The framework for GCSE Mathematics

A discussion paper by Roger Porkess

Introduction

There has been considerable discussion recently on a revised tiering system for GCSE Mathematics. However every proposal that has been put forward has been unsatisfactory. In attempting to overcome one set of problems, new ones are introduced.

Whenever such a no win situation arises, it is almost certain that the parameters which are being used to define the problem are wrong and that it is necessary to step back and take a more strategic view. That is the purpose of this discussion paper.

Why is it mathematics that causes problems?

Mathematics differs from other subjects in the extreme variability in students' performance. On the one hand, there are the 10 or 11 year old children each year who gain grade A in GCSE; on the other, there are those who learn very little indeed. Between these two extremes there is a continuous distribution of performance, with some finding school mathematics very easy (often taking GCSE at the end of Year 10) and others finding it extremely hard.

This variability in mathematics is a fact of life and it is not going to go away. We always have had child prodigies and we will continue to do so, and there have always been those who are very weak at the subject. We can hope, by good teaching, to improve many students' performance but the overall distribution will still lie within much the same very wide bands.

In devising an examination structure for mathematics at 16, we thus have the problem of trying to cover about 5 years of "mathematical age" (and that is without taking account of the really exceptional students at either end of the ability range).

The only other subject with a comparable spread is music, and that is assessed in a fundamentally different way: by grades, 1 through to 8, taken at any age, when individuals are ready. (Few take GCSE Music.)

The focus of much recent discussion has been on how to fit mathematics into the same mould as other subjects at GCSE. Should it, for example, have just two tiers of assessment?

Such an approach is fundamentally flawed. The assessment structure for any subject has to be based on its nature and students' performance in it.

Looking elsewhere

The problems in devising the major national mathematics assessment at the age of 16 are almost unique to this country since there are few comparable countries where it is not compulsory to continue with the subject to 18. So there is little help to be gained from looking elsewhere. It is however instructive to consider what was done here some 40 to 50 years ago.

At that time only about 30-40 % stayed in school until they were 16 (or more) and took O Level Mathematics. The best among these, perhaps 10% of the age cohort, took a second O Level, Additional Mathematics. The remaining children left school before the age of 16 without the chance to obtain a qualification in mathematics.

There was thus recognition, in the form of a double award, of the variability even within the talented minority who stayed in school beyond the then compulsory leaving age. (This recognition continued on to A Level with the double award of Mathematics and Further Mathematics.) The solution for the less talented was in effect to declare them outside the range of the examination.

Since then we have, thankfully, brought everyone into the system and in doing so have increased the range of material being examined very considerably (no one thought a railway timetable a fit subject for a question in days gone by). The style of questions has also become more varied. Much of this came via CSE. In effect we have brought in a new and extra examination in mathematics at Foundation/Intermediate GCSE with substantially different content.

So to cover the needs of our students we require the content of what historically were three different syllabuses: CSE, O Level and Additional Mathematics. This makes the content of mathematics very extensive. Indeed it is quite hard to see the two extremes as the same subject at all. One has only to look at a complete set of GCSE textbooks to see just how much material is involved.

The variability of performance in mathematics thus translates into the problem of how to construct an assessment system across a very extensive syllabus which includes topics of very different levels of difficulty.

The way ahead

In this situation, the difficulties associated with current attempts to fit mathematics into existing GCSE tiering arrangements are not surprising. There are however at least two ways in which it is possible to design a more suitable framework.

- To make mathematics into a double subject
- To allow a chained pattern of entry

Double Subject Mathematics

The GCSE general criteria make provision for double subject awards but these have never been applied to mathematics. However the extent of the mathematics content fully justifies a double award and it would not be difficult to design.

Both subjects (working titles: Mathematics, Extra Mathematics) would be subject to the GCSE criteria and so give the full range of grades. They would however cover different content.

> GCSE Mathematics is based on a limited syllabus, perhaps up to Level 8 of the old National Curriculum. The examinations will include some more searching questions on this material and a grade A candidate will be expected to be able to answer these. The tiering arrangements will provide only means of obtaining a grade C.
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> GCSE Extra Mathematics will be examined on a more advanced syllabus, the remainder of the existing National Curriculum and some additional topics. There will be two tiers of entry with the additional topics on the whole examined in the higher tier.

It will be possible for students to take the GCSE Mathematics early, say at the end of Year 10, or they will be able to take both at the same time, typically with their other GCSE subjects at the end of year 11.

There is currently a double award in science, or three separate subjects, and there are two separate subjects in English. It would be entirely consistent with what is offered in those subjects, and indeed with historical precedent, for mathematics to be treated in this way.

One GCSE with a chained pattern of entry

The alternative to a double award is to have many tiers of entry. The current system has three but, by having so few, fails to meet national needs in a number of respects.

The essential problem is that candidates need an examination which is at the right level for them. If it is too easy or too hard it is, in different ways, demoralising and will fail to provide accurate information about the candidate's level of performance.

The present three tier arrangement is unsatisfactory for substantial numbers of students at both ends of the ability range.

A further problem is created by the fact that, in practice, grade C in GCSE Mathematics defines a national "pass". There are different ways of obtaining a grade C and so it is perhaps inevitable, and certainly undesirable, that one route should be seen to be easier than another. This situation can only be avoided by having no overlap between the grades allowed for the different tiers.

If, in addition, the number of tiers is restricted, students who enter for a "Below grade C" tier are "failures" before they start; those who enter for an "Above grade C" tier run the risk of being classified as "failing" because they do not obtain a grade above C.

The solution is to have a part of the assessment which provides the only way of obtaining grade C and which can be taken in conjunction with other parts, above or below. This would be the middle of a chained scheme in which any candidate takes at least two consecutive papers.

While this would be a very great improvement on anything that is currently being suggested, it would still leave the substantial number of talented students who take Mathematics in Year 10 outside the GCSE framework. These students can take one or two AS modules in Year 11 but those who do not wish to continue with mathematics in sixth form are then left with incomplete qualifications. A satisfactory examination needs to be made available for this group; at the moment they are casualties of the system.

Conclusion

We all want to raise standards in mathematics but to do so we must start by looking at the requirements of the subject rather than those of an "average" subject.

The present discussions (and consultations) on GCSE Mathematics have something of the feel of rearranging the deckchairs on the Titanic. They will do no good because they cannot.

Since the raising of the school leaving age we have consistently failed to provide a satisfactory examination framework for mathematics at this level. We have the opportunity to make a real improvement now. Please let us make use of it.

Roger Porkess
MEI Project Leader

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Celia Johnson,
DfEE,
Sanctuary Buildings,
Great Smith St.,
London SW1P 3BT.

1/2/00

Dear Celia Johnson,

The framework for GCSE Mathematics

This letter, and the attached discussion paper, will come to you out of the blue. I was at QCA last week discussing the mathematics provision for 16 year olds, and the forthcoming changes to GCSE, and suggested that I should write a paper for the DfEE, setting out the points I was making. Richard Browne said that he thought you would be the appropriate person to receive it.

You will read in the paper that we are profoundly worried about the direction in which GCSE mathematics seems to be going, being made to fit into a model which is simply wrong for the subject. Any of the proposals for change which we have seen would be for the worse, and the present situation is far from ideal.

In putting this forward I would say that in MEI we do have ample relevant experience. We were responsible for the first modular A Level in any subject in 1990, and it is essentially our model from that time which is now being used for the new specifications coming on line later this year. That syllabus has proved very successful; indeed it is one of the largest uptake A Levels in any subject.

It is a matter of major concern to us that the opportunities for sensible and serious syllabus development are being progressively cut back, to the point where our curriculum is being starved of new ideas. We would very much like to develop one or other of the ideas in this paper into an up-and-running GCSE. We believe that if we did so, we would point the way to a better future, in just the same way as we did at A Level ten years ago.

I would be grateful if you could circulate the paper to relevant people before the impending decisions are taken. Should it be helpful, I would of course be happy to come to the DfEE to discuss the points I am making further.

Yours sincerely,