

Evaluation of Participation in GCE Mathematics

MEI Recommendations

Background

In January 2008, QCA published the report of a research project it had conducted into the GCE Mathematics specifications introduced in 2004. While the report itself was on the whole uncontroversial, the same could not be said of its accompanying recommendations, which seemed to be largely unrelated to the findings of the research.

In response, we wrote the paper that forms the Appendix to this document. A copy of the paper was sent to the Curriculum Division at QCA; in reply they said they “...*would be interested to know what recommendations you would make as a result of the research*”. This paper is MEI’s response to that request.

The scope of the QCA report

The QCA report is mainly concerned with the effects of the changes in the A Level Mathematics curriculum in 2004; there are a number of other factors which will also have had an effect on the situation during the period 2004-7.

- The work of the Further Mathematics Network in promoting and improving access to Further Mathematics in England is noted in the report. However, the Further Mathematics Network also works to increase numbers studying AS/A Level Mathematics.
- Increasing difficulty in recruiting and retaining suitably qualified staff to teach mathematics at all levels. “Of the head teachers surveyed in the UK for this OECD study, almost one-third felt that a shortage or inadequacy of teachers was hindering the learning of pupils in mathematics.”¹
- Changes to funding for A Level provision; the break-even class size for A Level in the state sector is now 15.² Smaller class sizes and increased contact time are suggested in the QCA report as possible strategies for retaining more students from AS to A2 Mathematics but economic considerations discourage such strategies and may prevent them from being adopted.
- The effects of performance tables and competition for popular university courses on subject choice at A Level.

The limited scope of the report means that it cannot provide sufficient information to allow judgements to be made about suitable future directions for A Level Mathematics and Further Mathematics.

Matters raised by the report's findings

The report's findings identify a number of important considerations.

The number of students taking up GCE mathematics

The increase in recruitment to Mathematics and Further Mathematics is pleasing, not just for its own sake, but also because it contributes towards meeting the national need for increasing numbers of people skilled in STEM subjects. This need was expressed in the Government's ambition "to work with schools and other partners, with the aim of achieving year on year increases in the number of young people taking A-levels in physics, chemistry and mathematics".³

However, the report comments on the fact that those opting to take A Level Mathematics tend to be the most able. This is a serious concern and needs to be investigated further with a view to widening participation so that many more students who would benefit from studying mathematics beyond GCSE actually do so.

The reasons why many schools and colleges target their recruitment to A Level Mathematics on the most able GCSE students need to be investigated with a view to ensuring greater equality of access to A Level Mathematics nationally.

MEI Recommendation 1

There should be a major research programme into the factors that inhibit students from studying GCE Mathematics and the factors that encourage them to do so.

Transition from GCSE to AS/A Level

The report's positive messages about the easing of transition from GCSE to A Level Mathematics are echoed in the informal feedback MEI has had from teachers, who feel that A Level Mathematics is now working well and is at an appropriate standard for their students. In view of the continuing and forthcoming changes to GCSE Mathematics, it will be important to ensure that any changes to A Level Mathematics are made in such a way and at such a time that they do not reverse this positive trend.

MEI Recommendation 2

In view of the increase in recruitment to AS/A Level Mathematics and Further Mathematics since the change to specifications in 2004, AS/A Level Mathematics and Further Mathematics specifications should be left unaltered until the effects of changes to GCSE Mathematics are known (including those that result from the move to two qualifications).

The QCA report is based on transition from 3-tier GCSE to Curriculum 2004 A Level.

MEI Recommendation 3

The effects of the introduction of 2-tier GCSE on recruitment to A Level Mathematics and ease of transition for students should be monitored carefully and the results used to inform the plans for the new GCSEs in Mathematics.

The report suggests some strategies for easing the transition from GCSE to AS/A Level Mathematics and improving retention; for example, bridging courses, increased support and smaller class sizes. These need to be explored and good practice spread. Schools and colleges need to feel confident that funding will be available for such initiatives so that educational needs are not put in second place to economic realities.

MEI Recommendation 4

There needs to be greater recognition of the need for bridging courses, reflecting the variability among students who have just completed GCSE. These bridging courses need to be funded.

Providing choice

The report comments on teachers' perceptions that the two applied units at A Level do not provide sufficient 'stretch' for the most able. This should come as no surprise; that is not what these units are designed to do. Appropriate ways to stretch the most able should be promoted (see below) but this is a completely different matter from the provision of suitable applied units. Allowing access to a choice of applied units for students in schools and colleges which are currently unable to provide such choice would be beneficial for some students; this fits in with the national personalisation agenda as expressed in the Schools White Paper "Higher Standards, Better Schools For All": "We will transform the support available to every child by widening curriculum choice in secondary education, so that more young people are motivated by study that stretches and interests them."⁴ The example of the Further Mathematics Network shows that such a widening of choice is possible.

The QCA report draws attention to the experience of higher education admissions tutors that progression onto some degree courses is easier for students who have taken particular applied units at A Level. Students of A Level Mathematics can deepen and extend their knowledge of mathematics, including applied mathematics, by taking AS Further Mathematics; this would give them the opportunity to take two more applied units. Following the 2004 changes to Further Mathematics specifications, AS Further Mathematics is an appropriate option for almost all students capable of passing A Level Mathematics. For students intending to study for degrees with significant mathematical content, in areas such as engineering, science, finance and computing, AS Further Mathematics is a good to option take up, whether in year 12 or in year 13.

MEI Recommendation 5

It should be recognised that when students have decided what they will do after A Levels, they would benefit from being able to choose at least one of the applied units they will take as part of GCE Mathematics and that, in some cases, this will be motivating.

MEI Recommendation 6

Where students' choices are restricted by the provision of applied units offered within their schools or colleges, the choice of units available to them should be extended through the use of external tuition and on-line resources such as those developed by the Further Mathematics Network.

MEI Recommendation 7

Where appropriate, universities should be encouraged to publish information about which applied units are most suitable to support particular degree courses. For example, mechanics for engineering or physics, statistics for social science or medicine and decision for computing or business.

MEI Recommendation 8

Students of A Level Mathematics should have the opportunity to take AS Further Mathematics, possibly in year 13, to support the mathematical requirements of their future plans, and universities should feel able to recommend that they do so.

Provision for the more able

The report mentions the fact that Further Mathematics is often used as a means of stretching the more able within the curriculum. It also comments on the work of the Further Mathematics Network but does not make the obvious link between the two.

The report says that the Further Mathematics Network needs to be made more widely known. This is already happening with over half the schools and colleges offering AS and A levels in mathematics now registered with the Network.

In addition, opportunities to stretch students beyond the curriculum, both in the sixth form and before it, should be more widely promoted so that more students realise how much enjoyment there is in mathematics.

MEI Recommendation 9

The role played by Further Mathematics in providing stretch for more able students should be given wider recognition.

Encouraging a wider range of teaching methods

The report includes statements from students that different teaching methods at AS/A Level could have helped them to continue.

MEI Recommendation 10

Good practice should be disseminated widely to teachers and to students on PGCE courses, for example, via the NCETM.

Re-sitting

The report draws attention to the fact that Mathematics AS/A Level has one of the highest rates of re-sitting of units. The opportunity for students to re-sit units and so gain credit for their increased understanding counterbalances the fact that mathematics tends to be perceived as a difficult subject. The preference of some HE tutors for students who are able to obtain high grades without re-sitting may be a factor which tends to put some students off taking AS/A Level Mathematics.

MEI Recommendation 11

In order to ensure that students are not dissuaded from taking AS/A Level Mathematics by the fear of failing to get high unit grades on the first attempt, information about re-sitting AS units should not be made available to HE tutors; nor should there be any re-introduction of re-sit restrictions.

A changing situation

The national picture is not static. There are a number of national initiatives which are likely to have a significant effect, positive or negative, on participation in GCE Mathematics over the coming years.

- The changes to GCSE to 2-tier and then to two GCSEs in Mathematics, including Functional Mathematics.
- The continuing work of the Further Mathematics Network in improving access to Further Mathematics and in raising the profile of mathematics generally.
- The introduction of new courses, particularly Level 3 diplomas.
- The role of the NCETM in disseminating good practice in teaching mathematics.
- MoreMathsGrads and its strategy to improve uptake of mathematical courses in HE.
- Other STEM initiatives.

In conclusion

Numbers taking A Level mathematics dropped drastically following the introduction of Curriculum 2000. Extreme care is needed in this changing environment to ensure that such undesirable consequences do not occur again, especially now that numbers are recovering.

Under present plans, the first students who have taken the two GCSEs will start AS Mathematics in 2012. However, the AS/A Level course they will then be taking will have been introduced a year earlier, in 2011, and so will have been designed with no knowledge of the effects of the new GCSEs. This makes no sense and indeed runs counter to the proposal for coherent pathways in the Smith report.

Any changes to AS/ A Level should thus be delayed until sufficiently long after the introduction of the new GCSEs for them to be informed by the characteristics of the students who have taken them; 2013 would seem a reasonable date. Otherwise, it will almost certainly be the case that a further round of changes will be needed to align the new AS/A Level with the new GCSEs.

However, 2013 is the currently planned date for the Curriculum Review, making a third round of changes, all in quick succession, highly likely.

The cost of change should not be underestimated. In purely financial terms, any change is expensive: developing new specifications, providing teachers with the necessary professional development, writing and publishing new teaching materials (both textbooks and on-line resources) and re-equipping schools and colleges with them.

Educational change can have positive effects, enthusing both teachers and learners and making the curriculum more fit for purpose in a changing world. However, not all change is improvement. Change without improvement saps the energy of teachers and so has a negative effect on students' learning. The best learning occurs in an environment in which teachers are confident in what they are doing and are able to take ownership of it. The QCA report highlights the importance of teaching methods for student retention. Similarly, Ofsted found that "The quality of teaching was the single most important factor influencing students' achievement."⁵ Unwanted changes imposed from above (and there is no grass-roots appetite for change at the moment) can only reduce teachers' effectiveness. Perhaps even more seriously, such changes are likely to lower their morale, and this at a time when we have a serious national shortage of mathematics teachers.

MEI Recommendation 12

No changes should be made to AS/A Level Mathematics specifications until after the 2013 Curriculum Review; at that time information will be available about the effects on students of the move to two GCSEs, as well as other influences such as Level 3 diplomas. This timescale will bring mathematics back into line with other subjects.

References

1. Mathematics and Science in Secondary Schools: The Deployment of Teachers and Support Staff to Deliver the Curriculum (NFER 2006)
2. Size matters: economies of scale in schools and colleges (LSN 2006)
3. The Government's Science and innovation investment framework 2004 – 2014: next steps (HMT 2006)
4. Schools White Paper: Higher Standards, Better Schools For All (Crown Copyright 2005)
5. Evaluating mathematics provision for 14–19-year-olds (Ofsted, 2006)

Appendix Commentary on *Evaluation of participation in GCE mathematics***Introduction**

In 2000 teaching began on new AS and A Levels in all subjects, under the curriculum 2000 programme. The mathematics syllabus proved highly unsuccessful and there was a large fall-off in uptake. As a result new mathematics A Levels were introduced, with first teaching in September 2004. The Smith report was published earlier in 2004 and recommended that the impact of the planned new mathematics A levels should be monitored. This work was carried out by QCA, culminating in a report entitled *Evaluation in participation in GCE mathematics*, published in January 2008.

Considerable research went into this report and it makes interesting reading. However, the recommendations section in the Executive Summary would seem to be a non-sequitur from the rest of the report. There are four recommendations and they would seem to be unrelated to the report's findings; it is hard to believe that they were written by the report's authors.

This paper comments on the four recommendations in the executive summary.

QCA Recommendation 1

Formally separating the requirements for an A level in mathematics and an A level in further mathematics would simplify the structure of A Level in general. By designating particular units to each award, the peculiar 'least-best' relationship would be severed, and there would be more clarity – both for the student and for those selecting students for higher education – about what is being studied for each award.

While the structure may seem strange to those coming on it for the first time, it has been in place for some 17 years in much the present form, and has worked well over that time. We should not be in a hurry to change it without very good reasons. It is well understood by students and teachers, and higher education institutions are provided with full information about the units that each student has taken and the results obtained.

If Mathematics and Further Mathematics could easily be separated, it would have been done long ago. The difficulty in doing so is caused by the fact that mathematics is taken by students with a wide variety of aspirations, supported by different applications units. (For example a student going on to read mechanical engineering at university will benefit from mechanics units while someone destined for medicine will be best served by statistics.) At the same time a Further Mathematics student will benefit from the breadth of studying more than one application area.

A particularly dangerous idea is that A Level might be served by a general applications unit, covering elements of mechanics, statistics and decision mathematics. This would lead to a very fragmented provision with students learning how to do certain questions but never coming to terms with the principles underlying the various strands. There would be a real loss of intellectual rigour.

QCA Recommendation 2

The perception among teachers and students that the different combinations of core and optional units result in different levels of difficulty should be considered further in the light of discussion about the students for whom the A level is intended.

Since the 4 core units are the same for all A levels in mathematics, the supposed differences can only occur in the 2 applied units.

When setting grade thresholds at the time of the awards, the awarding bodies look carefully at subject pairs data for those candidates who have taken each pair of units (e.g. Mechanics 1 and Statistics 1). If there were a consistent difference in difficulty, it would show up at this stage, and that information would be fed into the examination setting process. It would also result in different thresholds for the units; typical thresholds show no consistent differences.

That does not, however, mean that particular students will find all units equally easy. That will depend on their aptitude and on what other subjects they are taking. Their intended careers will also affect their motivation.

QCA Recommendation 3

The issue of whether the A level teaching is geared to the right level to encourage participation and achievement by students who are not high-flyers is something that may merit further investigation. It also needs to be considered in terms of how teachers see mathematics A level's ability to challenge those who are more able.

This recommendation touches on the negatively skewed distribution of mathematics students. About 40% currently obtain grade A; on the whole the same students get grade A in their other subjects – they are talented individuals. The problem with mathematics is that there should be many more grade C to E students taking it than is currently the case. The recommendation seems to point the finger of blame at teachers but this is probably not justified. It is more likely that school/college policies, often motivated by performance tables, are responsible.

There is a serious national need for increased uptake of mathematics post-16. The present grade distribution shows that there are large numbers of students who could obtain middle grades on mathematics at this level if they took the subject. The various reasons for their not doing so need to be properly understood; then it will be possible to work towards removing the barriers that currently deter them.

As is noted in the Smith report, many teachers make Further Mathematics available as a way of stretching and challenging their higher attaining students. With the Further Mathematics Network up and running, this course of action is open to every school and college in England. The recommendations do not recognise that Further Mathematics solves the problem of providing for the most able students.

QCA Recommendation 4

A clear statement about the expectation and purposes of mathematics provision at A level is needed, so that there is less division of opinion about how far it is fit for its purpose.

Depending on the outcome of this, there are two choices:

- *develop a qualification that meets the needs of the ‘clever core’, accepting that you are building an exclusive route*
- *revise the A level to be a qualification that is well aligned to the demands of other A levels, but design some form of supplementary stretching qualification that is accessible only to very able mathematicians; this – of course – raises the issue of what level this new qualification should be pitched at, since it seems unlikely that it could be easily encompassed within ‘A level’.*

A Level Mathematics specifications already contain statements, approved by QCA, relating to the purpose of the qualifications. Now that the Further Mathematics Network is a reality, it would be helpful for these statements to be updated and to include information about the relationship between Mathematics and Further Mathematics. Changes to GCSE should also be taken into account.

This recommendation then says that there are two choices. There are, of course, many more options than that, including the very important one of leaving A Level Mathematics just as it is. That would be consistent with the generally positive findings of the report in terms of improvements in uptake of both Mathematics and Further Mathematics, retention and conversion rates from AS to A Level.

Neither of the bullet-pointed suggestions is to be recommended. The first feels as though it is based on a caricature of an identifiable ‘*clever core*’. Actually there is a continuum of ability. The idea of providing mathematics for only the most able runs against the national interest; we should be aiming to develop mathematical skills in the large number of people who will need to use them later in life.

The second bullet point suggests that A Level Mathematics should be revised so that it is ‘*well aligned to the demands of other A levels*’. It is unclear what this means; it could be taken as a call for A Level Mathematics to be made significantly less demanding. The changes made in 2004 were a measured step in this direction and should be allowed to settle down for much longer before any further diminution in demand is considered.

Another interpretation of ‘*well aligned*’ is that the second proposal is based on an underlying assumption that it is possible to design A levels in different subjects so that they are all perceived by students to have the same pattern of demand. This is just not the case. Wherever mathematics is pitched it will be found very hard by some students and trivially easy by others; in contrast, the perception of subjects like history and media studies will be much more uniform. In the assessment of most subjects discrimination is based on students’ responses to readily understood questions. By contrast, in mathematics discrimination is built into the questions themselves; a ‘hard’ question can be one where some students cannot even get started. Consequently many students’ experience in mathematics is quite different from that in other subjects.

Conclusion

The report's recommendations would seem to say more about the pre-suppositions of whoever wrote them than about the research upon which they are supposedly based.