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'A' level mathematics and the 3R's – recruitment, retention and reward

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Introduction

Despite, or perhaps because of, the introduction of top-up fees, attracting students to study mathematics at university seems to be getting easier, while sending them out at the other end has never been difficult: the tricky time is the bit in between. With 'A' level grade inflation comes the increasingly difficult task of identifying which students are in need of additional support, particularly the timing of any necessary remedial intervention, and clearly both the student and the university benefit from improvements in retention rates. In this article, performances are examined for various stages from 'A' level through to degree classification for recent cohorts of mathematics students at the University of Reading since the introduction of curriculum 2000, with the purpose of identifying any trends, including possible correlation between 'A' level results, diagnostic tests on entry and subsequent performances, and to see if these are sufficient indicators to permit early targeting of students needing additional support. The discussion concludes with an example of how the statistics can be used, in anger, to set personal attainment targets for students, which was prevalent throughout their schooling, with a view to improving achievement. The statistics can also help to provide applicants with realistic predictions of possible attainment levels, bringing the process full circle as this can lead to opportunities to improve, even further, recruitment to mathematics programmes.

The academic cycle

For a while now, we have seen the university year as a number of perpetual cycles, with assessment being a major one. Associated with this particular cycle is another that we have become caught up with in recent years: the recruitment, retention and reward cycle, and the relationship between each of these and with attainment in 'A' level mathematics.

At Reading, we have seen our intake grow, quite dramatically, giving us the distinct impression that *recruitment* is getting easier. Of course, in difficult financial times, those of us in the mathematical sciences may have been trying that much harder, or it may be that the introduction of top-up fees has focussed applicants minds more clearly on possible career options, bearing in mind the obvious benefits that such graduates offer employers. At the end of their studies, as they receive their *reward*, we are always pleased to see the back of them, usually for good reasons. The really demanding part of this cycle is the bit in between, as we endeavour, staff and students alike, to maintain interest and enthusiasm. Above all, we would like our students to fulfil their potential and, by doing so, improve *retention* rates. Coupled with the three

R's is the relevance of the particular level of achievement on entry, usually in 'A' level mathematics.

Recruitment

Most mathematicians have a view on the reasons for 'A' level grade inflation, but we shall not comment on this here. We recruit students with the 'A' levels they have: it is our task to identify which students are in need of additional support, particularly the timing of any necessary remedial intervention, and to provide the appropriate guidance during their studies. The graph in Fig 1 shows the 'A' level mathematics grade, by percentage, of entrants to our single subject and joint honours programmes in recent years. A grade B is the anticipated entry requirement but, as with many institutions, places are offered for one grade lower than this (or two in very exceptional circumstances) and only when compensated by a higher grade in another subject. It is clearly important to monitor entrants with grades lower than the anticipated ones, but it is not only these that we need to monitor, as we shall see. The graph in Fig 1 shows a preponderance of A's and B's, but a significant minority with grade C. On entry, we feel it is vital to discuss with students their expectations based on their previous performance, and to make this an ongoing process. There are two perspectives to this, however: their expectations of themselves, and our expectations of them. Bringing these together is where the statistics can play an important part.

Retention

Our interest in monitoring performance and retention, particularly at the crucial school-university transition, started around 10 years ago when we began to notice gaps in students' knowledge. We had kept abreast of changes to the 'A' level syllabus/curriculum or specification as they have affectionately become known, and so there must be another explanation. We felt that it was more likely that variations in their background, such as quality of teaching,

teacher's subject knowledge, and the emphasis placed on certain topics (including avoiding some altogether) for examination purposes, were holding back some students. This meant that they found lectures more difficult to follow, and consequently affected motivation, including that of the staff. To remedy this situation we introduced a 'Drop-in Maths Surgery', which is still as popular today as it was then, with the purpose of providing help for mathematics students, primarily in year 1, to bridge the gaps we had identified. It was, and still is, for 'A' level support, with the corny strap line – *'if you find differentiation difficult, trigonometry tricky, or integration impossible, then just "drop-in"'*. Five years later, we were to experience the first cohort of the Curriculum 2000 initiative where students not only routinely took four 'AS' levels, but the 'syllabus' was divided up into modules with numerous opportunities to sit, and re-sit, examinations. Anticipating yet further changes in students' knowledge and, more importantly, ability to transfer that knowledge to other areas of mathematics, we embarked on a more thorough monitoring regime. As part of that, we introduced a diagnostic test to identify weaknesses and misconceptions of individual students. This very conveniently tied in with the Drop-in Surgery: students identified as having a need could be directed to attend. Additionally, subsequent performances at the end of years 1, 2 and 3 of three year programmes, which we term Parts 1, 2 and 3, are monitored and compared with 'A' level mathematics grades. This data can be used to identify trends and to set personal attainment targets for students, which was prevalent throughout their schooling, with a view to improving motivation, effort and, ultimately, retention, reward, and thence back to recruitment.

'A' level

As a backdrop to this, our recruitment levels have improved significantly over the last ten years. From 1997 to 2001, they

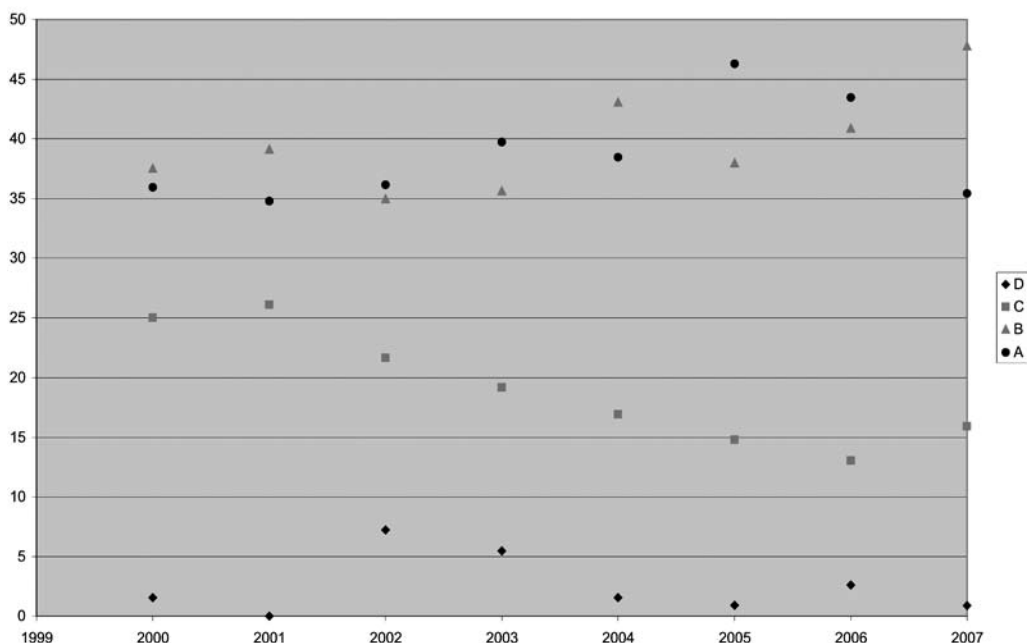


Fig 1 – 'A' level mathematics grade, by percentage, of entrants to single subject and joint honours programmes in recent years

remained steady, but 2002 saw a 50% increase, and recent entries are almost treble the 2001 numbers. Although the 'A' level profile has not changed greatly, as can be seen in the graph in Fig 1 showing the percentage by 'A' level grade for the period 2000-2007, the modal class does switch between A and B, with a noticeable shift in the latest entry which will need more careful monitoring. So is grade B 'a safe bet'? Is grade A 'a guarantee of success'? Is someone with grade C 'doomed to failure'? Although many university departments insist on a grade A, if that were a universal requirement many would be denied the opportunity of pursuing mathematics in HE, and it would not provide us with the mathematical sciences graduates that the economy needs. Indeed, in recent years our top-performing student had a grade B, while the next two had a grade C and a grade A. Thus, even if there is a correlation between 'A' level and subsequent performance, it may not be as strong as we might have thought.

Expectations

Returning to the expectations of staff and students, we feel strongly that both should be exposed to the raw data, both collectively and individually, and presented appropriately, to focus minds and set realistic targets. In all cases, unless specified otherwise, the data correspond to the entry period 2002-2006. First consider the relationship between the diagnostic test, Part 1, 2, 3, and 'A' level, as shown in the box plots in Fig 2, with the mean • also marked. This indicates that, while grade A students generally do better, there is a fair degree of overlap between grades A and B,

and grades B and C are also closer than we might have expected, particularly at Part 3. Fig 3 shows a comparison of the mean marks for the various assessments and 'A' level grade. As one might expect, students do better, on average, the higher their 'A' level grade, which is reinforced by the

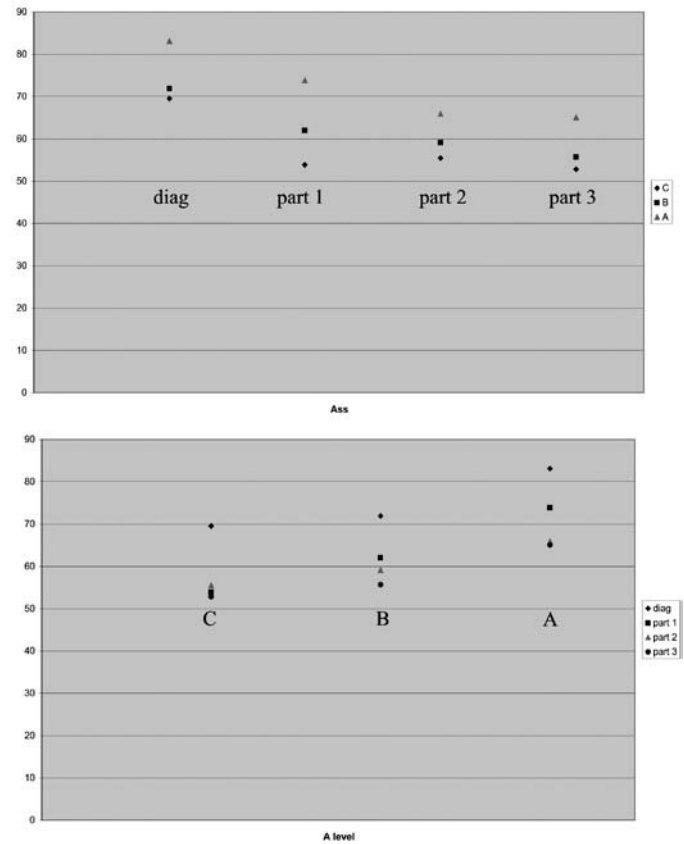


Fig 3 - Comparison of mean marks for assessments and 'A' level grades

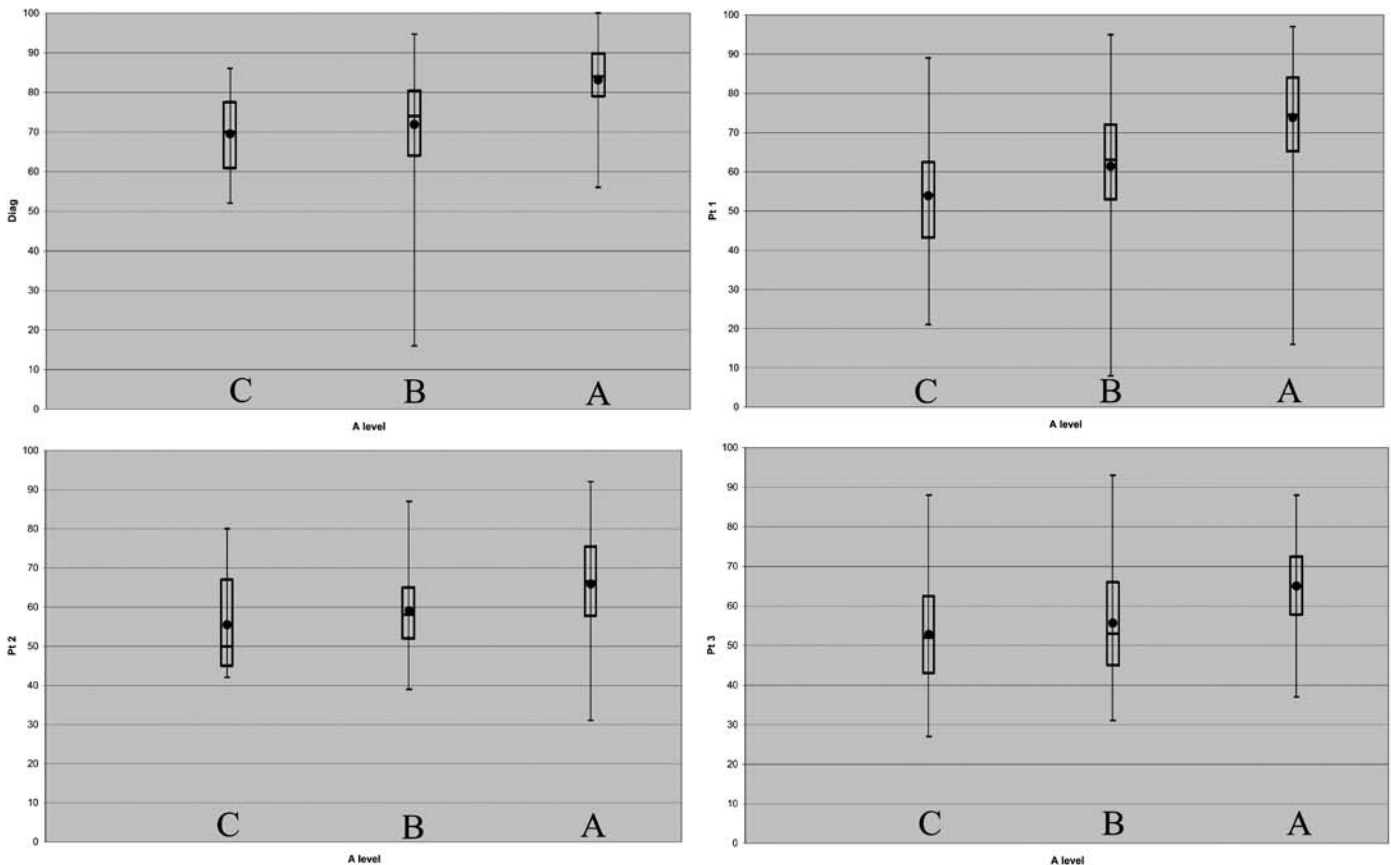


Fig 2 – Box plots, together with the mean •, of performances in diagnostic test, part 1, 2, 3 by 'A' level grade

data shown in Fig 2. But this also shows the other important trend that they need to be aware of: marks tend to get lower as one progresses through the university system.

Finally, we turn to what we feel is the most productive way of using the data we have collected. The graphs in Figs 4, 5 and 6 show the relationship between the performances at Part 2 and Part 1, Part 3 and Part 2,

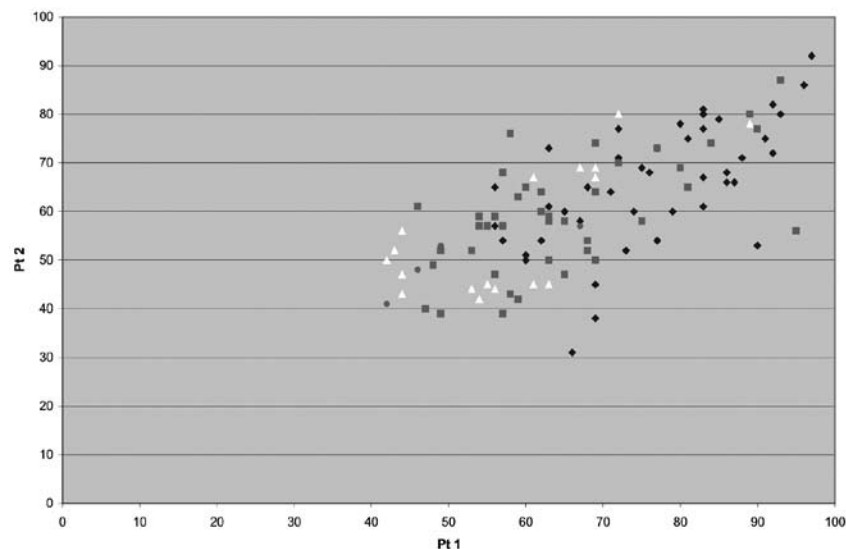


Fig 4 - Scatter plot of Part 2 and Part 1 performances by 'A' level grade

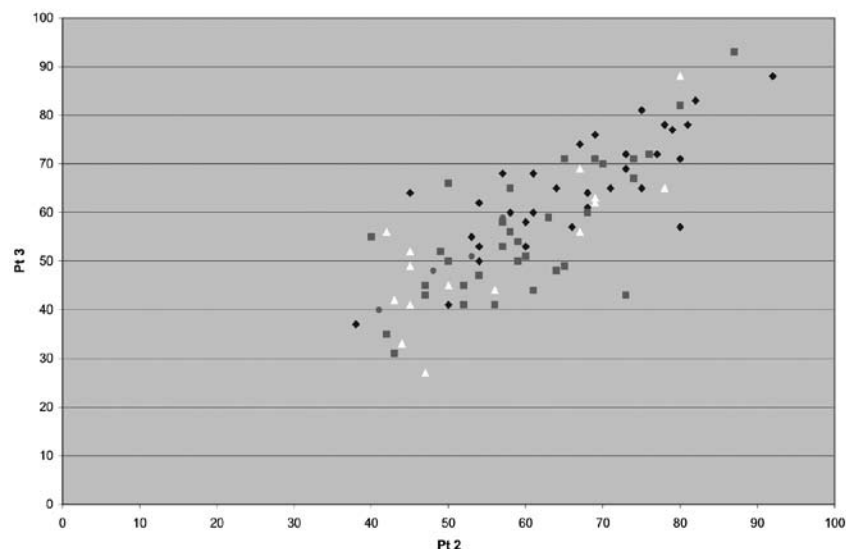


Fig 5 - Scatter plot of Part 3 and Part 2 performances by 'A' level grade

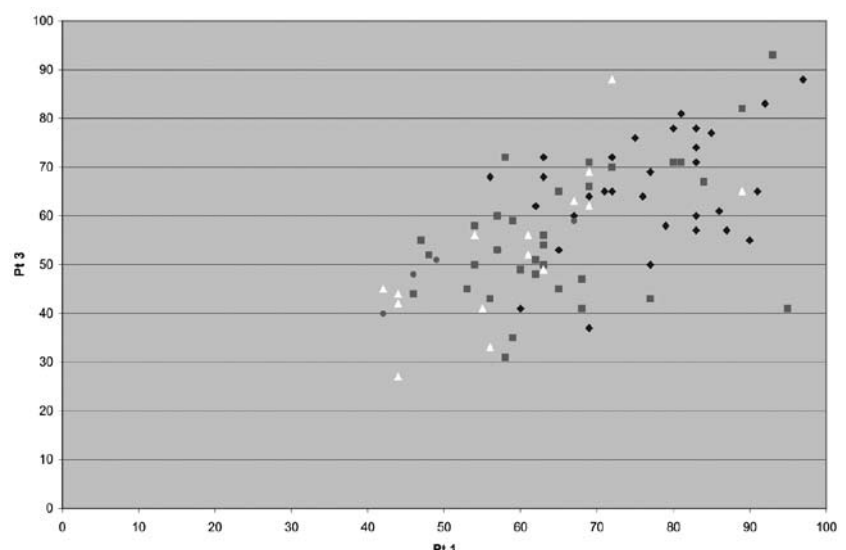


Fig 6 - Scatter plot of Part 3 and Part 1 performances by 'A' level grade

and Part 3 and Part 1 for a typical cohort. While there is a fair degree of correlation, there is also sufficient spread to make students realise that it is neither necessary nor sufficient to do well in one Part to guarantee success in another. These graphs are for use in a whole-class setting *without* the colour code and key so that 'A' level grades are *not* identified. These give students an overall impression of what is possible. Following this, students can then be shown the graphs *with* the colour code and key; so that 'A' level grades *are* identified, on an *individual* basis. It is then that their eyes are opened to the possibilities, both favourable *and* less favourable. Aspirations can then be discussed between tutors and students, with the latter having the opportunity to set a target to work towards.

Conclusion

In conclusion, we feel that the approach of exposing students to this information can only be of benefit to both them and the university, and will hopefully lead to improvements in retention. Moreover, this information can also help to provide applicants with realistic predictions of possible attainment levels, bringing the process full circle as this can lead to opportunities to improve, even further, recruitment to mathematics programmes.