# Gerald's Column
by Gerald Fitton

There are a few bad teachers but nothing like as many as you might believe.

I'd like to tell you a story about some teachers. It all happened over ten years ago and so most of the main players are beyond the reach of the nouveau managers who are destroying our profession. In telling the story I want to introduce you to the normal distribution function and its implementation in those spreadsheets which don't included it as a standard function.

My story also needs illustrating with graphs. For this article I have chosen to use Fireworkz to generate the graphs but I have added text to them using DrawPlus (an excellent extension of Draw by Jonathan Marten) before porting them into Impression for publication.

The Problem

It must have been about ten years ago that the Head of Department called all seven of us A Level Maths Lecturers into his office and told us the bad news! It would seem that our joint performance had been measured by an outside body and, as a team, we were not up to standard! The number of passes in Maths at Grade C was below average for the County as was the number of Grade A passes. Bill, our boss, was a caring Head of Department. He didn't give us the same rocket as he had undoubtedly received himself. He wanted to know what was going on and wanted suggestions for improving our performance.
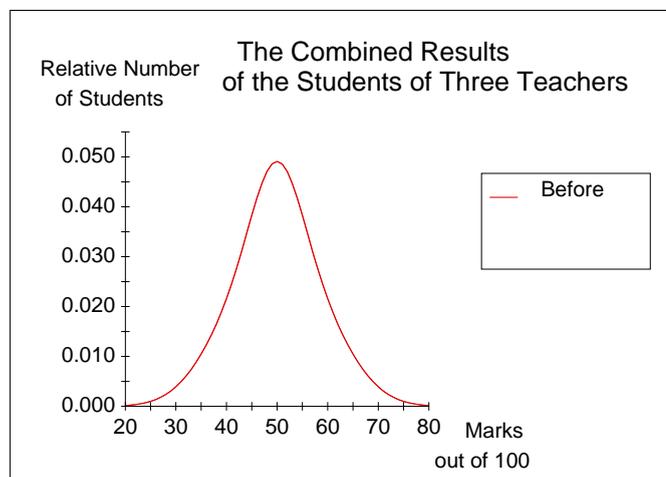
We had the Maths A level results and we had the results of a mock examination which we ran a few months before the real examination. The students of all seven lecturers sat the same mock exam; the marking had only a very minor subjective element. The correlation between the mock results and the real examination were good so we decided to use the mock results rather than the real results for the investigation. One advantage of using the mock results was that we had marks (out of 100) rather than grades and hence a finer gradation of scores. A second advantage was that we would be able to find out which topics resulted in low marks and which in high marks.

The graph above is not a completely accurate representation of the situation as it was those

ten years ago. I have simplified my representation of the situation by making the mean mark 50% and I have arranged for 95% of the Students to have marks between 32% and 68% (a standard deviation of about 9%). In fact the mean was a little higher, the results were spread more widely and the distribution slightly skewed.

The target (using my adjusted model) was to raise the mean to 55% and for 95% of the students to receive marks between 40% and 70% (a standard deviation of about 7.5%).

Gerald

I have made one more further simplification so that you can follow what is going on; I have followed the fortunes of only three of the seven Lecturers. Of these three, one is fairly typical and the other two represent the extremes of performance.

The first performance criterion to come under scrutiny was the percentage of students who got a Grade A. In the model I'm using for this explanation 68% would correspond 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 graph below shows.

A meeting was called to discus the Grade A study and Gerald was duly summoned to account for his poor Grade A performance. It was Brenda, (who got the most Grade A Students) who pointed out that Gerald also had the fewest (indeed hardly any) failures.
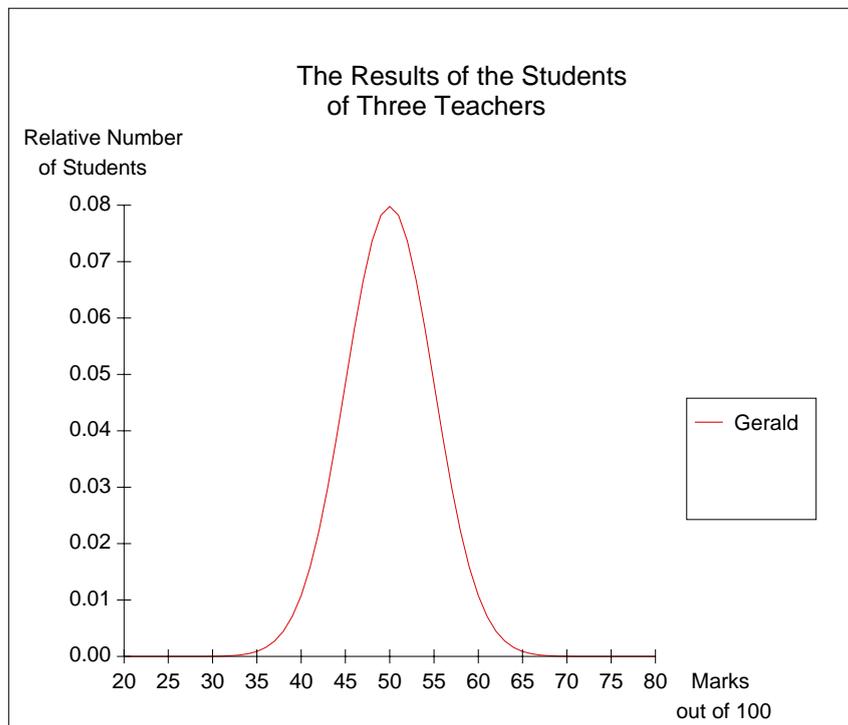
The graph shown above was produced using a Fireworkz spreadsheet. It is the graph of a normal distribution with a mean of 50 marks and standard deviation of 5 marks.

The Normal Distribution

As far as I am aware the Normal Distribution was first discovered by Carl Fredrich Gauss (1777 – 1855). In my view he is the greatest mathematician ever to have lived. I would rank Archimedes second and Newton third. It was his mathematics which allowed Albert Einstein to do his Relativistic sums. The unit for magnetic field is named after him. When I was at College the Normal Distribution was called the Gaussian Distribution of Errors and its integral, the cumulative distribution function was called Erf(x) (ERror Function).

Most spreadsheets include the normal distribution function, the cumulative normal distribution function and its inverse as standard functions. PipeDream and Fireworkz do not so if you want them you have to write them yourself.

The formula for the normal distribution function is:

y = exp(–(x – mean)/sd)^2/2)/(sqr(2*pi)*sd)

Substitute the mean = 50 and sd = 5 in the above formula and draw an X – Y graph from x = 20 to x = 80. You will repeat the graph which is shown above. It is a fair representation of Gerald's results.

Val

The next lecturer to come under scrutiny was Val. Now Val was what I would call a good competent standard lecturer. Her results were fairly typical of five of the seven Lecturers and her students' marks ranged from about 30% to 70% whereas Gerald's ranged from about 35% to 65%. Gerald does better with the 'weak' students than Val. Val does better with the 'good' students.
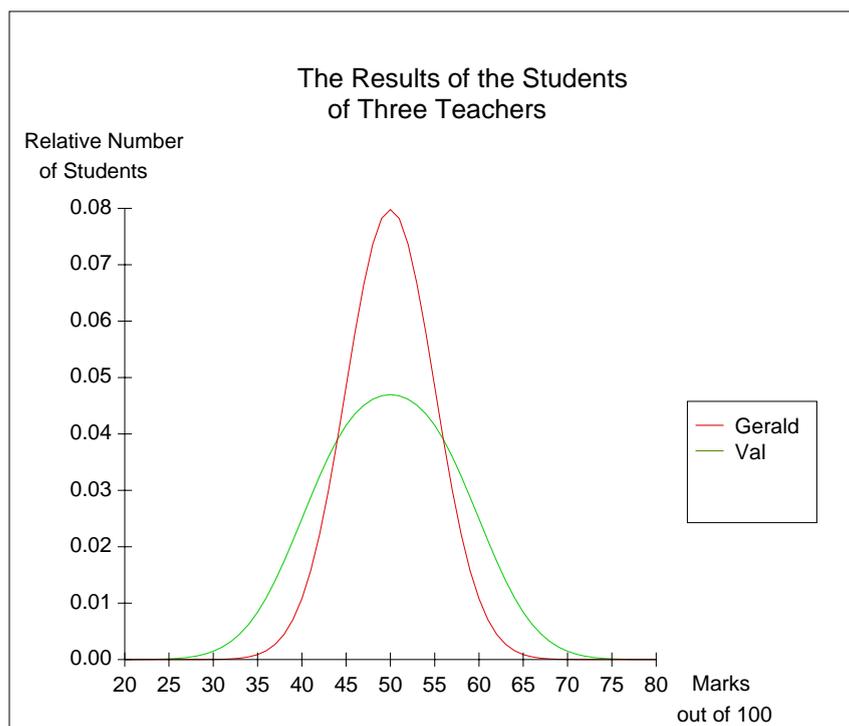
We tried to fit a normal distribution function to Val's results but it didn't work out at all.

A remark by Val put us on the right track. She said, "I get on a lot better with some of my Students than others."

We tried adding together two normal distribution functions and got a good fit. If you want to have a go at the graph shown above then you can reproduce Val's results by adding together a normal distribution having a mean of 45 and another with a mean of 55. The standard deviation of both is 6.

The screenshot above shows part of the developing spreadsheet. In column b I have calculated the normal distribution values for Gerald's mean and standard deviation. In columns c and d you'll find the two components of Val's distribution. Column e contains the average value of columns c and d.
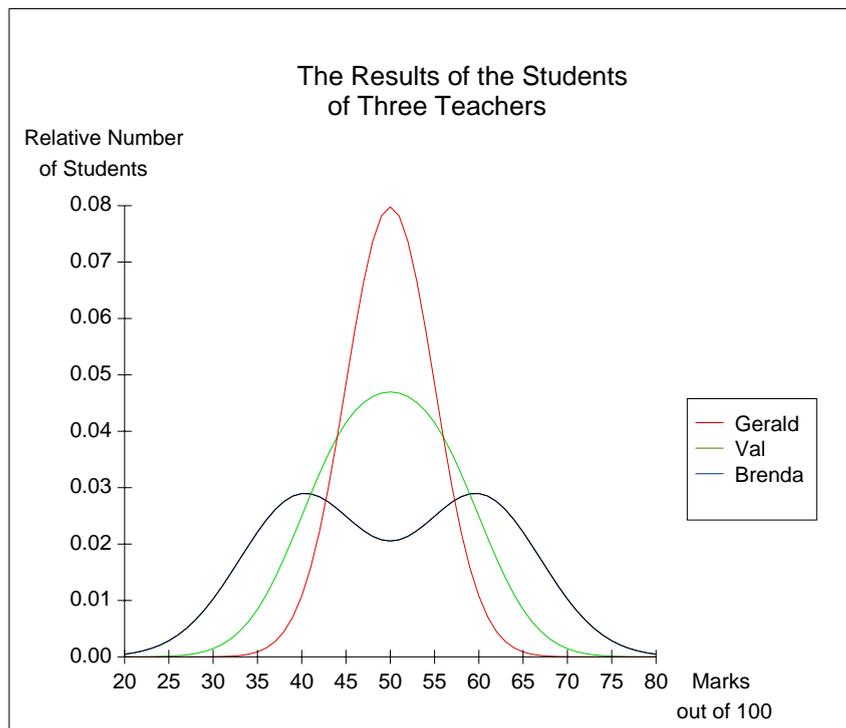
Brenda

Now we come to Brenda. Brenda's weaker students used to say of her that she "Took no prisoners". 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 was going senile!

Our best students got on very well with Brenda but, if you couldn't keep up with her then you were lost! Just like Val's (but more so) we found that we couldn't fit a normal distribution to her Students' results but we did find that it was the sum of two normal distributions.

I have to admit that, in my simplified representation of the problem here I don't do justice to Brenda. The mathematical model depicted here implies that she 'lost' half her students.

It was less than half.

Have a look at the distribution below and you'll see that Brenda's distribution is bi-modal.

The Results of the Students of Three Teachers

Brenda achieved the highest percentage of Grade A students by far – but also the highest failure rate. The antithesis of Gerald.

I have used columns f and g of the spreadsheet for the two components (means 40 and 60 both with standard deviation 7) and h for the average of the two.

The Solution

Take yourself back in time to the mid 1980s. The conventional wisdom from on high at that time was that all students had to be treated equally, indeed they might all be equal. Streaming was a taboo word. It is to the great credit of Bill, our boss, that he agreed to stream the students and pretend that we weren't doing so.

We streamed the students for Maths after the first term and then Bill fiddled the registers so that all Lecturers got their fair share of the credit for Grade As, etc.

You will guess that I (Gerald) got the students who might otherwise fail and Brenda got the whizz kids (and enjoyed her teaching much more).

So what was the end result?

Referring to the columns of my spreadsheet I have used column i for 'Before'. I have added Gerald (column b), Val (column e) and Brenda (column h) and divided by 3. For the 'After' in column j I have added columns b, d and g. In fact the results were slightly better

than the graph of column j shows – particularly at the top end.

The Combined Results of the Students of Three Teachers
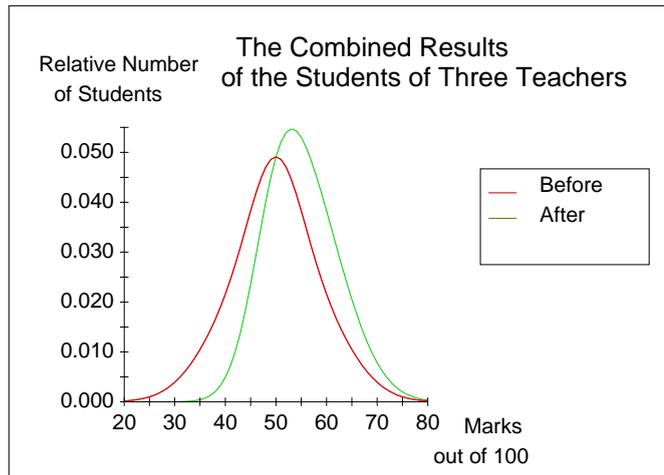
For the simplified mathematical model I've used here the mean has increased to about 55% and the standard deviation has been reduced to about 7.5%.

Streaming or Setting

It would seem that the pendulum of popular wisdom is swinging back to a form of streaming called 'setting'. The difference between the two is that streaming labels a 'weak' student as weak in everything and they sit in the 'weak' stream classes for every subject. Setting groups the students for each activity so that you might find a different group in Gerald's class for Maths than you would for Gerald's class for Computing.

Bill, Val, Brenda and Gerald

So what happened to the main characters in the scenario above.

There was a reorganisation and the Department headed by Bill was broken up. Bill was told he didn't have a job under the new regime and was forced into early retirement. He suffered a heart attack shortly after retiring but recovered well after a heart by pass operation.

Brenda couldn't stand the extra paperwork which Bill used to handle so well. So she took early retirement and died suddenly a year later.

Val moved to Torquay to get married – but couldn't get a full time job in teaching Maths for about five years.

Gerald (me) was transferred to the Business Studies Department and took to writing a monthly PipeLine column for Archive.

Finally

(a) Please send a disc, self addressed label and return postage if you want a problem

solved; (b) My address is that of Abacus Training (see back inside cover); (c) Many thanks for all your letters.