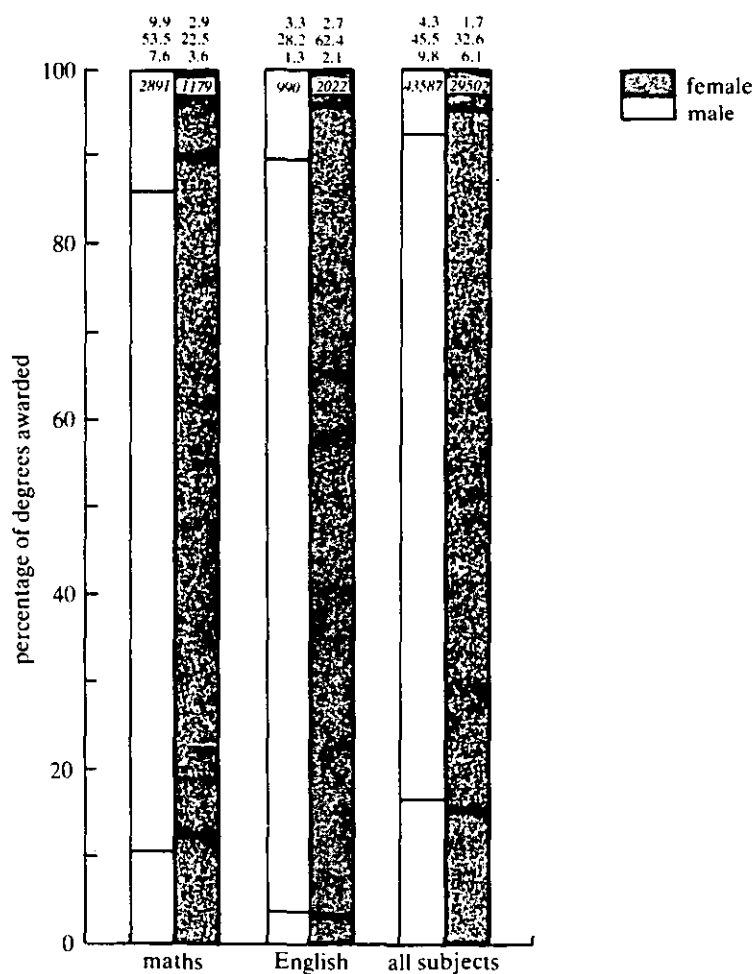


FIGURE 5. First degrees obtained in Great Britain in 1983 by gender. The percentage of males and females awarded each grade in each subject is marked on the bars. Each bar is divided into three sections. They are, top to bottom, first, other honours and pass degrees. Total numbers of males and females awarded a first degree in each subject are marked in italics in the top section of each bar.

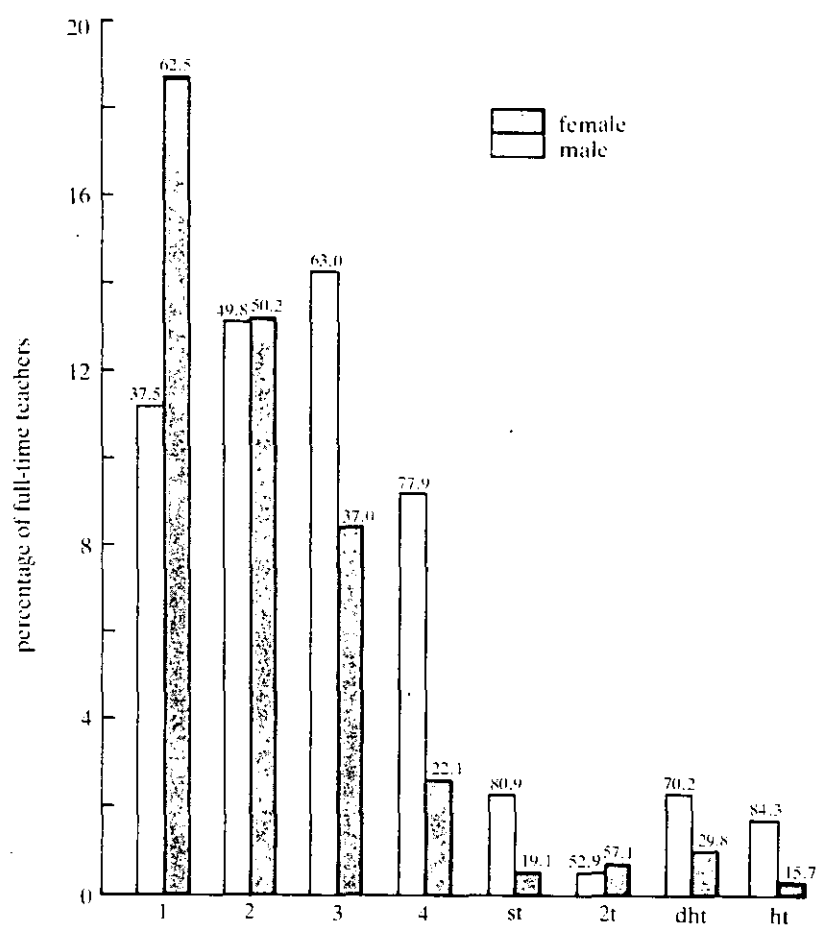


FIGURE 6. Proportion of male and female full-time teachers in secondary schools in England and Wales in 1983. The total numbers were male 132 606, female 110 308. The percentage of male and female teachers at each grade is marked on the bars. Grades are indicated thus: 1, scale 1; 2, scale 2; 3, scale 3; 4, scale 4; st, senior teachers; 2t, 2nd teachers; dht, deputy head teachers; ht, head teachers.

