

Gerald's Column by Gerald Fitton

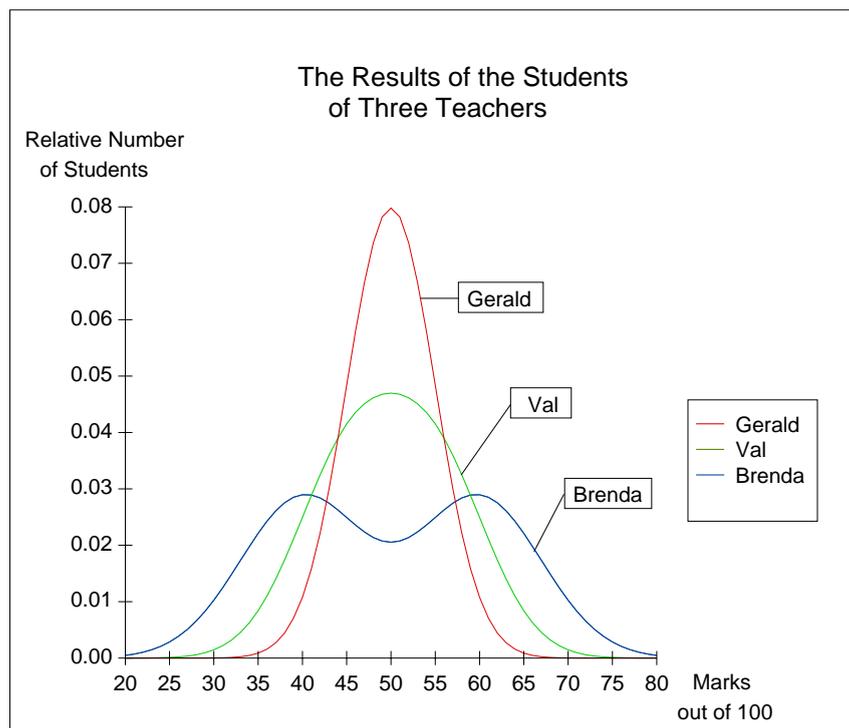
Earlier in this series I explained how a Probability Distribution Function (PDF) could be built up theoretically using the symmetry. An alternative method which I introduced a couple of months ago is based on making many measurements of the statistic.

Having recorded many measurements what can be done with them? Descriptive Statistics is the subject which covers the techniques used to consolidate masses of data into a few numbers which describe the statistical distribution.

There is no doubt that 'The Middle' is the most important parameter of a distribution. We've spent a couple of months on finding and using numbers that describe this 'Middle' of a distribution. In this article I shall try to persuade you that it's useful to have a number which describes the 'width' of a distribution.

Narrow or Wide

Have a look at the graph below. Archive is published in monochrome so you will not see how I have used three different colours for the three lines. Buy the CD or download the Impression file. Then you will see that the lines labelled Gerald, Val and Brenda are in red, green and blue respectively! If you can't be bothered then you will just have to make do!



I would like you to notice that the 'Middle' of all the three lines is 50%. If we were to use this parameter to decide which lecturer is 'best' and which is 'worst' then, well sorry, but there's nothing to choose between them. Of course, there is a difference between the performance of the three lecturers. What is it? You will not have failed to notice that Brenda's results are more 'spread out' than are Gerald's.

Is this different important? Can it be quantified? Is it useful? Read on!

The Department

In order to understand the importance of this ‘spread’ you need a little background.

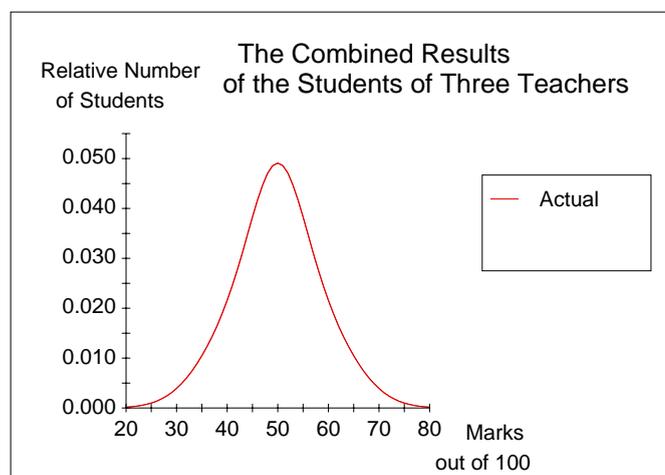
My story is set in the mid 1980s when Performance Indicators for Colleges was just coming into vogue. As one of seven maths lecturers in the Science & Humanities department I taught all sorts of mathematical things to all sorts and ages of student. My department, S & H, employed about forty of the College’s three hundred lecturers. Within S & H, subjects ranged from maths and physics to psychology and philosophy; the maths section was by far the largest.

Our Maths section was deemed to have Performance Indicators too far below average. Bill, our Head of Department was under serious pressure to ‘fix it’ or give way to someone else who could. I would like you to cast yourself in the role of Bill.

The Data

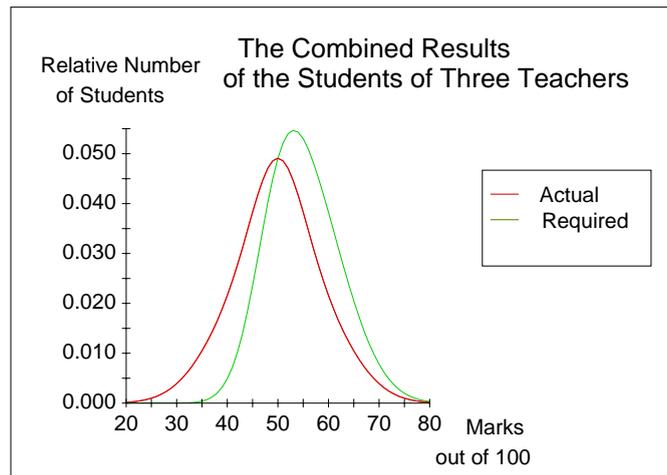
In the interests of simplification I shall restrict my discussion to just the three maths lecturers, those whose names appear in the graph.

We used to run a mock maths exam at about Christmas time and, from previous experience, the mock exam results reflected quite fairly the performance of the various lecturers. The results of the real exam in June were returned as A, B, C, D, etc whereas our mock exam returned numerical data which was much more finely graded.



The graph of combined results is (almost) representative of our mock exam results. I have cheated, but only a little bit! I have used a mathematical model which represents the salient features of the situation rather than risk obscuring them with a lot of irrelevant detail. My simplification includes making the graphs symmetrical about a mean of 50%. In fact the mean was a little higher, the results were spread more widely and the distribution slightly skewed.

In order to avoid further criticism from the body responsible for generating this ‘Performance Indicator’ of our exam results we needed to raise our mean mark from 50% to 55% as indicated in the graph below. What could Bill do about it?



Is Gerald the 'Bad' Lecturer?

The first performance criterion to come under scrutiny was the percentage of students who got a Grade A. In the model I'm using 68% corresponds to a Grade A. It soon became apparent that, of all seven Lecturers, Gerald's Students got the fewest Grade As. Indeed it was rare for any of Gerald's Students to get more than 65% as the first graph shows. I'm sure that you will appreciate that when this (number of grade As) Indicator was revealed, the lecturer whom I'm calling Gerald felt a bit sick!

Brenda, as well as being a maths teacher was also the number two in the department. She had a rod of iron and a kind heart. It was she who pointed out to Bill that Gerald also had the fewest (indeed hardly any) failures. That led us to look at the failure rates for each of our seven lecturers.

Val

Now Val was what we would all describe as a good competent 'standard' lecturer. Her results were fairly typical of five of our seven maths lecturers. Her students' marks ranged from about 30% to about 70% whereas Gerald's ranged from about 35% to 65%.

It was Val who gave us a clue to what was happening. She said "I get on better with some of my students than others"

How about Brenda?

Now we come to Brenda.

Brenda's weaker students used to say of her that she "Took no prisoners". Our best students got on very well with Brenda but, those that couldn't keep up with her were lost!

Brenda was the most brilliant mathematician in our Department. If I ever had a mathematical problem I couldn't solve then I would take it to Brenda and she would come up with the answer so quickly that I wondered if I were going senile!

I have to admit that, in my simplified representation of the problem here, I don't do justice to Brenda. My mathematical model implies that she 'lost' half her students. It was nearer a third than a half—but, nevertheless, quite a lot of students.

Brenda achieved the highest percentage of Grade A students by far—but also the highest failure rate. The antithesis of Gerald's results. Gerald's are 'squashed together' whereas Brenda's are spread so far apart that the distribution is what is called 'bi-modal'.

Does that make her a 'better' or 'worse' lecturer than Gerald—or just different?

Bill's Problem

Now, what I would like you to do is to put yourself in the position of Bill, the head of our department. He was the one who was being threatened with the sack. He had to improve out joint performance. What could he do about it?

Next month I might be persuaded to tell you what he did—in the meantime perhaps you'd like to think about it and tell me what you would do. Who would you take off the maths course, Gerald or Brenda?

I have told you this story so that, when you read of 'bad' and 'good' lecturers or teachers, you will realise that such statements (based only on where the Middle is) is not as simple as it first appears. The mean mark for all our three lecturers was the same, 50%. Indeed, any lecturer with a much reduced mean mark would get a 'wiggling' from Brenda and be threatened with the ultimate sanction, a Staff Training Course!

What differed from lecturer to lecturer was the spread of their results. Each lecturer was 'good' with students of a particular range of ability; Brenda could stretch the best students whilst Gerald could pull the weak students up from the brink of failure.

Next Month

I realise that this month I haven't mentioned the word "Spreadsheet" nor even "Computer". The reason is that I felt it important that you understand why being able to put a number on the width of a PDF is important. Next month I shall tell you about such a number and I'll also help you to understand why most spreadsheets include two functions (with names such as `std()` and `stdp()` or something similar).

The reason why there are two is not simply to confuse you—even though that is a common enough consequence of this proliferation of measures of the width of a PDF.

In the meantime, if you have a suggestion which will resolve Bill's dilemma then please write to me or email me.