Bridging the maths gap

Due to ACME by 23 March 2012

MEI response

1. Would you, or people you know, have benefited from a course that bridges the post-16 maths gap?

Students going on to take degree courses which require mathematical or statistical understanding are at a disadvantage if they have not studied any mathematics after the age of 16. Firstly, not having done any mathematics for two or three years means that they are no longer as proficient as they were at the age of sixteen. Secondly, the concepts which they meet at university and the speed at which they will be expected to acquire them can often require a greater proficiency than they had at the age of 16. AS or A Level Statistics would be a suitable preparation for many more students than currently take it, as would suitable FSMQs or AS Mathematics. However, students do not necessarily know what they want to do post-16 at the time of choosing A Level subjects, nor is it reasonable to expect them to know. Moreover, they do not always realise how mathematical and/or statistical their future studies will become.

It is important that A Levels in subjects which require mathematics for further study include sufficient mathematical or statistical content to enable students and teachers to be aware of the importance of mathematics for progression. However, it is not always possible to include sufficient mathematics in other A Levels so students must be able to take suitable mathematics courses alongside their other A Levels and they need to be aware of the importance of doing so.

A new course, studied over two years and covering key concepts in mathematical modelling, understanding of risk and and the use of statistics, building on GCSE mathematics, would be valuable for all level 3 students. Such a course could form the first rung in a ladder/single spine structure for post 16 level 3 mathematics.

2. What mathematics do you think would prepare young people for university and the workplace? What should they be able to do by age 18? What do you wish you had learned?

Considerable specialised work and consultation will be required to specify a suitable curriculum. However, the following themes would seem important, and should be linked directly to applications wherever possible:

A. An appreciation of statistical inference and risk, including a basic understanding of the Normal distribution, statistical significance and conditional probability; this could include the use of statistical software to analyse real data sets.

B. Basic calculus and topics from operational research and numerical methods, developing a basic understanding of the importance of rates of change and the use of technology when solving quantitative problems.

C. An introduction to mathematical modelling, showing how mathematics is applied to solve real problems, analyse real situations, inform decisions and plan complex projects.

Examples of applications might include:
analysis of data in sciences and social sciences; finance; medical screening; market research; quality management and control in manufacturing; insurance and risk; population growth; the planning of inspection and delivery systems; internet security, pollution control; planning complex events (e.g. the Olympic Games); computer simulation (e.g. to model traffic flows); computer graphics; internet search engines; mobile phones.

Assessment needs to be fit for purpose. It is very difficult to assess students' ability to solve real problems in a timed written examination. Concern about plagiarism in coursework need not prevent the inclusion of suitable longer investigations as part of a course. Assessment models which are worthy of consideration include the following.

- A response under examination conditions which is dependent on a problem solving or modelling coursework.
- Students presenting their work on a project to their peers or to an invited audience as part of the assessment.

3. What 'size and shape' should a course for these pupils be, and how would it fit in with their other studies?

The courses could be modular with modules of similar size to current AS Level modules (60 guided learning hours each), with all students expected to do at least one module in each of years 12 and 13. (Students who achieve Level 2 at the end of year 12 would do at least one module in year 13). This would need 1.5 – 2 hours of timetabled classes per week for students following the minimum pathway and students following other pathways spending correspondingly more time studying mathematics.

To ensure ease of delivery and parity of esteem between courses, one possibility would be to have the course for all students as a foundational part of AS Mathematics so that students who wanted to progress further could build on what they had already done. Having the same starting point for all students who have succeeded in a level 2 qualification means that guidance is not needed until students have begun to make decisions about likely routes post-18 and that no students have inadvertently closed doors because of choices they made at the age of 15.

It would be appropriate to offer additional optional elements for some students; for example it is likely to benefit those specialising in social sciences or business to have the option of taking an additional Level 3 statistics unit.

Delivery of the courses must be workable across the wide range of post-16 providers, from small school sixth forms to very large colleges. The inclusion of a common starting point for all students will ease delivery and improve understanding of the course structure.

Specialised resources to support the teaching and learning of the courses could be developed and made available online. These resources could include some self-study elements, which would enhance the students' learning experience and encourage the development of independent learning skills.

4. How can young people be encouraged to study more mathematics?

The December 2010 Nuffield Foundation report, *Is the UK an Outlier?,* shows that uptake of post-16 mathematics is comparatively low in the UK. For many countries where it is significantly higher, mathematics is compulsory post-16. However, for other countries, such as Ireland, mathematics is required for university entrance. In England, universities are generally reluctant to increase their requirements in terms of the amount of mathematics studied for fear of putting off applicants.

Mathematics could be made compulsory post-16, however, this is not enough; students need to understand why it is important for them to study mathematics. It is essential that universities emphasise the importance of mathematics for further study. Information needs to be generic as well as specific to particular courses at particular universities. For example, if university psychology departments together emphasised the importance of study of statistics post-16 for further study of psychology, regardless of university, this would send a powerful message to students, teachers and parents and would avoid the problem of a particular department being perceived to raise its entrance requirements.

Constructing a course which all post-16 students start on would minimise any threat to take up of A Level Mathematics.

5. How can we make this a reality?

A standard mathematics course for all level 3 students would enable efficient use of resources Appropriate teaching and learning materials, which might include an online virtual learning environment and considerable support for non-specialist teachers, in conjunction with appropriate CPD, would reduce the need for more specialist mathematics teachers.

To ensure that the number of students studying appropriate mathematics post-16 increases dramatically, a considerable investment is required to design appropriate courses, develop teaching and learning resources, promote the courses effectively and provide suitable CPD for teachers. This investment is essential to future national well-being.
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6. In conclusion

MEI hopes to be in the forefront of development work for suitable new courses. We are currently engaged in a project called 'Integrating Mathematical Problem solving', funded by the Clothworkers' Foundation, which is particularly concerned with how to increase participation in level 3 mathematics across the curriculum.

We have attached MEI's position paper on Post-16 Mathematics, which explores these issues, and we have started to consider possible models for level 3 mathematics in more detail. We would be very happy to liaise with ACME to develop this work.