# Statistics - Keeping it in the Women's World

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## 1. Introduction

After a student's school experience of statistics, university study must often seem dry and arid indeed. In the last decade New Zealand schools have put enormous effort into making mathematics, and statistics in particular, as accessible and as relevant as possible to as many pupils as possible. And they have had demonstrable success - the increase in the proportion of young women taking mathematics at 6th Form is from 55% to 70% from 1974 to 1987 (Pole, 1989).

This upward trend is particularly marked in the final (7th Form) year of secondary schooling in which two mathematics courses are available, "Mathematics with Statistics" and "Mathematics with Calculus".

At the end of the 7th Form year the majority (78-80% or some 10,000) of students in New Zealand secondary schools sit the Bursary examination. Mathematics is an optional subject for this examination and students can choose one or both of the Mathematics with Statistics and Mathematics with Calculus papers.

In both 1987 and 1988, of the students that sat the Bursary Mathematics with Statistics examination (8070 and 9961 respectively) there were about 59% boys and 41% girls. There was an increase of 20% in the total number between the two years which compares favourably with the increase of 18% in the number of students in all subjects. This can be broken down into an increase of about 17% for boys and 23% for girls (Forbes et al., 1990).

Thus, in the secondary schools, statistics, above other branches of mathematics, is proving attractive to female students. What happens then when this substantial proportion of young women come to university - do they continue to study statistics and do they succeed at it?

TABLE 1
Percentage of girls taking Bursary examinations

| Examination | Percentage of girls |
|---|---|
| 1987 Mathematics with Calculus | 38 |
| 1988 Mathematics with Calculus | 37 |
| 1987 Mathematics with Statistics | 41 |
| 1988 Mathematics with Statistics | 42 |

## 2. Statistics at the tertiary level

At Victoria University of Wellington there are two first year statistics courses. They have different aims, backgrounds and destinations in mind:

> *STAT 131 Data and Probability Analysis* - this course is designed for those students with a stronger school background in mathematics and statistics (which could include many women as we have seen), who wish to continue in the subject .
> *STAT 193 Statistics for the Social and Natural Sciences* - this course is for those with a weaker school background in mathematics and statistics and is a terminating course.

The gender breakdown for these courses for the last few years is as follows:

TABLE 2
Females in first year statistics courses

| | Percent female | | Female percent of A grades | |
|---|---|---|---|---|
| Year | 131 | 193 | 131 | 193 |
| 1986 | 23 | 45 | 21 | 59 |
| 1987 | 20 | 44 | 26 | 62 |
| 1988 | 30 | 36 | 27 | 48 |
| 1989 | 21 | 41 | 25 | 59 |
| 1990 | 37 | 52 | 37 | 57 |

It is of concern that the proportion of females in 131 has only, with particular effort, approached that of females in general mathematics courses. It is also of concern that there is always a greater proportion of females in 193 than in 131 when this is the course for the ill-prepared and yet we expect more and more females to have studied seventh form Mathematics with Statistics. Can it be that in the university we are doing something that actively puts young women off the 131 course which is the one they should be taking if they are to continue in statistics?

It would seem to be easier, in general, for females to succeed in the 193 course than in the 131 course as they consistently take a larger proportion of the A grades than their proportion in the class. A small group of students take both courses and for such students, with rare exceptions, their grades in both courses are remarkably close, usually within three marks out of one hundred, so there is no reason to suggest that one of the courses is markedly easier than the other.

In 1989 the female students in the 131 class were better prepared than the male students (in terms of school background), female marks were higher in tests, yet in the final examination their scores were poorer (Blithe, 1989).

## 3. Reasons for the gender imbalance

There are some external reasons why the female students should not do as well as the males: in the final year of secondary school a far smaller group of girls (about 45-47%) compared with 64% of boys are opting to do both mathematics papers. Thirty-six percent of boys took Mathematics with Statistics only, compared with 53-55% of girls. Whereas approximately half the students sitting only one paper are female, just about one-third of those sitting both papers are female. Students sitting both papers have an advantage over those sitting only Mathematics with Statistics because of the overlap in the pure mathematics section and the greater depth studied in these topics in Mathematics with Calculus (Forbes et al., 1990). This advantage continues on at university where the ever-increasing calculus content of statistics courses and particularly in STAT 131, makes them harder and harder for those students who have little of it in their background.

In the 1989 STAT 131 final examination the males performed better in five of the six questions. They performed better in the abstract questions and overall the examination had six abstract sections, four sections involving people (or animals) and two involving machinery. One of the "people" questions also involved cars. This suggested that an imbalance in question content may also be affecting results.

Over the last few years the mainstream first year courses in algebra, geometry, and calculus, and the first year statistics courses at Victoria University have had the content of their problems analysed. All the problems that were set either for assignment or given as optional tutorial exercises or set in term tests were looked at. It was found that, compared to the 3-4% of practical or non-abstract questions set for assignment in the algebra, geometry and calculus courses, the statistics courses did much better.

In STAT 131, problems were categorised into abstract and traditional (urns, dice, $P(A \cup B)$, cards, coins, random numbers ...), problems about people and animals (blood pressure, bacteria, ...) and a smaller category of non-traditional and non-abstract problems whose content could be seen as belonging to that sphere of activities that is traditionally thought to be appropriate to males (Morse code, football matches, stock market). The breakdown was as follows:

| | | |
|---|---|---|
| 131: | abstract or traditional problems | 70 |
| | non-traditional and non-abstract problems from the boys' world | 10 |
| | people problems | 36 |

In STAT 193 the breakdown was rather different:

| | | |
|---|---|---|
| 193: | abstract or traditional problems | 50 |
| | problems from the boys world | 7 |
| | people problems | 64 |

Clearly there is a far greater proportion of "people" problems in 193 than in 131.

This difference in content certainly suggests some reasons why the female students might be preferring to opt for STAT 193 over STAT 131 as there is much research to show that "The most influential factor in girls' attitudes to study is whether the subject is perceived as a 'male' or 'female' subject" (Purser and Wily, 1987). New Zealand universities have few female academic staff, so female students do not have many role models. In the six New Zealand universities, 25 staff are teaching first year statistics: three are female. STAT 131 has two male lecturers while STAT 193 has three male lecturers and one female lecturer. It does not seem that an effort is made to try to offset this disadvantage by taking particular care with the content of assignment and tutorial material.

The masculine image of mathematics is often reinforced in our lecture rooms by the very nature of many of our traditional examples, especially in probability. Many of the classical examples from gaming that we use are more familar to male students and many of them have experience of playing such games.

One of the Royal Society recommendations in it's report *Girls and Mathematics* (The Royal Society, 1986) was that classroom teachers should "encourage all pupils to talk about mathematics and attempt to bring a 'social' (perceived as "female") element to the teaching. Introduce group work and cooperative teaching styles; do not allow boys to dominate discussion in mixed groups or girls to defer to boys in discussion." Schools are getting increasingly good at this sort of thing.

This is just as pertinent to university teaching and how we run our classes and, in particular, our tutorials and consultations. In New Zealand universities we are still a long way from bringing a social element to our teaching and group work is still largely frowned upon.

This paper is concerned with the average female student; and I remain to be convinced the universities are doing nearly enough for them. If teachers in the primary schools can be expected to teach the full range of natural talent and ability that is presented to them, surely we in the universities should manage to deal with the 18% of the cohort (Vere-Jones, 1985) that comes to us and, in particular, to the female component of that 18%!

## 4. Advantages of studying statistics

Are there advantages to females in studying statistics anyway apart from the obvious ones of general educational benefit and intrinsic interest? In New Zealand there are such advantages.

Surely equity, if it means anything, must mean having an equal chance at the jobs that are available today. We have to fit all our students for the jobs that are available. What are these jobs? Firstly they are fewer and fewer in the manual sector.

It is predicted that by 1997 manual jobs in the primary and manufacturing sector will have dropped to 19% (Haines and Callister, 1989). The fastest growing jobs are (Haines and Callister, 1989):

Fastest Growing Jobs, 1976 - 1986

| | |
|---|---|
| *Statisticians*, systems analysts | +125% |
| Professional, technical others | +108% |
| Economists | +106% |
| Government administrators | +104% |
| Broadcasting | +91% |
| Managers | +78% |
| Clerical supervisors | +76% |
| Working proprietors | +67% |
| Jurists | +55% |
| Authors and journalists | +47% |
| Artists and photographers | +51% |
| All Occupations | +10% |

Not all of these employ large numbers of course, and the jobs that are expected to grow the fastest are the ones with the higher levels than average of commmunication, reasoning, and number skills.

In some of these expanding areas of employment for which there were high hopes of an equitable sharing of the benefits, influences are already at work that appear to show that these benefits are primarily going to men. Of course statistics isn't the only area in which this is happening - the trend began in computer science both here and overseas.

At Victoria University 30% of first year computing students are women but they make up only 6% of the graduating year (compare with, for example, mathematics, in which women make up 32% of first years and 38% of third years) (Boutel, 1988).

This is not just a New Zealand phenomenon; in the UK the number of women reading computer science has been steadily decreasing for some years now. The percentage of women taking computer science there has fallen from 25% in 1978 to 15% in 1984 and is currently of the order of 10% (Lovegrove and Hall, 1987).

## 5. Conclusion

Bearing in mind that STAT 193 is a terminating course it seems that our existing courses do not encourage many female students to continue on to higher levels. An urgent appraisal of the content of all lecture examples, and assignment and test questions, needs to be made to ensure that our female students are given a fair chance to tackle problems that are relevant to them and to enjoy and succeed in university statistics.

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