



Bridging the Mathematics Gap : Have Your Say

Response from the London Mathematical Society to the Advisory Committee on Mathematics Education (ACME)

Executive Summary

The problem posed is important; but the way it has been posed invites each respondent to toss their favourite scheme into the ring. This would lead to a proliferation of official offerings designed for all sorts of imagined constituencies, which no ordinary centre would be able to provide. Such complexity is likely to lead to a ‘Diploma-style’ debacle, which is likely to undermine existing provision.

We take the view that the number of *additional* programmes must be kept very small, and that the precise nature of these programmes cannot be decided until we have explicitly recognised the need for ‘viability’, and hence for simplicity. This is why our response suggests one should begin by focusing on the ‘complement’ of your central question: “How might we best provide for those who are best advised to take a *general purpose* mathematics programme at 16-19 (as opposed to mathematics embedded in vocational courses, or specialised packages such as ‘statistics for biologists’). We focus on how much mileage could be squeezed out of existing ‘general purpose’ provision – with a view to clarifying the extent of the ‘gap’ to be bridged.

The *Wolf Review* implies that some students will be obliged at 16-19 to demonstrate a degree of mastery of the core of GCSE Foundation Tier (perhaps in a ‘Mature’ version to inject an element of freshness to the experience). Those students who have already achieved a suitable grade on Foundation Tier and wish to study a ‘general purpose’ programme, cannot avoid the need to master the core of GCSE Higher Tier (which therefore needs to be packaged and labelled so that it is not ‘just another GCSE’). At the other end of the spectrum, we explain why a proliferation of A level mathematics courses should be avoided: we indicate how, if the current curriculum review manages to strengthen attainment at the end of Year 11, more students could be expected to take the current ‘general purpose’ A level. We also argue that AS level (perhaps as a 2 year programme) might be a better way to prepare large numbers of students for numerate courses in higher education.

Introduction

The LMS welcomes moves to think about mathematics provision post-16. We would be even more positive

- were the proposed timescale (for drafting, piloting and refining proposals, and for the training of teachers) more realistic, and
- were the current consultation to start from exploring the extent of the ‘gap’ *that remains after* (a) existing plans have been implemented (e.g. arising from the *Wolf Report*), and (b) after maximum mileage has been squeezed out of existing provision, such as the potential growth of AS as a (one or) two year programme,

so that we could focus on providing for those who need an ‘academic’ mathematics programme, but who cannot possibly take AS level in some form.

Any moves towards ‘maths for all post-16’ will constitute a major change, and it is unclear where first to focus. It is also hard to assess how particular proposals for one part of the cohort might impinge on provision for *other sections* of the cohort: in particular, by focusing first (we believe wrongly) on what you see as a ‘gap’, populated *by those whose commitment to mathematics is limited*, you may well encourage schemes which further undermine the reputation and viability of existing programmes designed for those who take mathematics more seriously at 16-19. In particular,

further weakening of the A level core in the name of ‘accessibility’ risks undermining the viability of A level mathematics as a serious preparation for HE.

What is clear (for example, from the recent Diploma fiasco) is the evident danger of trying to please everyone, and hence of devising a scheme whose complexity ultimately leads to painful and expensive failure.

So, rather than beginning by focusing on the ‘gap’ to be ‘bridged’, we begin *by looking at the ‘complement’* of this set: namely those who could be catered for by some version of what is currently in place. Our comments focus mostly on ‘academic’ courses post-16 – by which we mean *any* ‘general purpose’ mathematics programme such as GCSE or A level (as opposed to ‘maths embedded in vocational courses’).

Given the eventual scale of the proposed changes it is essential to err initially on the side of caution. Any realistic proposal must take into account the shortage of suitably qualified mathematics teachers, and the time scale required if one is to pilot and develop a new structure which presumes a significantly larger number of mathematics teachers at 16-19.

The details

We start by observing that much of the current ‘gap’ between GCSE and AS level is of our own making. For example,

- we incentivise schools to enter large numbers of students for GCSE at ‘Foundation tier’ simply to ‘play safe’ – even though we know this guarantees that they have effectively *no chance of progressing to AS/A level* (and hence inflate the apparent number of students who fall into your ‘gap’);
- the negative consequences of having abolished ‘Intermediate tier’ are well-known, and this exacerbates the extent of the ‘gap’ – yet this move could easily be reversed;
- all those who require some ‘academic’ mathematics at 16-19 need to grapple with the relevant work on fractions, ratio and proportion, formulae, algebra, graphs, etc. – material which is mainly addressed at Higher tier, but which is scarcely required at ‘Foundation tier’; yet we meekly accept the arbitrary *National Qualifications Framework* which effectively prevents us from structuring 16-19 programmes and assessment to incorporate as ‘natural’ a progression from ‘Foundation tier’ material in Year 11 to key ‘Higher tier’ material in Year 12 – even though we know that this would partially reduce the number who fall into the perceived ‘gap’.

Hence the first answer to your question 4 would appear to be that

we should structure the GCSE curriculum and assessment in Years 10-12 so as to ensure that as many students as possible establish a strong basic platform from which to progress.

This is not to deny that one would still be left with a significant middle group: at present only 15% of those with a grade B at GCSE go on to AS level, and just 1% of those with a grade C. So something is clearly needed. However, given that the survey appears to overlook the obvious initial approach of *getting the most out of existing provision so as to minimise the gap*, we have accepted your invitation to respond without being “constrained by the given questions”.

Our comments are also strongly influenced by known DfE data concerning A level entries (we refer to the corrected version of data presented at a meeting in the DfE on 7 February 2012). In particular,

- any viable proposal has to bear in mind the likely effect on those A level exam centres who enter small numbers of candidates.

In 2011 55% of centres entered at most 20 candidates, and 33% of centres entered at most 10 candidates.

These centres are precisely those which would be seriously stretched by any ‘ramification’ of available A level mathematics programmes – which would oblige many of them to make choices *on behalf of their students* – even though these choices will affect students’ possible progression routes into HE.

- *In 2011, there were 2565 centres entering A level maths candidates.*
- *Of these, only 378 entered more than 50 candidates.*
- *A further 422 centres entered more than 30 candidates; and 376 entered 21-30 candidates.*
- *832 entered 1-10 candidates, and 557 entered 11-20 candidates.*

This data contains a serious warning about what kind of change to avoid.

We do not comment on what is appropriate at age 16-19 for the bottom 10-20% of each cohort.

For the next 25% or so, Alison Wolf has recommended (and the Secretary of State has accepted) that students who have not yet achieved a GCSE Grade C in Year 11 should normally be expected to take this forward as a goal in Years 12-13. We understand the reasons for this approach; however, we are concerned that current

moves risk making this an anti-educational ‘tick-box’ exercise, with strong pressure on schools and colleges to encourage *immediate* retakes in November of Year 12 – even though we know that success rates will be low, and that even if a C is scraped, the students’ inner attitude to mathematics will suffer. We would prefer to see a sensible one-to-two year study program leading to a "*Mature GCSE*" for say 20-30% of the cohort – covering the core material of GCSE, but in a fresh, more hands-on way.

Of the top 50+% (who achieve GCSE Grade C in Year 11), the upward trend in A level mathematics entries encourages us to think that it might be possible to get the percentage taking something very like the current A level up to 15+% of the cohort. However, *the figures in the italicised bullet points above mean that we **must** avoid the confusion of introducing **two or more incomparable** programmes which could both be interpreted as leading to an ‘A level maths’ qualification.*

Since 33% of centres enter 1-10 students, any move to introduce other ‘maths’ A levels (such as *Use of Mathematics*) will mean that this sizeable minority of centres, who are most **unlikely** to run **two** such programmes side-by-side, *will be forced to choose*. Moreover all the current political pressures on them will oblige them to think in terms of ‘broadening’, rather than strengthening, their provision – so they will mostly choose the ‘most accessible’ programme! If we make such a move, England will once more have devised a system which ‘offers choice’ rather than one which *directs students clearly*; and will have again ignored the fact that pressures on schools and colleges mean that any choice will be made *by the institution*, not by students!

The known data on class sizes show that the average A level class size at 16-18 is now around 12.5 – and increasing. Given the number of very small classes in centres with <10 candidates, this means that those institutions with > 10 A level maths students tend to have classes which are considerably larger than this ‘average’ (as a result of funding pressures and senior management thinking)! Hence we can be sure that *a similar institutional choice is likely to be made by many of the next 20+% of centres*, who enter 11-20 students.

So if *Bridging the gap* seeks to be more inclusive by recommending more than one A level course whose title and content might be construed as "Level 3 academic Mathematics", we can be sure that this will force many (perhaps most) of this majority of 55+% of centres *to choose on behalf of their students*, and we can be sure that they will all be tempted to choose the ‘easier’ option, rather than the option which offers progression to quality courses in HE.

We conclude that

- we **must** stick to (essentially – see below) **one** A level in mathematics,
- and
- we must then work to devise a structure
 - (a) which can handle a slightly larger fraction of the cohortand
 - (b) which satisfies (if possible) the demands of the Secretary of State and of many universities for a return to more rigorous assessment in preparation for university entry to numerate disciplines.

These requirements may appear incompatible; but it is important to look for some simple solution which is acceptable to the different interest groups, even if it is optimal for none of them. To this end we indicate a possible framework.

Alison Wolf's pragmatic approach, together with a crucial relaxation of the rigid *National Qualifications Framework* suggests

- an initial, if in some ways educationally unsatisfactory, program for many in the lower 45-60%: roughly speaking, this might consist of (i) something very different for the bottom 10-20%; (ii) some form of *Mature GCSE* for the next 25% or so for whom this could be a manageable goal; (iii) a transition programme for those with GCSE maths at Foundation tier to allow them to grapple with key content which is needed for progression.

Until the underlying principles are clear, it is hard to know what to propose for those who constitute the middle 20% or so. Provision will no doubt include a limited range of vocational programmes for those who do not intend to go to university. It may be possible to re-organise and strengthen the current range of FSMQ modules. But it is harder to grasp the viability of, or need for, KS5 programmes such as "Statistics for Biologists, Geographers, and Psychologists", which seek to provide preparation for HE and the workplace – *but without expecting candidates to grapple with the mathematics that underpins the methods they are expected to learn and to use.*

We therefore postpone comment on the middle 20%, in order to consider a simpler approach for the top 25-30%. Here the goal should be to direct *as many as possible* of those who are aiming at university, and who need some ‘academic’ Mathematics, into taking *something like* the current AS level. The recent growth in entries for AS level Mathematics suggests that we might consider a structure which allows around 25% of the cohort (150-180 000 students) to take something like the current AS – provided that more students view AS-level maths *as a (one or) two-year programme*.

If this could be made to work, then it would help reduce the need to introduce unnecessary (and confusing) variety among ‘academic’ mathematics courses. Such an approach depends on the observation that, whatever mathematics a potential HE student may need, *we can be sure that it will depend on* such things as fractions, algebra, and graphs; and these are already developed beyond GCSE as a significant component of AS level. Thus, even if the current design of AS could be improved in some ways, the course already constitutes a reasonable preparation for those who wish to be better placed – so that when they get to university they are equipped to learn specific techniques related to their chosen field of study. That is, we claim that it makes sense for academic programmes at age 16-19 to leave HE to teach the specific techniques they may need, and for curriculum provision at 14-19 to concentrate on *providing a reliable, general purpose, platform* (either GCSE or AS level mathematics) – (i) by clarifying the National Curriculum, (ii) by strengthening the core of GCSE, and (iii) by providing suitable general purpose syllabuses, teaching, and assessment of AS level.

If we manage to devise a sensibly fresh *Mature GCSE*, and if we find a way to make the current AS and A-levels accessible to a slightly larger fraction of the cohort, then the initial job of devising ‘academic’ maths programmes at 16-19 would be largely done. All that would remain is to consider whether we need to devise some simple and coherent general purpose ‘academic’ course that might serve the needs of those who already have a GCSE Grade C at Higher tier, for whom vocational programmes may be inappropriate, yet for whom AS level (even as a two-year course) would be inappropriate. It is unclear how large this residual group might be. We remain open-minded as to what might be needed: it may be that in the first instance their needs could be met by some variation of FSMQ modules, or by a modified version of AS/A level *Statistics*.

Up to this point it may not be clear how this proposal can be squared with the conflicting demands of wider access to AS and A-level, and the demands from certain end-users (and the Secretary of State) for ‘greater rigour’ and end-of-course assessment. One possible resolution, which we hope will be considered seriously, is:

- to preserve a single A level *syllabus* (more-or-less the current one), so that students in each institution – especially those with small entries – can be taught in a single group (at least for the first year and a bit),
- but to (re-)invent two ‘flavours’ – ‘modular’ and ‘linear’ – where the modular structure is *explicitly easier*, but where **only the linear qualification provides access to numerate courses in universities**. (We recognise that this would require Ofqual to drop its current bureaucratic ‘qualifications framework’, with its ‘levels’ and ‘equivalences’.)

LMS Education Committee

23rd March 2012