Gender Differences in Performance on an A Level Mathematics Paper

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1. Aims of the study

This research aims to replicate the study by Forbes (1988) who investigated gender differences in attainment in a Scholarship examination in mathematics. There are three major differences between this study and hers. First, this research is based on a mainstream Advanced Level examination paper rather than a Scholarship paper. Second, the study aims to discover whether the results found in New Zealand apply to pupils in Britain. Third, the examination paper includes questions on mechanics, which did not appear in the New Zealand examination, as well as statistics and pure mathematics.

Following Forbes, the initial hypotheses are that girls and boys will perform equally well on some, at least, of the pure mathematics questions. There is also the opportunity to look for gender differences in attainment in mechanics questions.

2. Gender differences in mathematics : an overview

If the statistics published by examination boards in England and Wales are analysed it will be seen that, for all boards, a higher proportion of boys do achieve grade A as compared to girls, in all Advanced Level mathematics examinations. Interestingly though, girls are relatively more successful than boys in the Associated Examinations Board A Level Statistics, for which a higher proportion of girls than boys gain grade A.

APU surveys (1978-80a,b) at primary and secondary level have shown that there are differences in the mathematical performance of boys and girls even at age 11. The boys performed better in applied and practical areas of measures, rate and ratio. Girls did better in computation (whole numbers and decimals) and algebra, although by age 15 they had slipped marginally behind the boys in these topics as well as in others. Also, the top 30% of attainers accounted for most of the differences in performance between

boys and girls at 11 and 15. In the 1978 secondary survey the top 10% of all pupils in mathematics was split between 61.5% boys and 38.5% girls. This difference between the top attainers is established at age 11 and is no doubt at the root of the differences which appear at A Level, in entries and results.

Walder and Walkerdine (1985) see the need for a dynamic model of learning in which children are not simply passive recipients of external social forces. They question the efficacy of attempts to introduce better role models for girls, to change stereotyped images in textbooks, and to provide information. They maintain that girls struggle to achieve femininity of the kind which will make them appear "attractive", "nice" and "kind" and that attempts to change this behaviour may well meet with serious resistance.

In her latest book, Valerie Walkerdine (1989) criticises the findings of the APU surveys, saying that:

> "The differences between boys and girls ranged from 1 or 2 percent to about 8 percent. They were considerably smaller than the differences between pupils living in metropolitan areas, and were totally swamped by the differences between the regions of the United Kingdom or between schools having high or low percentages of free school meals."

Walkerdine tries to discount the differences found between boys and girls as even small differences can become statistically significant over very large samples (rather than small-scale studies where evidence for such differences tends to become anecdotal). Walkerdine sees the need for a new approach in the teaching and content of mathematics so that females are not placed in a disadvantaged or less powerful position relative to males. (She has few recommendations, though, of how this might be achieved.)

To conclude then, there is some controversy as to whether girls actually are failing at mathematics, or whether their achievement is not being adequately assessed by the present system. Various theories are put forward to explain any lack of success in mathematics by girls but most of these are unable to account for their competence in primary school. Certainly, girls do opt out of mathematics physically at age 16, and perhaps also mentally before the age of 16, at least for average or below average ability groups.

3. Description of the study

The examination paper used for this study was the SMP Mathematics Advanced Level Paper 1 set in June 1988. This paper was chosen because all the questions are compulsory (there are no optional sections) and they cover all of the three main areas traditionally studied at A Level: pure mathematics, statistics and mechanics.

As SMP (or the School Mathematics Project) is not itself an examination board, its examinations at A Level are administered by all the examination boards. This means that candidates all sit the same SMP examinations on the same days.

The sample consisted of 2884 candidates who sat the SMP A Level Mathematics examination in June 1988. All candidates taking the examination with the Oxford and Cambridge Joint Matriculation Board (JMB) were included in the sample. The candidates were split into eight sub-groups by school type and sex, as shown in Table 1.

TABLE 1
Composition of sample and mean total marks

Category of School	Boys		Girls	
	No.	Mean	No.	Mean
Independant	1356	83.80	189	75.89
Grammar	140	80.3	9	68.1
Comprehensive	722	68.51	313	63.37
Sixth Form College/FE College	102	72.33	53	69.43
Total	2320		564	

The majority of schools entering candidates with the Oxford and Cambridge Board are independant schools, while most of the schools entering candidates with JMB are comprehensive schools, with smaller numbers of grammar schools and sixth form colleges.

Nationally, girls form about 30% of the total number of candidates for A Level pure and applied mathematics, so girls are under-represented in this sample. Independant schools, on the other hand, are over-represented, and have a high proportion of male candidates, thus contributing to the preponderance of males in the sample.

Unfortunately, the number of girls from grammar schools is very small indeed, making it difficult to give any firm conclusions about that group. For the major part of the analyses used in this study, the sample is split into the eight sub-groups for comparison. At no time is the entire sample amalgamated, and the unusual proportions of the various sub-groups within the total sample do not affect the conclusions drawn.

4. Analysis of the results

The data were sorted and analysed using SPSSX on a mainframe computer. Two-tailed significance tests were used on the means, and have only been quoted as significant where the 5% level, at least, has been reached.

The data were analysed for gender differences in mean marks, i.e. girls' mean marks were compared to those of boys at the same category school. School differences were also analysed by comparing all school groups for girls and boys separately. So, firstly, girls were compared with boys at the same type of school, then compared with all other girls (and boys with all other boys). This was done to see whether girls seemed to be particularly disadvantaged (or advantaged) relative to boys at any one category of school and at which type of school girls did best in comparison to other girls.

Table 1 shows the mean total marks for boys and girls at all four categories of school.

For candidates attending independant schools or comprehensive schools, the boys' mean total mark is significantly different (i.e. higher) from that of the girls in the corresponding school category. While there is a difference between the mean total marks gained by boys and girls from grammar schools, the sample of girls is too small for the

measured difference to be statistically significant. Interestingly, only the girls attending sixth form colleges (or FE colleges) have a mean total mark which is sufficiently close to the boys' mark, for the difference not to be statistically significant.

The gender differences in attainment are worrying as girls make up the smaller proportion of A Level mathematics candidates (only 30%) so one might assume that they would be of higher average ability than the larger group of boys. It is possible that many girls of very high mathematical ability do not take the subject at A Level due to social factors and/or a lack of confidence in their own ability.

While it is possible to indicate significant differences between the mean scores of candidates from different categories of schools, these may indicate differences in the pupils' ability rather than other factors influencing attainment. This is likely to be true if pupils from selective schools, i.e. independant or grammar, are compared with those attending non-selective schools, i.e. comprehensive or sixth form colleges. Also, there are differences in the provision of resources, time allocated to lessons, and the qualifications of teachers between these two categories of schools.

Nevertheless, the following important differences between schools were found, with girls' and boys' results analysed separately.

Girls attending independant schools do gain significantly higher mean marks than girls attending comprehensive schools. However, their superiority does not extend over girls attending sixth form colleges and FE colleges. The mean marks obtained by these girls at tertiary colleges also compare very favourably with those of their male counterparts. There are high numbers of graduate specialist teachers at such colleges and it may be that girls respond well to the mature college atmosphere.

No further significant differences were found when other groups of girls were compared: comprehensive and sixth form college candidates, for example.

Among boys, more of the differences were significant. This is due in part to the fact that the sample sizes for boys were larger, thus making it more likely that small differences will reach statistical significance.

Boys attending independant schools and grammar schools both have significantly higher mean scores than boys from either comprehensive schools or sixth form colleges.

No significant difference was found between the mean total marks of boys from comprehensive schools and sixth form colleges.

4.1 *Analysis of individual questions*

A summary description of the examination questions is set out below in Table 2.

Questions 1-12 inclusive were worth 5 marks each; Questions 13-20 were worth 10 marks each. Boys achieved significantly higher marks at the 0.1% level on Questions 3, 6, 14, 15, 16, 18 and 19 for the independant schools and on Questions 6, 15 and 16 at comprehensive schools. They also scored significantly better than girls at the 5% level on Questions 10, 11, and 12 for independant schools and Questions 3, 14 and 20 for the comprehensive schools. Within the grammar schools, boys scored significantly better at the 5% level on Question 17, and within the FE colleges on Questions 3, 6 and 15. Only in one case, Question 1 for the FE colleges, did the girls score significantly better than the boys (5% level).

TABLE 2
Summary description of questions

1.	statistics - histogram	11.	sums of series
2.	statistics - probability	12.	mechanics
3.	sketching trig functions	13.	calculus - differentiation sketching
4.	calculus - differentiation	14.	trig functions
5.	complex numbers	15.	mechanics
6.	mechanics	16.	sine and cosine rules
7.	Simpson's rule	17.	binomial/normal approximation
8.	vectors	18.	matrix transformations
9.	calculus	19.	vectors
10.	trig functions	20.	functions/rates of change

5. Conclusions

Generally the results on the statistics questions provide only qualified support for Forbes' (1988) findings. For Questions 1 and 2 the girls do perform as well, or better than, the boys, but for Question 17 the results are mixed.

For the mechanics questions, boys, in general, have higher marks than girls, and students at independant schools have an advantage over their peers at comprehensive schools. Mechanics is clearly a difficult topic for many candidates, with large numbers (particularly girls) scoring low marks, and a large proportion of candidates failing to attempt these questions at all.

In summary, although there were clear differences between pupils attending different types of school, these by no means overshadowed the differences between girls and boys. On the contrary, the type of school magnified the gender differences, with selective schools having the greatest differences between girls and boys.

References

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