

Reform of the National Curriculum in England Response to consultation by the London Mathematical Society

LMS Education Committee
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April 2013

The London Mathematical Society (LMS), founded in 1865, is the UK's learned society for mathematics. The Society's main activities include publishing journals and books, providing grants to support mathematics and organising scientific meetings and lectures. The Society is also involved in policy and strategic work to support mathematics and the mathematics research community. This work includes engaging with government and policymakers on mathematics education and research, participating in international mathematical initiatives and promoting the discipline.

The London Mathematical Society welcomes the opportunity to respond to this consultation. Our response covers Mathematics at Key Stages 1-3 and also Key Stage 4 and GCSE assessment.

We are pleased by the recognition that GCSE Mathematics should be a double award, with the implication that the importance of the subject and the space which it needs in the curriculum are recognised. We are also happy to learn that the evidence from the twinned pair GCSE pilot is generally positive and is being used to inform developments at Key Stage 4. We have more to say on this below.

We do have concerns about the pace at which the review is being carried out, and believe that a **structure such as a properly funded curriculum committee for mathematics, with a rolling remit, would be a better mechanism for the construction, maintenance, monitoring and periodic review of the mathematics curriculum** and related matters such as assessment.

A major concern is that in addition to the curriculum, however well constructed, there needs to be

- i. guidance notes for teachers, so that the interpretation of the curriculum is not largely driven by anticipating tests;
- ii. funded subject specific CPD for teachers;
- iii. teaching materials.

We are particularly concerned that leaving the market to provide suitable textbooks and teaching materials would not work well, and feel that a project needs to be organised to develop these, with the necessary funding.

Assessment and accountability will drive what is taught and how it is taught, so these must be carefully developed hand in hand with the curriculum. A variety of ways of assessing pupil progress should be used, along with pluralistic accountability measures, including at key stage 4 progression to A-level. These points (i) (ii) and (iii) above are needed if the following principles are to be embedded in the system:

- (a) the importance of hard questions on more elementary material, rather than the early introduction of more advanced topics, as a means of encouraging secure conceptual development needs to be built into the system;
- (b) the need for topics and concepts to be encountered some time before they are tested in a formal way;
- (c) the need for connections between different subjects to be made in ways which positively reinforce learning in each linked subject, and avoid fragmentation.

Stage by stage:

On **primary**, we feel that under the circumstances the team has achieved a reasonable outcome, but we are concerned that the content is over-ambitious so that some of the more advanced topics will often be taught mechanistically and the key basics may not be taught with the right depth and understanding.

The KS1/2 curriculum is admirable in seeking to raise aspirations. But it must moderate its expectations, and set the bar at an achievable height (by moving significant topics to KS3 - and leaving schools to judge whether to begin to explore them in Year 6). If we fail to do this, schools will seek to deliver skills without understanding, and this will undermine the objective of raising achievement.

The best way to achieve the overall aims of the curriculum, in the context of the system and teachers we have, is to consider what curriculum, delivered by non-specialists in primary schools, can best facilitate achievement in later secondary education. This is more effective than looking for achieved content at 11, and is more likely to give better results in international test-based comparisons at particular ages than a direct aim at these tests.

On **secondary** the Key Stage 3 and 4 curriculum both have their merits, but each has been produced on a very rushed timescale.

We are concerned that at Key Stage 3 there is too little detail, while at Key Stage 4 too much is left to be determined by exam boards as they develop GCSE assessment.

Overall, we are happy with the broad balance, provided that the main points of the ACME position paper <http://www.acme-uk.org/news/news-items-repository/2012/12/acme-launches-raising-the-bar-developing-able-young-mathematicians> on developing able mathematicians are heeded. A key principle of this report is that ***potential heavy users of mathematics should experience a deep, rich, rigorous and challenging mathematics education, rather than being accelerated through the school curriculum.***

Recommendations of this report which directly relate to the national curriculum include

Recommendation 1: Providing an extended interpretation of the mathematics curriculum

The National Curriculum should be enhanced with an 'extended interpretation' of the listed content to demonstrate the greater *depth, challenge and sophistication of link-making* envisaged. This extended interpretation of the mathematics curriculum would be a more challenging version of core curriculum content, though it might incorporate a small amount of additional material. There will be young people in every mainstream school who would benefit from being exposed to this mathematical experience.

The design, development and implementation of this interpretation of the curriculum should be properly funded, piloted and devolved to a small group of knowledgeable people from the mathematics and mathematics education communities. The group should have a remit including an obligation to consult with the relevant stakeholders. This group would work closely with any panel having oversight of the wider mathematics curriculum and assessment systems. Such provision should form part of the non-statutory guidance for Key Stages 1 to 4.

The curriculum for *all* students should build on the National Curriculum to give significant weight to the development of problem-solving and reasoning, both of which are critical to the development of mathematical potential.

Recommendation 2: Access to the extended mathematics curriculum

We envisage that around 30% of the cohort will find the extended interpretation a challenging but satisfying experience: access should be made available in all mainstream schools. The extended interpretation should be implemented concurrently with the new National Curriculum: this issue is both serious and urgent.

Recommendation 3: Assessment of the curriculum

Formal assessment of the extended interpretation should be incorporated into assessment structures at ages 11 and 16: it might eventually be targeted at 20-25% of any cohort. We recommend that this extended interpretation is the basis for the Additional Mathematics assessment at age 16, as proposed in the [current] consultation on English Baccalaureate Certificate. Some exposure to material in the extended interpretation of Key Stage 4 should be a prerequisite for A-level Mathematics.

Before commenting further on GCSE and related Key Stage 4 matters, some specific points of detail:

- Anticipating more advanced work, *probability and statistics* should be seen as a joint topic, not as two separate items in either the Key Stage 3 or the Key Stage 4 curriculum.
- 'Number theory' is a term for a specific area of mathematics; its use as a heading in both the Key Stage 3 and Key Stage 4 curriculum does not correspond to this standard meaning.
- Topics from mechanics such as momentum should not be included in the mathematics curriculum. Their treatment within physics, where they properly belong, should be coordinated with relevant work in mathematics.

Current concerns about KS4 and GCSE do not largely stem from inappropriate curriculum content, but from the form of GCSE assessment. The knock-on effect of league table pressures transmitted to mathematics departments by school managers is often 'teaching to the test' in an extreme form, with serious consequences because the tests themselves contain predictable types of question and do not demand real syllabus coverage. Longer lists of content will not ensure raised standards; real mastery and understanding of a more limited list is what is required. This is important when building a secure foundation for A-level study as well as for the other purposes of GCSE.

One of the many advantages of GCSE mathematics being a double award is that this should allow enough assessment space for good tests to be developed, particularly in the light of the twinned pair pilot.

We welcome the plan to introduce an enriched curriculum and extension paper. The extension paper should be in addition to the double award, we do not believe that half of the double award should be for the most able 25% with others only getting half as much time on mathematics.

We believe there should be tiers in GCSE mathematics, and suggest three overlapping tiers with everyone doing at least two. We recognise that tiers can 'cap ambition' and wonder if all should be allowed to take all tiers.