

The Royal Society's Advisory Committee on Mathematics Education (ACME)

Frank Kelly, Chair ACME
(University of Cambridge)

HoDoMS Conference,
Birmingham, 19 April 2018

Outline

- Review of ACME
- Strategic context
- Recent changes made to Maths A-levels

Why does the Royal Society have a dedicated mathematics education committee?

- Mathematics pervades other disciplines and the mathematics education community is more diverse than other disciplines. For this reason, ACME was set up by the Royal Society and the JMC in 2002. The Royal Society, JMC and CMS confirmed that a mathematics-specific committee was still required in 2016 and was best hosted by the Royal Society.
- There is political acknowledgement of the need for all learners to develop mathematical and quantitative skills to move into higher education and employment.
- The education landscape has changed dramatically since 2002. The DfE and BEIS have noted the importance of strong policy engagement with the Royal Society and the mutual benefit of working in collaboration to achieve specific objectives.

Mission of the redefined ACME:
To improve the mathematical and quantitative skills of young people.

- ACME is a **committee of the Royal Society**, working closely with the JMC and the CMS.
- ACME **develops strategic relationships** so that it is seen by government and others as the trusted body on mathematical and quantitative education in schools and colleges.
- ACME is made up of **high-level experts with an interest in mathematical and quantitative education, from the classroom, research and industry**. ACME will **establish strong links with Fellows** with expertise in mathematics, statistics and computer science and disciplines that use mathematics.
- **Contact Groups will provide a key source of expertise** for the redefined ACME. The JMC and CMS will harness the expertise of the mathematics community, for example to convene curriculum and qualification expert panels.
- An **evaluation** will be undertaken after five years.

Scope of the Royal Society's Advisory Committee on Mathematics Education

1. The supply of mathematics teachers and the education and professional development of teachers.
2. The mathematical and quantitative knowledge and skills set out in curricula and qualifications within and beyond the mathematics classroom.
3. The processes for developing and reviewing mathematics curricula, qualifications and assessment and the evidence base and expertise required for such development and review.
4. The mathematical and quantitative competency needed by business, industry, the third sector and government.
5. The mathematical and quantitative skills needed by higher education institutions.
6. Cultural attitudes towards mathematics in schools and colleges.

ACME members:

Frank Kelly
Martin Bridson
Paul Glaister
Paul Golby
Jeremy Hodgen
Mary McAlinden
Lynne McClure
Emma McCoy
Jil Matheson
David Spiegelhalter
Sally Bridgeland

**(three meetings per year: next
are on 7 June, 17 October 2018)**



Professor Frank Kelly
CBE FRS

Chair



Professor Martin
Bridson FRS

Member



Professor Paul
Glaister

Member (JMC)



Dr Paul Golby CBE
FREng

Member



Professor Jeremy
Hodgen

Member



Dr Mary McAlinden

Member



Mrs Lynne McClure

Member



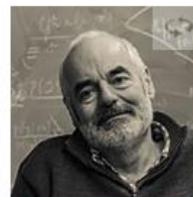
Professor Emma
McCoy

Member



Dame Jil Matheson
DCB

Member



Sir David
Spiegelhalter OBE
FRS

Member



Mrs Sally Bridgeland

Member

Contact Groups
organisational
support from the
LMS, IMA, RSS,
MA, ATM

- **A level contact group (evolved from ALMAB):** Richard Craster (Chair), Clare Dunning, Peter Giblin, Paul Glaister, Mark Heslop, Ryan Mercer (Royal Society Observer), Sue Pope, Roger Porkess, Alice Rogers, Neil Sheldon, Louise Walker, Helen Wilson
- **Post-16 mathematics pathways contact group:** Andrew Noyes (Chair), Jeremy Hodgen, David Spiegelhalter,...
- **GCSE and Key Stage 3:**
- **Early years and Primary:** Sue Gifford (Chair), Lynne McClure,...
- **Also, a Community of Interest:** former ACME and ACME Outer Circle members invited to join.

A selection of earlier ACME work, for example on problem solving, teacher supply and statistics across other subjects

ACME Advisory Committee on Mathematics Education

A blueprint for mathematics education

maths Snapshots
ISSUE 1 • JUNE 2014

The Advisory Committee on Mathematics Education (ACME) is an independent committee that utilises its expertise to develop advice to influence mathematics education policy. ACME undertakes evidence-informed analysis, harnessing and reflecting the expertise of the mathematics community.

ACME's blueprint...

1. All young people value mathematics and develop confident, positive attitudes to learning and using it.
2. They are mathematically fluent and can reason and solve problems within mathematics, in other contexts and in their daily lives.
3. They are taught by well-qualified, effective and inspirational teachers of mathematics.
4. They study appropriate and engaging mathematics up to the age of 18.
5. Policies that make this happen are joined-up, long-term, evidence-informed, transparent and well-designed.

1. Valuing Mathematics
 2. Competent learners
-

Embedding Statistics at A level:

a report on statistical requirements and assessment across A level courses in Biology, Business, Chemistry, Geography, Psychology and Sociology



THE ROYAL SOCIETY

ACME Advisory Committee on Mathematics Education

Professional learning for all teachers of mathematics

Principles for teachers, senior leaders and those who commission and provide professional learning

ACME Advisory Committee on Mathematics Education

Beginning teaching: best in class?

High-quality initial teacher education for all teachers of mathematics in England

ACME Advisory Committee on Mathematics Education

Problem solving in mathematics: realising the vision through better assessment

June 2016

ACME Advisory Committee on Mathematics Education

Teachers of maths: supply, training and development

maths Snapshots
DECEMBER 2016

There are not enough specialist teachers of maths in primary, secondary and further education. There is an urgent need to:

- attract more high-quality maths teachers into all sectors
- train all teachers to teach maths more effectively
- support teachers through high-quality, career-long professional learning and provide career opportunities for maths teachers to develop their knowledge and skills
- retain a greater proportion of the best teachers in classrooms.

Where are we now?

There is a shortage of appropriately qualified teachers of maths.

- Many primary schools have no teachers with specialist training and expertise in teaching maths.
- Secondary schools have a shortage of 5,500 specialist maths teachers in England. [cs](#)
- One quarter of those teaching 11-14 year olds do not have a maths-relevant qualification. [cs](#)
- One in five maths graduates choose to go into teaching. [cs](#)
- Across all subjects, almost one in four teachers leaves teaching within five years. [cs](#)

Different routes into teaching contain different quantity and quality of maths-specific training.

- There is no guarantee of high-quality, maths-specific training across Initial Teacher Training (ITT) routes.
- In 2012-13, Ofsted reported that school-based models of primary ITT offered weak mathematical subject training. [cs](#)
- Subject Knowledge Enhancement (SKE) courses provide an essential support for entry into maths secondary teaching for those with limited subject knowledge.

There is no overarching, long-term strategy for career-long professional development.

- There are no guidelines about progression from novice to expert teacher of maths.
- Teachers' access to maths-specific professional development is variable and geographically inequitable.
- There is no system-wide quality assurance of professional development.
- The quality of maths-specific training provided through Teaching Schools is unknown. These schools are judged 'outstanding' by Ofsted but the grading does not require maths training expertise.
- Some highly effective programmes have been discontinued, such as the Primary Mathematics Specialist Teacher (MAST) programme.
- With the aim of coordinating and developing professional development from primary onwards in mathematics the Government in 2014 established over 30 'Maths Hubs'. (See **Maths Snapshot: International comparisons.**)

- Urgently recruit and retain expert maths teachers in secondary and further education.
- Establish specialist teachers of maths in all primary schools.
- Provide high quality subject-specific professional development for all teachers of maths.

Updated policy briefing on teacher supply, March 2018

THE
ROYAL
SOCIETY

Policy briefing on teachers of mathematics Recruitment, retention and development

This briefing is from the Royal Society Advisory Committee on Mathematics Education and supersedes the *Maths Snapshot: Teacher supply, training and development* (2014)¹. Since then, there have been significant changes to the policy landscape and new data and analysis on the teaching workforce is now available. However, some of the challenges remain unchanged.

In addition, the demand for maths teachers has grown for a number of reasons, including increasing pupil numbers, policy changes to increase participation in mathematics among students aged 16 – 18 and new accountability measures (Progress 8). *The Smith Review* (2017)² identified a number of delivery challenges that limit the ability of education providers to offer mathematics qualifications and teach them well. This briefing draws on a range of sources to provide an overview of the capacity of maths teachers across all key stages, as well as the implications for policy.

The Smith Review (2017) identified a number of delivery challenges that limit the ability of

Supply and demand

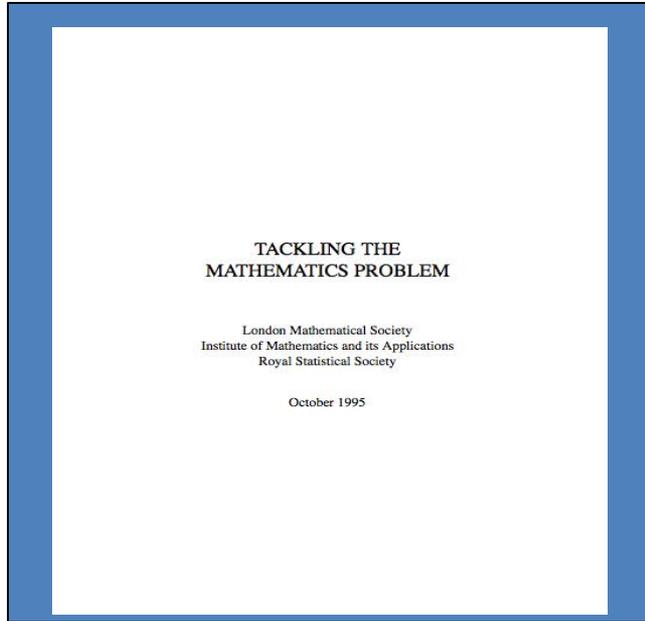
There is a shortage of appropriately qualified mathematics teachers across all phases of education.

- The school population is growing and it is expected that by 2023 there will be 900,000 more primary learners, 9% more than in 2014, and 480,000 more secondary learners, 17% higher than 2014³.
- At primary level, there is a shortage of maths expertise. Less than 1% of trainees take a maths specialism and up to 13,000 new specialists need to be trained to meet the target of one per primary school, as set out in the *Williams Review* (2008)⁴.
- At secondary level, schools are finding it difficult to fill posts with the quality of teachers they need. At least 4,400 more specialist maths teachers are needed to fill current vacancies⁵. In 2016 – 17, the number of postgraduate trainees in mathematics missed the Teacher Supply Model target by 16%⁶. Furthermore, 18% of maths lessons were taught by teachers who do not have a post A-level qualification in the subject⁷.
- In further education (FE) colleges, a sizeable minority of

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- Review of ACME
- **Strategic context**
- Recent changes made to Maths A-levels

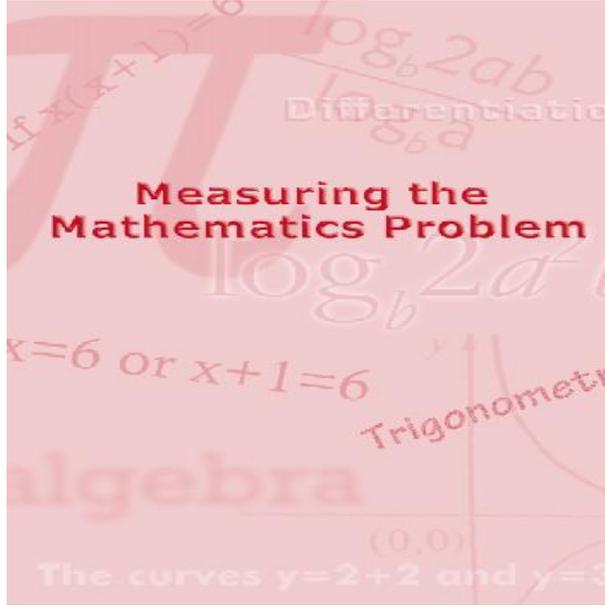
LMS, IMA, RSS 1995



There is unprecedented concern amongst mathematicians, scientists and engineers in higher education about the mathematical preparedness of new undergraduates.

*LMS, IMA, RSS, 1995,
Tackling the Mathematics Problem.*

Engineering Council (2000)



Acute problems now confront those teaching mathematics and mathematics-based modules *across the full range of universities*.....

Prompt and effective support should be available to [university] students whose mathematical background is found wanting.....

Duncan Lawson's slides

*Measuring the mathematics problem.
Engineering Council (2000)*

The “mathematics problem” persists and broadens... Increasing quantification (Biological Sciences)



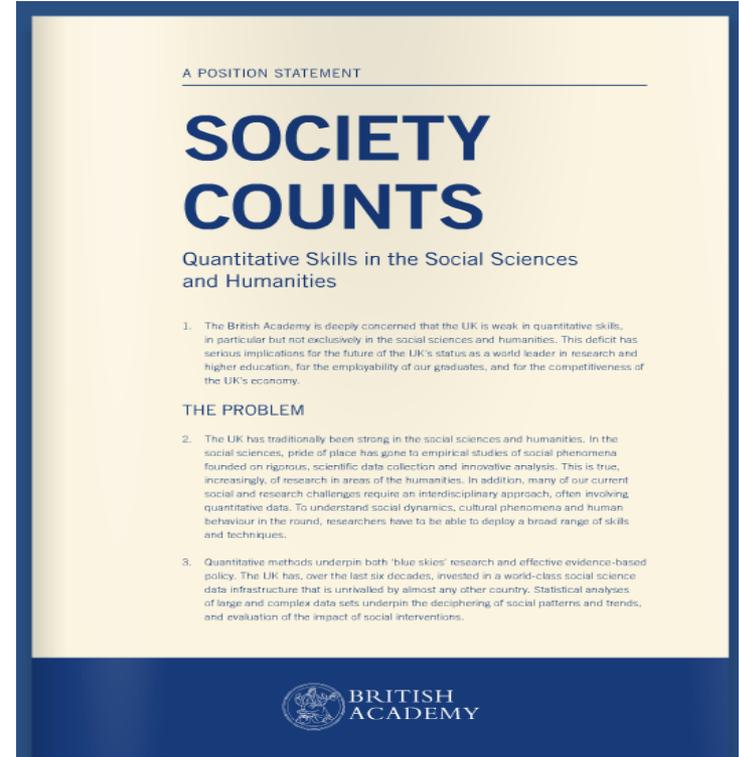
As bioscience becomes increasingly quantitative, there is also an urgent need to raise the mathematical and computational skills of biologists at all levels.

Biotechnology & Biological Sciences Research Council:
The Age of Bioscience: Strategic Plan 2010-2015

Many biological science graduates have not studied mathematics beyond 16 ... their understanding of statistical techniques is low ... demand for statistics skills will increase.

- *The UK is weak in quantitative skills, in particular but not exclusively in the social sciences and humanities.... another reason for the poor skills of undergraduates is the dearth (of increasing quantification) (of academic staff able to teach quantitative methods)*

British Academy position statement
 Society Counts: Quantitative Skills in the Social
 Sciences and Humanities (2012)
http://www.britac.ac.uk/policy/Society_Counts.cfm





English universities are sidelining quantitative and mathematical content because students and staff lack the requisite confidence and ability. This has the potential to damage standards in English universities.

Solving the maths problem: international perspectives on mathematics education
Royal Society of the Arts (2012)

Key findings

- In Japan and China more than 50% of degrees awarded are in STEM subjects, compared to less than a quarter in the UK.
- 25% of adults are functionally innumerate
- Many students do not realise that mathematical facility is necessary for success in a wide range of HE subjects
- English universities are side-lining quantitative and mathematical content because students **and staff** lack the requisite confidence and ability



HOUSE OF LORDS

Select Committee on Science and Technology

2nd Report of Session 2012–13

**Higher Education in
Science,
Technology,
Engineering and
Mathematics
(STEM) subjects**

Report

Ordered to be printed 17 July 2012 and published 24 July 2012

Published by the Authority of the House of Lords

London : The Stationery Office Limited
£price

HL Paper 37

24 July 2012

The weight of evidence that we have received led us to conclude that post-16 maths and the interface between school and HE study warranted a closer look.

The gap between the mathematical skills of students when they enter HE and those needed for STEM degrees is a problem which has become acute.

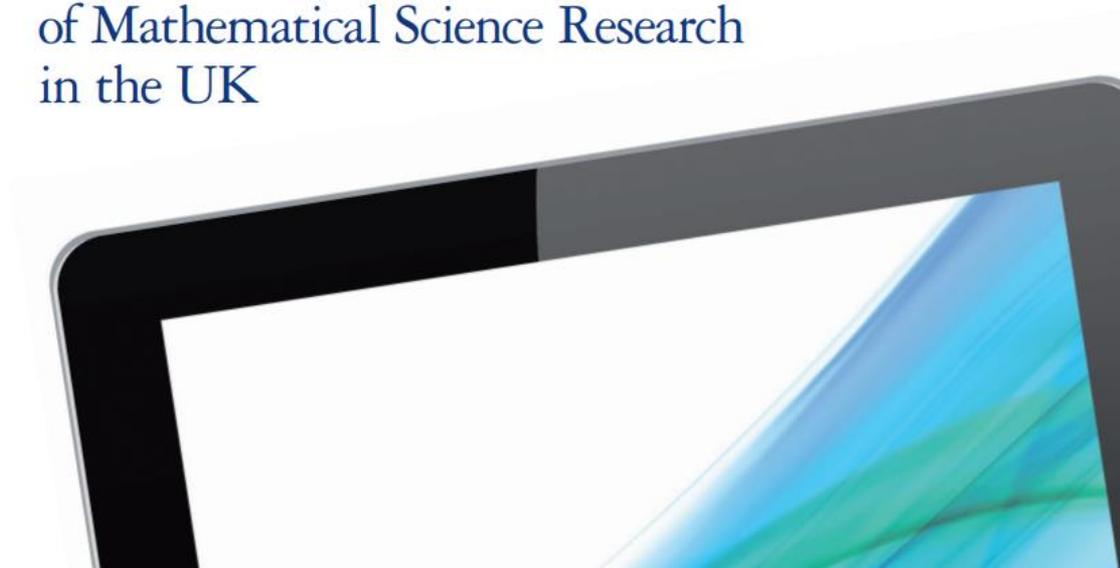
Deloitte.

EPSRC

Engineering and Physical Sciences
Research Council

**The Council for the
Mathematical
Sciences**

Measuring the Economic Benefits of Mathematical Science Research in the UK





Mathematical sciences research

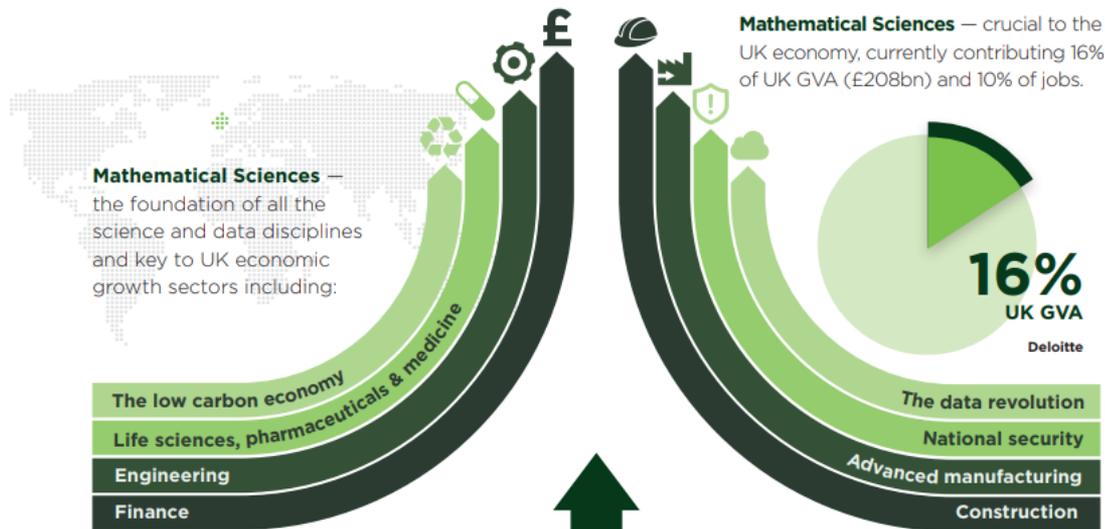
Leading the way to UK economic growth

MATHEMATICAL SCIENCES DRIVING THE UK ECONOMY

A report by



IMPACT



Research shows widespread gaps in mathematical knowledge and skills across many sectors and levels of industry and employment. The potential for such weaknesses to fundamentally undermine the UK's economy is evident, and it is in the UK education system where these problems begin.

CHALLENGE

Insufficient Mathematical Sciences graduates, postgraduates and researchers to meet current or future

ACTION

Need for substantial increase in Mathematical Sciences MSc and PhD numbers, at least doubling in the short term

[Home](#) > [Education, training and skills](#) > [Further and higher education, skills and vocational training](#)
> [Further and higher education courses and qualifications](#)

Independent report

Smith review of post-16 mathematics: report and letter

Professor Sir Adrian Smith's review of mathematics education for 16- to 18-year-olds in England.

Published 20 July 2017

From: [Department for Education](#)

Applies to: **England**

Documents



[Report of Professor Sir Adrian Smith's review of post-16 mathematics](#)

PDF, 1.28MB, 89 pages

Related content

[Further and higher education courses and qualifications](#)

Degrees, diplomas, funding, 16 to 19 study programmes, conditions of funding, component levels, course directory, what qualification levels mean.

[Check if a university or college is officially recognised](#)

15 mentions of “maths” in the Autumn Budget 2017 -
<https://www.gov.uk/government/publications/autumn-budget-2017-documents>

75 mentions of “maths” in the Industrial Strategy -
<https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future>

- **Advanced Maths Premium** - the recent Government [announcement](#) which will see schools provided with an extra £600 per year for each additional pupil taking an advanced Maths qualification;
- **Specialist Maths schools** - the declaration in the [Autumn Budget](#) to provide £18 million to support the creation of these institutions;
- **Concerns regarding teaching** - the Government's recent [review of teaching in FE](#), which highlighted the shortage of specialist maths teachers as a key factor restraining Mathematics provision within education, as well as the [announcement](#) of new bursaries to attract and retain Maths teachers; and
- **Industrial Strategy** - the Government's commitment to Mathematics as a key factor in ensuring the success of the strategy, with its desire being to 'widen the pool of students capable of studying advanced Mathematics and other STEM subjects'.

[Home](#) > [Education, training and skills](#) > [School curriculum](#) > [Key stage 5 \(AS and A Levels\)](#)

News story

New Advanced Maths Premium can open more doors for young people

Schools will receive £600 for every additional pupil who takes an advanced maths qualification, helping to ensure Britain has skills for success in the future.

Published 28 February 2018

From: [Department for Education](#), [HM Treasury](#), [The Rt Hon Nick Gibb MP](#), and [The Rt Hon Elizabeth Truss MP](#)



Related content

[Key stage 5 \(AS and A Levels\)](#)

Sixth form colleges, marking and grading exams, results data.

Specifications in relation to the reasonable adjustment of general qualifications

What qualification levels mean

Central message

The contribution that mathematical sciences make is largely hidden, but underpins much of our 21st century technology, economy and society, and many of our key innovators and wealth-creators are talented and imaginative individuals with a high degree of maths training.

At the same time mathematics has an elegance and beauty which can fascinate both the next generation and our society generally, as some of our gifted communicators have shown in books, on TV and in public lectures.

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Changes to AS/A level Mathematics – first teaching September 2017

AS Pure: In

- $y = e^x$ and $y = \ln x$ including (informally) differentiating $y = e^{kx}$;
- use of exponential growth and decay in modelling
- use of logarithmic graphs to estimate parameters in relationships of the form $y = ax^n$ and $y = kb^x$
- differentiation from first principles
- vectors in 2D, not including scalar product

AS Pure: Out

- no series work except binomial expansion (all in full A level only)
- no radian measure (now in full A level only)
- no trapezium rule (now in full A level only)
- no remainder theorem

Full A level Pure: In

- proof by contradiction (including specific examples of irrationality of $\sqrt{2}$ and infinity of primes)
- use of functions in modelling, including consideration of limitations and refinements of models
- all work on series is now in full A level only
- small angle approximations for sin, cos and tan
- exact values for sin, cos and tan
- proofs of addition formulae
- find your own substitutions for integration (simple)
- Newton-Raphson method
- trapezium rule

Full A level Pure: Out

SHORT UPDATE

AS and A levels in Mathematics and Further Mathematics are changing - are you ready?

Paul Glaister¹, Department of Mathematics and Statistics, University of Reading, Reading, UK.
Email: p.glaister@reading.ac.uk

Abstract

The purpose of this article is to give an overview of the reforms to AS and A levels in Mathematics and Further Mathematics, with links to relevant sources of information and resources, to assist colleagues in HEIs with their planning for curricula etc for new entrants in Autumn 2019. The article begins with a brief history of the reforms and their rationale, together with details of the final subject content and nature of the assessment regime in which these sit. The specific details of the eight major changes to Mathematics and Further Mathematics AS and A levels are included. The article concludes with some details on the related specifications and assessment materials provided by the Awarding Organisations: AQA, OCR, and Pearson/Edexcel.

Keywords: mathematics education, AS/A level reforms, mathematics, further mathematics.

1. AS/A level reforms: history, timeline and rationale

The impact of curriculum and funding changes on level 3 mathematics uptake - <http://furthermaths.org.uk/news>

At the end of the autumn 2017 term, MEI conducted a survey of schools and colleges offering A levels, to try to establish how uptake of the mathematics AS/A levels and Core Maths has changed between academic years 2016/17 and 2017/18. We received responses from over 500 schools and colleges.

The full survey report has just been published, and is available at <http://bit.ly/MEISurvey18>.

An executive summary is available at <http://bit.ly/MEISurvey18Exec>.

Comparing 2017/18 with 2016/17, the survey analysis suggests:

1. There has been an overall reduction (roughly 10%) in the number of Year 12 students starting AS/A level Mathematics
2. The number of students starting AS/A level Further Mathematics has not changed significantly
3. The uptake of Core Maths continues to grow
4. Overall, there has been an increase in the GCSE Mathematics grades which schools and colleges require students to achieve before allowing them to start AS/A level Mathematics and Further Mathematics programmes

Point 1 is hard to interpret as it is also the case that since A levels became linear far fewer schools and colleges are offering AS levels. Many had continued to offer AS Mathematics because, until this academic year, AS/A level Mathematics had continued to be modular. In the past, many students took AS Mathematics as one of 4 AS levels in year 12 and then dropped it, either because they had always planned to do so, recognising that AS Mathematics is a very valuable qualification in its own right, or because they decided they preferred to take only their other 3 subjects to full A level. The move to linear A levels has resulted in many schools and colleges offering only 3 A level subjects to their students in year 12, so it is natural that the number starting AS/A level Mathematics should fall. It is hard to estimate what the overall impact on numbers taking A level Mathematics in 2019 will be, especially as we don't know what change there was in year 12 uptake between 2014/15 and 2016/17. The recently announced Advanced Mathematics funding premium will help to boost both AS and A level numbers for Mathematics and Further Mathematics in academic year 2018/19 and beyond.

Point 2 looks like very good news, but again we cannot be sure what the impact on A level numbers in 2019 will be. Again, the Advanced Mathematics funding premium should support continued increases in uptake of AS/A level Further Mathematics.

Point 3 also looks very positive, and the Advanced Mathematics funding premium should really boost Core Maths numbers. Schools and colleges who were not offering Core Maths in academic years 2016/17 or 2017/18, but who are offering it from this September may receive £600 of Advanced Mathematics Premium funding for every student taking Core Maths for at least the next 3 years, and those who were already are offering Core Maths will receive the premium for every additional student.

Point 4 is a concern. The new 9–1 GCSE Mathematics is intended to be a better preparation for AS/A level Mathematics than the previous GCSE Mathematics and MEI believes strongly that schools and colleges should not automatically deny some students with good passes at GCSE Mathematics the opportunity to start AS/A level Mathematics.