UK Mathematical Sciences – Research and Teaching in Symbiosis

A position paper of the London Mathematical Society

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EXECUTIVE SUMMARY

1. The UK's mathematical sciences research base is strong. About 50% of research activity in the mathematical sciences was rated as internationally excellent or world-leading in Research Assessment Exercise (RAE) 2008.

2. The UK mathematical sciences research base has increased by about 18% in the past decade. 1632 (full time equivalent) mathematical sciences researchers were submitted to RAE2001 and 1924 to RAE2008. During the same period the numbers in some cognate subjects such as physics and chemistry remained constant or declined.

3. Numbers of UK mathematical science students have greatly increased in recent years. The total number of full time equivalent students (FTEs) on undergraduate (UG) and postgraduate (PG) courses in the mathematical sciences increased by over 13% between 2003 and 2008, when the total was 34,120. During this period the number of students in UK Higher Education (HE) increased by 4.8%. The number of UK UG students graduating in the mathematical sciences is about double that in either physics or chemistry.

4. Students with mathematical sciences degrees are in high demand in the UK economy. This is demonstrated, for example, by statistics on starting salaries for undergraduates.

5. Activity in UK mathematical science has become more concentrated geographically over the past decade. There were 112 submissions in the mathematical sciences to RAE2008, compared with 151 to RAE2001.

6. EPSRC funding for research in the mathematical sciences is dwarfed by support for cognate subjects such as physics and chemistry. Thus the mathematical sciences research fund allocation was £14.3M in 2009-10, the corresponding sum for the physical sciences was £81.6M. The difference is much too great to be explained by differences in equipment costs.

7. Despite the strong and crucial performance of UK mathematical sciences in both teaching and research, the trends outlined here are likely – if allowed to continue – to lead to the closure of a number of first-rate UK mathematical sciences departments. In a climate dominated by cuts and of grants awarded with full economic costing, university administrations find themselves under severe pressure to invest only in areas capable of generating high levels of research grant income, and withdraw support from other areas. Such decisions are blind to wider economic and social imperatives, and thus can have unintended consequences that are deeply damaging to the needs of the country.

We hope that the information collected in this document will help in examining the extent to which these dangers have been overcome in the period since 2004, or whether some of them remain as serious threats to the future health of mathematical science in the United Kingdom.

2. UK Mathematical science - scale and distribution of research

(i) Research volume: The volume of research activity in the mathematical sciences in the UK is high, and showed significant increases over the early years of this century. First, as shown in Table 1, there was a significant increase in the number of academic staff submitted to the mathematical sciences sub-panels in the 2008 Research Assessment Exercise (RAE) over the number submitted in 2001. Second, Table 2 gives a comparison of research grant spend in 2001-02 and 2006-07 for grants from the UK research councils (RCUK) and other sources. ot eas y

- Submitted FTEs in statistics and OR remained essentially constant. It is possible, though unlikely, that these figures hide an increase in numbers of statistics researchers who were submitted to the RAE in subjects other than statistics. A more likely explanation is that these figures simply reflect the continuing difficulty in recruiting academics to statistics and OR posts in the UK.
- The figure for non-RCUK research spend in the mathematical sciences is constant across the period, at £12.3M.

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buoyant demand (from many employment sectors) for highly trained young mathematical scientists[5] makes it vital to maintain a wide geographic spread of top-quality mathematicians and statisticians across the UK's higher education institutions.

3. UK mathematical science – research quality

UK research activity in the mathematical sciences was rated highly in RAE2008[6], with around 50% of research activity[7] in each of the three relevant subject areas being rated as internationally excellent (3*) or world-leading (4*). This is shown in Table 4, in which two further features are also worthy of note:

- Performance is very similar across all three disciplines.
- Excellence is widespread, not exclusively concentrated in a small number of departments.

It is worth recalling again here the scale of the activity: as table 3 records, there were 112 submissions to the three mathematical sciences Units of Assessment (UoAs) in RAE2008, and 21 universities made submissions to all three of the mathematical sciences UoAs.

Citations Top 20, for mathematical sciences 1998-2008, shows Scotland in second place, England in fourth[8].

4. Teaching in the mathematical sciences

(i) **All students**: The total number of students studying mathematical sciences at UK Higher Education institutions has shown a steady increase throughout the most recent period for which HESA data is available[9], as shown in Table 5:

	2003-4	**2004-5**	**2005-6**	**2006-7**	**2007-8**	**% increase in 5 years**

The number of PhDs per year increased fairly steadily through the period of RAE2008 – for example 261 were awarded in 2001, and 376 in 2006. The RAE returns record a total of 2191 PhDs in the mathematical sciences in the period of RAE2008.[11]

5. Comparison with sister disciplines

The growth in the number of UK mathematical sciences researchers over the last decade has already been noted above. During the same period, activity in some cognate subjects has remained approximately constant or even declined. This is reflected both in the numbers of academics in each discipline, and in the numbers of undergraduates produced, as Table 8 y

EPSRC Programme 2009-10	DTA[13] allocation	CDT[14] allocation	Research Funding
Mathematical Sciences	£11.1M	3 CDTs, cost £10.8M	£14.3M
Physical Sciences	£32M	5 CDTs	£81.6M

Table 9: EPSRC programme allocations, 2009-10

A part of the mismatch shown in the above figures between Research Council support for mathematics and that for cognate subjects is a consequence of the fact that research in (for example) the physical sciences is more expensive than research in the mathematical sciences. However, even after the costs of equipment are removed, the imbalances are likely still to be striking.

Other G8 countries do *not* accord the mathematical sciences the same Cinderella status as the UK in regard to the share of research support. Thus, for example[15], the US National Science Foundation's 2010 budget for the mathematical sciences is $246.4M, while for physics and chemistry combined it is $535.1M. In Germany, the Deutsche Forschungsgemeinschaft[16] (DFG) awards substantially more each year than the EPSRC to mathematical sciences (€70.6M in 2009 having risen year on year from €36.4M in 2006).

6. Conclusions

There is a vibrant mathematical science community in the UK, which

- produces a large annual cohort of well-trained graduating students in the mathematical sciences;
- helps to give the necessary mathematical training to those graduating in other disciplines, thereby crucially supporting the development of future scientists, engineers, financial and IT specialists;
- carries out a large volume of research of high international quality;
- produces around 400 PhDs per year in the mathematical sciences.

This activity is widely spread geographically; this indeed is a crucial feature, since the current numbers of undergraduate mathematicians, the support teaching for other subjects, and the variety of mathematical research will all be impossible to maintain if UK mathematical science is yet further concentrated into fewer centres.

[13] DTA – Doctoral Training Account.
[14] CDT – Centre for Doctoral Training.
[15] AAAS REPORT XXXIV RESEARCH AND DEVELOPMENT FY 2010.
[15] Deutsche Forschungsgemeinschaft, Jahresbericht 2009, Aufgaben und Ergebnisse.