Draft: LMS Response to the Education White Paper: The Importance of Teaching

The London Mathematical Society is the foremost UK learned society for mathematics with an international membership. 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 policy-makers on mathematics education and research, participating in international mathematical initiatives and promoting the discipline.

Our primary concern is university mathematics, but the hierarchical nature of mathematics gives us a major interest in school mathematics education, and our concerns and involvement extend to all levels and to all students and teachers of mathematics.

The London Mathematical Society welcomes the White Paper on *The Importance of Teaching*, and its commitment to the creation of a teaching system among the best in the world. It especially welcomes:

- in 4.8 and 4.9, the emphasis on core subjects and a stronger emphasis on content;
- in 4.25, the emphasis on the special importance of the teaching of STEM subjects;
- in 4.26, the desire to increase the number of new mathematics teachers and to improve the skills of the existing mathematics teachers;
- in 4.47, the request to learned bodies to be involved in the reform of GCSEs and A levels.

We are eager to be actively involved in these developments by, in particular,

- contributing to the specialist subject knowledge of mathematics teachers via their continuing professional development (CPD);
- contributing to the revision of the mathematics curriculum and to its assessment;
- assisting in the provision of good mathematics text books and other resources;
- continuing our general support of a variety of enrichment activities.

We would, however, wish to comment in a little more detail on these and other issues raised in the White Paper and, finally, as a summary, we list recommendations, including a number where we might perhaps make a useful contribution. However, it must be noted that academics are nowadays under great pressure to show that their commitments generate appropriate levels of income for their HEIs. Academic involvement in curriculum, assessment and training issues will be successful only if HEIs are funded for their academics' involvement at levels comparable to those for research and teaching.

Teacher recruitment, training, retention and professional development. We welcome the commitment to recruit more and better teachers and to make teaching (and especially mathematics teaching) a more attractive and prestigious profession. However, we are very concerned about proposals to move away from university-based provision of initial teacher training (ITT). Evidence from around the world shows that teachers tend to teach as they were taught and that attempts to use school-based ITT to achieve significant reform usually fail. Premature immersion in school can leave the trainee with little alternative to the crude strategy of either repeating whatever they experienced as a pupil, or accepting whatever is ‘normal’ in their school. The recent Ofsted report on Finland underlined the importance for ITT of a reduced, tightly focused in-school experience, with trainees having access to a pedagogical framework and sufficient time to analyse this experience.

There is strong evidence that the best teaching of secondary mathematics requires the teacher to have knowledge of mathematics beyond what is being taught. So we agree that there needs to be much more emphasis on this in the CPD of mathematics teachers, but particularly for those in their first few years of teaching. (However, the government will need to ensure that specialist subject knowledge and subject pedagogical knowledge are not replaced by "generic" training, as happened with the Masters in Teaching and Learning programme.) The need to develop, and to reflect upon, specialist knowledge during one's first years of teaching is also important for primary school teachers, many of whom dropped the subject at age 15 or 16 during their own education.

The most successful mathematics CPD initiatives, especially those focused on reform, have accepted the need to work over time. For example, teachers may engage collaboratively and collectively on various mathematics-related tasks that simultaneously challenge their understanding of the subject and provoke new pedagogic insights. These insights are then taken into school for implementation before participants return to their HEIs for both reflection and further engagement with mathematics.

A renewed involvement of HEIs in subject-centred CPD is essential if the subject knowledge deficit of so many UK teachers of mathematics is to be addressed successfully. As part of this process it is essential that teachers have time to engage in CPD and related activities; to facilitate this, a review of the School Teachers' Pay and Conditions Document may be needed.

The curriculum. The current national curriculum for mathematics does need revision in content, implementation and assessment. Because of the cumulative way that mathematics builds through its various levels, not all of which will be visible to (or, in many cases, understood by) any one teacher, the national mathematics curriculum needs to be *finely* specified, as it was in 1999. Further, the implementation and assessment of this curriculum must be monitored as part of the inspection regime, so we recommend that a revision is made to the "four heading protocol" proposed for Ofsted to include a specific heading addressing such matters.

Experience in 1999 and since shows how much academic mathematicians can contribute to curriculum design and specification, injecting much-needed expertise and rigour. This contribution could extend to the provision of good textbooks and other (e.g. internet-based) resources. The current situation – the endorsement by awarding bodies of text-books which are superficial, narrowly aligned to a syllabus and exam-focused – is much more than a minor problem. It has been stultifying, and should be removed. We note that in high achieving countries, both assessment systems and textbook production remain under some type of government and academic control.

Progression and assessment. A fresh and more coherent view needs to be taken of the progression of (say) the top 25% of students. Most of these students should go on to study mathematics beyond age 16; and, to succeed at higher levels, basic material needs to be mastered much more robustly than is currently required for even the highest grades at GCSE. We need a structure at KS4 which helps this important group to lay the foundations on which their later success will depend. (At present this improved provision is too often the preserve of those in privileged schools.) In particular, we have to stop the current practice of taking GCSE early, which encourages superficial learning and often reduces pupils' enjoyment of mathematics. Instead, we must ensure that the most able pupils are appropriately challenged, motivated and inspired by the examinable KS4 curriculum.

We applaud the requirement that Mathematics be among the five 'good' GCSEs (English Baccalaureate), but suggest that schools need stronger central guidance on how much time should be devoted to such subjects as mathematics.

The UK needs mathematics qualifications beyond (single) Mathematics A-level: Further Mathematics, and the additional challenge provided in the spirit of AEA and STEP, are invaluable in stretching the best students. We applaud the Further Mathematics Support Programme's work in encouraging the study of more mathematics at this level, and welcome moves to give them additional support in the future. We would also like to see wider participation in other high quality extension activities. We welcome moves to give them extra support in the future. We note that a recent, as yet unpublished, analysis of Cambridge undergraduates' mathematics and mathematics-related achievement found, in terms of their final degree classifications, those who had been encouraged to participate in a mathematical community beyond mathematics classes (e.g. through the United Kingdom Mathematics Trust (UKMT) Challenges) achieved significantly better results, and had significantly more positive attitudes, than those who had not.

Mathematics assessment strongly benefits from end-of-course, linear assessment, and we support moves towards this both at GCSE and at A-level. Effective mathematics teaching is a long-term project, whose goals are undermined by a modular structure: mathematics is a body of unifying ideas which often take time to assimilate. There may still be scope for some modular courses, in which case this need for time to assimilate ideas and methods means that it would be detrimental to remove re-sits altogether. Rather we suggest that, partly to discourage premature entry, key decisions, school targets, league tables, etc. should be based on the result of the first sitting of each exam.

As with the curriculum, we would welcome moves towards greater involvement of academic mathematicians in both the setting of examinations and the assessment of their value for university admissions; this could add a valuable richness of mathematical background. This will require the reversal of a cultural trend which has moved this country from university examination boards to commercial awarding bodies overseen by Ofqual – an arrangement which is known to obstruct involvement of the wider mathematical community.

International comparisons. We welcome moves to compare our examinations with those in other countries. However, international comparisons can be misleading: there are special reasons to question the reliability of results from PISA. Contrary to claims in the White Paper, the results from TIMSS demonstrate marked, even remarkable, improvement at year 5, at least up to 2007. But there is still much that could improve. First, it is not clear whether the gains at year 5 have since become permanently embedded (if only because the focus on mathematics in primary schools has recently weakened). Moreover, if one looks more closely at the progress made in Year 9, one sees that the gains in Year 5 may have been rooted in "backward-looking" drill, rather than in teaching that cultivates "forward-looking" structural methods. This suggests the need for extensive CPD for those teaching at KS2 and KS3.

Changes – whether of teaching styles or examination questions – cannot simply be imported from other countries. Effective systems need to be considered in the context of the nation’s wider culture and the quality and training of its teachers. Ideas which show promise can then be reworked and piloted in an English setting as part of a long term programme for improvement. We do not feel that the Finnish comparison is helpful in our subject: Finnish success is a cultural rather than a didactic phenomenon. Singapore and Hong Kong are more interesting, and show the value of a coherently-designed curriculum and assessment system, with evidence of high-level mathematical input throughout. Of course these two examples also benefit from a high-quality, highly-motivated cohort of teachers and a culture in which mathematical achievement as a whole is celebrated. Singapore, which as a multicultural society is perhaps a useful parallel for the UK, also begins with an intellectually coherent overview of what it is to learn mathematics and a high profile of mathematics within society. Closer to home, some commentators have noted the success of Flanders: it is the highest performing European system in both PISA and TIMSS.

Recommendations to the Government

On the basis of the preceding analysis, we suggest that particular attention should be paid to the following points:

For teacher training and development:

1. Refine the plans for initial teacher training of mathematics teachers.
2. Encourage CPD provision which leads to the enhancement of mathematics teachers' subject skills and ensures some knowledge of basic mathematics on part of primary school teachers.

For curriculum and assessment:

3. Provide a finely specified mathematics curriculum.
4. Monitor its implementation via Ofsted.
5. Encourage the provision of good text-books and other resources, and discourage books tied to a particular examinations board.
6. University mathematicians should have a say in the design, classification, and setting of standards of examination of those mathematics qualifications which are relevant for university admission.

To improve progression:

7. Discourage early sitting of GCSE mathematics and over-use of re-sit examinations.
8. Encourage more robust learning of mathematics and involvement in mathematical activities and enrichment beyond the basic curriculum across all schools.

More generally:

9. Continue to pay attention to international comparisons, but be wary when implementing change based on that comparison.
10. Try hard to raise the profile of mathematics in society and to celebrate its intellectual qualities and achievement.

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