Boundaries and Bridges in post-16 Mathematics Education

NANAMIC Conference, National STEM Centre, York, July 12 2018

Post-16 Mathematics: landscape, policy, practice and priorities, including Smith and the Industrial Strategy

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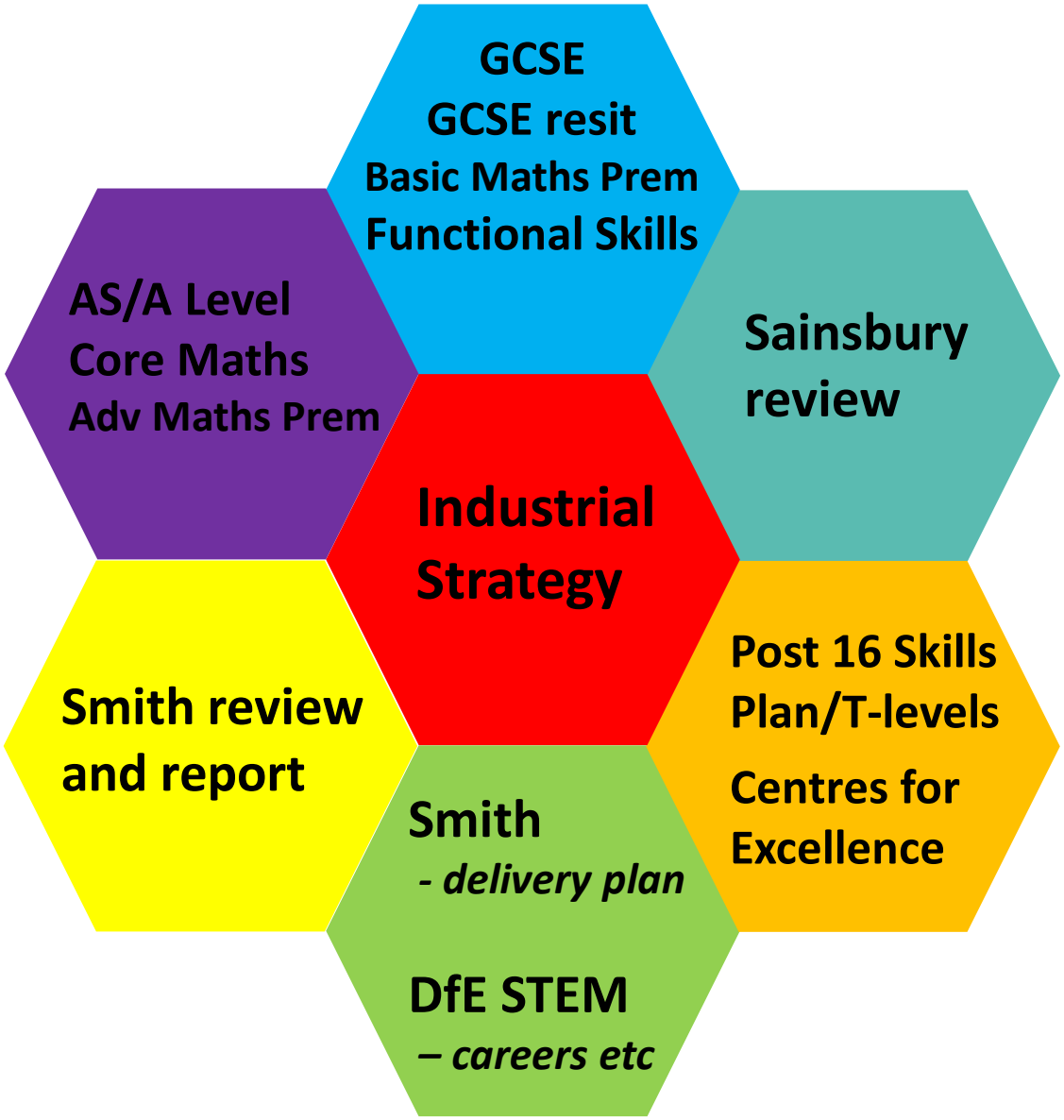
Overall picture



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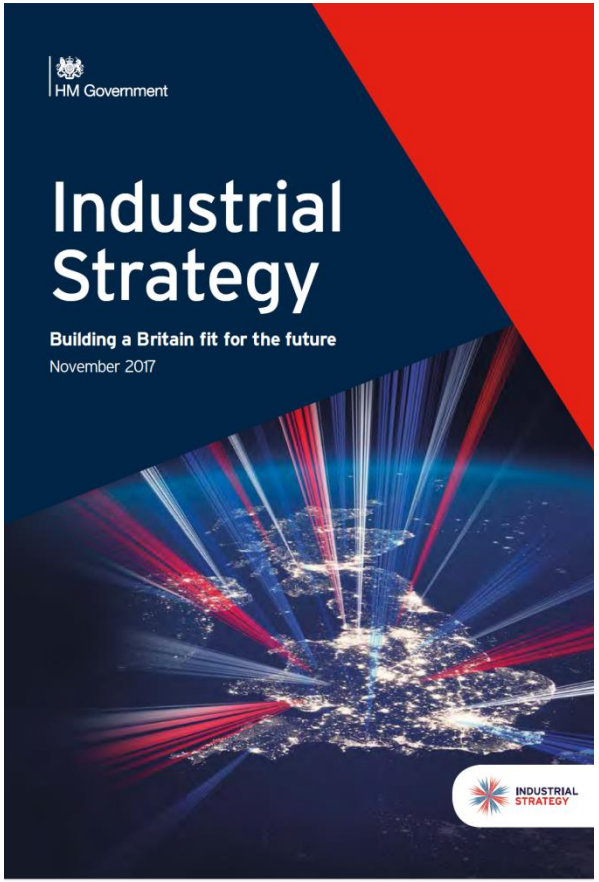
Landscape & the journey to 2018

- GCSE reformed for first awards 2017
- Functional Skills reformed for 2019 →
- ALCAB AS/A level reform in Mathematics and Further Mathematics 2014→2017
- Core Maths launched 2014
- Sainsbury Review/Post 16 Skills Plan 2016/T levels 2017
- DfE/HMT Post 16 Smith Review 2016-2017
- Industrial Strategy 2017

Latest announcements



Driving up the study of maths

Sir Adrian Smith's review of maths education for 16-18 year olds in England, published in July, found a strong demand for mathematical and quantitative skills in the labour market at all levels[107].

It also identified a consistent under-supply reflecting the low take up of maths among 16-18 year olds in England, and low achievement relative to other developed countries. It set out a strong case for raising participation and improving both basic and advanced maths skills: adults with basic numeracy skills earn higher wages and are more likely to be employed than those who fail to master basic quantitative skills. Higher levels of achievement in maths are associated with higher earnings for individuals and higher productivity. Strong quantitative skills are increasingly important as an underpinning for all forms of STEM study, but also for highly-skilled employment outside core STEM disciplines. As the Smith review points out, learned societies argue that students across the sciences, social sciences and humanities need significant quantitative skills, and these should be a central component of their education.

Maths should not be perceived as an exceptional talent; it is a basic skill that can be mastered with the right teaching and approach, as shown by OECD evidence from successful models such as Singapore, Switzerland and Denmark[108].

Improving the take up of maths qualifications and the quality of maths teaching across the education system is one of the most significant interventions that government can make to tackle STEM skills shortages and secure wider benefits for the economy[109].

Demand is clearly growing. For example, the UK's world-class creative industries, which cover film, TV and video games, are growing at twice the rate of the economy as a whole and are heavily reliant on STEM skills[110].

We have already taken some early actions in response to the Smith Review. This includes a level 3 Maths Support Programme, which will build on the momentum created by the Further Maths and Core Maths Support Programmes, and work with schools and colleges to improve maths education by sharing best practice and working to increase participation and attainment in maths among 16-18 year olds. The programme will work to deliver focused intervention targeted to those who need it most.

There were almost 3,000 entries in the first year (2016)[115], and this grew to 5,361 entries in 2017[116]. To deepen the understanding of the gender disparity in STEM subject choices at ages 16 to 19, we will explore how to improve the accessibility and transparency of data published on STEM, by institution and subject.

We need to go further on maths. Building on Sir Adrian Smith's recommendation to make core maths available to all students on level 3 pathways, **we will incentivise education institutions to offer maths by providing a £600 premium to existing per pupil funding rates for each additional student who takes maths or further maths at AS/A level or core maths.** This will help education providers to support more students aged 16 and over to study maths.

We also recognise that universities are an important influence on students' choices. In response to Sir Adrian Smith's recommendations, we are working with institutions such as the Royal Society and the British Academy to encourage universities and employers to signal the value of level 3 maths qualifications for entry to undergraduate courses that have a significant quantitative element, and the value for a wide range of job roles. These investments will begin to meet

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White Paper - Industrial Strategy
Building a Britain fit for the future

People

- To generate good jobs and greater earning power for all.
- We do not have enough people skilled in science, technology, engineering and maths.
- We will help people develop the skills needed for jobs of the future.
- Invest an additional £406m in maths, digital and technical education, helping to address the shortage of science, technology, engineering and maths (STEM) skills.

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Building a Britain fit for the future

- Of the 16 year olds who have achieved an A*-C grade in GCSE maths, fewer than a quarter continue to study maths after age 16.

- Although there has been a 20 per cent increase in entries to maths A levels since 2010, less than a third of students studying STEM related A levels go on to gain a STEM degree, and a significant proportion of STEM graduates do not go into STEM occupations.

- There is also significant regional variation in uptake of STEM subjects, including maths. In Reading in 2016, 57 per cent of students who achieved A*-C at 15 went on to study maths at level 3; in Barnsley it was 10 per cent.

- And we know girls are less likely to choose STEM subjects than their male counterparts.

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Driving up the study of maths

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White Paper - Industrial Strategy
Building a Britain fit for the future

- We have already taken some early actions in response to the Smith Review. This includes a level 3 Maths Support Programme, which will build on the momentum created by the Further Maths and Core Maths Support Programmes, and work with schools and colleges to improve maths education by sharing best practice and working to increase participation and attainment in maths among 16-18 year olds. The programme will work to deliver focused intervention targeted to those who need it most.

- Around 30 per cent of young people do not currently achieve a GCSE standard pass aged 16, and of these, only around 17.5 per cent achieve a good standard of maths by the age of 19. In these crucial years, the basic maths gap widens compared to high performing countries. England remains unusual among advanced countries in that the study of maths is not universal for all students beyond 16.

White Paper - Industrial Strategy
Building a Britain fit for the future

- To tackle this, we will test innovative approaches to improve outcomes in basic maths for those aged 16 and over, through a £8.5m pilot.

- We will also invest £40m to establish Further Education Centres of Excellence across the country to build teaching capacity and spread best practice.

- We are also reforming functional skills qualifications to improve their quality and levels of employer recognition, and will continue to monitor and review the current policy which requires students without a GCSE standard pass in maths and English at 16 to continue to study towards this aim.

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White Paper - Industrial Strategy
Building a Britain fit for the future

- We are seeing growth in the new core maths qualifications introduced in 2014, which are designed to prepare students for the mathematical demands of university study, employment and life. These have been endorsed by a large number of universities, including many in the Russell Group.

- We have funded 145 early adopter schools and colleges to begin teaching the new qualifications.

- To deepen the understanding of the gender disparity in STEM subject choices at ages 16 to 19, we will explore how to improve the accessibility and transparency of data published on STEM, by institution and subject.

White Paper - Industrial Strategy
Building a Britain fit for the future

- We need to go further on maths. Building on Sir Adrian Smith's recommendation to make core maths available to all students on level 3 pathways, we will incentivise education institutions to offer maths by providing a £600 premium to existing per pupil funding rates for each additional student who takes maths or further maths at AS/A level or core maths. This will help education providers to support more students aged 16 and over to study maths.

- These investments will begin to meet the demand for coveted STEM skills, as well as close the advanced maths gap that exists between our education system and the best in other developed countries.

White Paper - Industrial Strategy
Building a Britain fit for the future

- We will put technical education on the same footing as our academic system, with apprenticeships and qualifications such as T levels. We will continue to support teaching in our schools, flexible career learning and other measures to transform people's life chances.

- Establish a technical education system that rivals the best in the world, to stand alongside our world-class higher education system.

- We are also focused on expanding the capacity for maths teaching. We offer generous financial incentives for those training to teach priority subjects such as maths, and last year we trained more maths teachers than in any of the previous four years. To incentivise recruitment to initial teacher training and ensure we retain as many teachers as possible, we are piloting new style bursaries in maths.

- We will now invest £27m in the further expansion of Teaching for Mastery maths programme to reach 11,000 primary and secondary schools in total by 2023.

- We will work with top maths universities to expand the specialist maths school model pioneered by Exeter University and King's College London. We are providing £350,000 annual funding for every maths school to deliver the specialist maths school model, including extensive outreach work with schools and teachers to ensure all students have the chance to achieve their mathematical potential.

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GCSE 2015 onwards - content

Subject content

- Number
- Algebra
- Ratio, proportion and rates of change
- Geometry and measures
- Probability
- Statistics

GCSE specifications in mathematics should enable students to:

1. develop fluent knowledge, skills and understanding of mathematical methods and concepts
2. acquire, select and apply mathematical techniques to solve problems
3. reason mathematically, make deductions and inferences and draw conclusions
4. comprehend, interpret and communicate mathematical information in a variety of forms appropriate to the information and context.

Functional Skills for 2019

Industrial Strategy

- Reforming functional skills qualifications to improve their quality and levels of employer recognition

- Continue to monitor and review the current policy which requires students without a GCSE standard pass in maths and English at 16 to continue to study towards this aim.

White Paper 2010
The Importance of Teaching

- A levels are a crucial way that universities select candidates for their courses, so it is important that these qualifications meet the needs of higher education institutions.

- To ensure that they support progression to further education, higher education or employment, we are working with Ofqual, the awarding organisations and higher education institutions to ensure universities and learned bodies can be fully involved in their development.

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ALCAB 2014 – HE view

Issues:

- The mathematical thinking of the most able is not developed.
- The distinction between A and A* grades seems based on the avoidance of careless slips rather than genuine mathematical ability, making it hard for admissions tutors to pick out the students with the greatest potential.
- The A* should be awarded for demonstrating understanding and flair, not the ability to do routine calculations accurately, and the assessments should be developed accordingly.
- It is not clear what applied mathematics students have learnt.
- Current statistics provision tends to focus on routine calculations at the expense of interpretation and understanding.

ALCAB reforms/AS & A levels (from 2017)

Key aims:

- Better **support transition to mathematical study** at university.

Key changes:

A level mathematics

- Specified in more detail to clarify requirements.

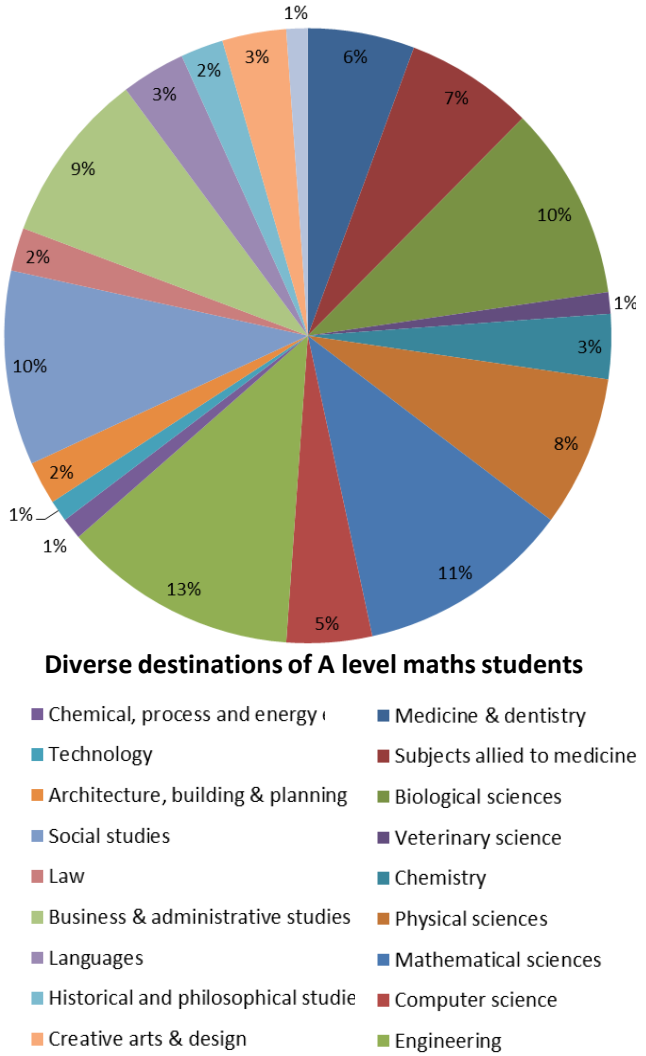
- **100% prescribed**, giving universities confidence about the mathematics that undergraduates have studied.

- Compulsory applied content in statistics and mechanics and removal of decision mathematics.

- Emphasis on mathematical argument, language and proof; mathematical problem-solving and modelling; use of large data sets in statistics.

A level further mathematics

- Common pure core - 50% of overall content, allowing scope for options.



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AS/A level reforms - aims

ALCAB's primary aims were to provide modern A levels that:

- contain the necessary material that will serve HE and employment
- will be interesting to learn and teach

specifically:

- introduce calculus and its applications
- emphasise how mathematical ideas are interconnected
- show how mathematics can be applied to model situations mathematically
- make sense of data
- understand the physical world
- solve problems in a variety of contexts
- prepare students for further study and employment in a wide range of disciplines

AS/A level reform: ALCAB & Overarching Themes

ALCAB's intentions can be neatly summarised by the three Overarching Themes:

- OT1 Mathematical argument, language and proof
- OT2 Mathematical problem solving
- OT3 Mathematical modelling

and AS/A level specifications must require students to demonstrate these, and must be applied, along with associated mathematical thinking and understanding, across the whole of the detailed content.

There are two further themes:

- use of technology
- use of data in statistics

All five themes should have some impact on the way students have been taught, and an impact on their learning of mathematics.

As such, students who have been taught by teachers who have embraced the reforms and ALCAB's intentions as set out in the Mathematics and Further Mathematics Subject Content documents, should be better prepared for studying mathematics in HE.

AS/A level reform: ALCAB & Overarching Themes

In particular, students should be better at:

- understanding what proof is and what it means to prove (or disprove) a statement
- using mathematical language
- developing and articulating mathematical arguments
- providing extended responses
- drawing together different areas of knowledge, skills and/or understanding from across the subject content
- tackling 'synoptic' problems that can now be set in the linear framework where any content from across the qualification could appear in an assessment
- 'problem solving'
- determining summary statistics using technology, and interpreting real data presented in summary or graphical form (as opposed to focussing on calculation of summary statistics by hand)
- understanding modelling (in application settings), and the limitations of models.

AS/A level Maths and Further Maths – mathematical problem solving

- Tasks have little or no scaffolding: there is little guidance given to the candidate beyond a start point and a finish point. Questions do not explicitly state the mathematical process(es) required for the solution.
- Tasks provide for multiple representations, such as the use of a sketch or a diagram as well as calculations.
- The information is not given in mathematical form or in mathematical language; or there is a need for the results to be interpreted or methods evaluated, for example, in a real-world context.
- Tasks have a variety of techniques that could be used.
- The solution requires understanding of the processes involved rather than just application of the techniques.
- The task requires two or more mathematical processes or may require different parts of mathematics to be brought together to reach a solution.

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Not all of these attributes would be required within a single task to establish it as problem solving.
Neither does the presence of one or more attributes within a task automatically imply problem solving is taking place.

AS/A level reforms statistics

Use of data in statistics - require students to:

- become familiar with one or more specific large data set(s) in advance of the final assessment (these data must be real and sufficiently rich to enable the concepts and skills of data presentation and interpretation in the specification to be explored)
- use technology such as spreadsheets or specialist statistical packages to explore the data set(s)
- interpret real data presented in summary or graphical form
- use data to investigate questions arising in real contexts
- explore the data set(s), and associated contexts, during their course of study to enable them to perform tasks that assume familiarity with the contexts, the main features of the data and the ways in which technology can help explore the data
- demonstrate the ability to analyse a subset or features of the data using a calculator with standard statistical functions

The intention is that, rather than students focussing on performing routine calculations to determine summary statistics, they should use technology to do this and then focus on the understanding and interpretation of these statistics.

AS/A level reforms statistics

Large Data Sets (LDS) – the intention of the statements in the Content Document was that:

- learners will have been provided with large sets of real data at the start of the course and some of the examination tasks will be based upon these data sets
- such examination tasks will explore how the application of suitable statistical techniques to the data can provide insight into the contexts from which they have been drawn
- well prepared candidates will have been working with the data sets for nearly two years and so should be familiar with the contexts
- most examination tasks based on the data sets will include elements of interpretation relevant to their contexts
- assessment should adequately reflect the intentions of the Content Document, in all respects, but in particular in respect of the 'use of large data sets'

A/AS Level mathematics progress

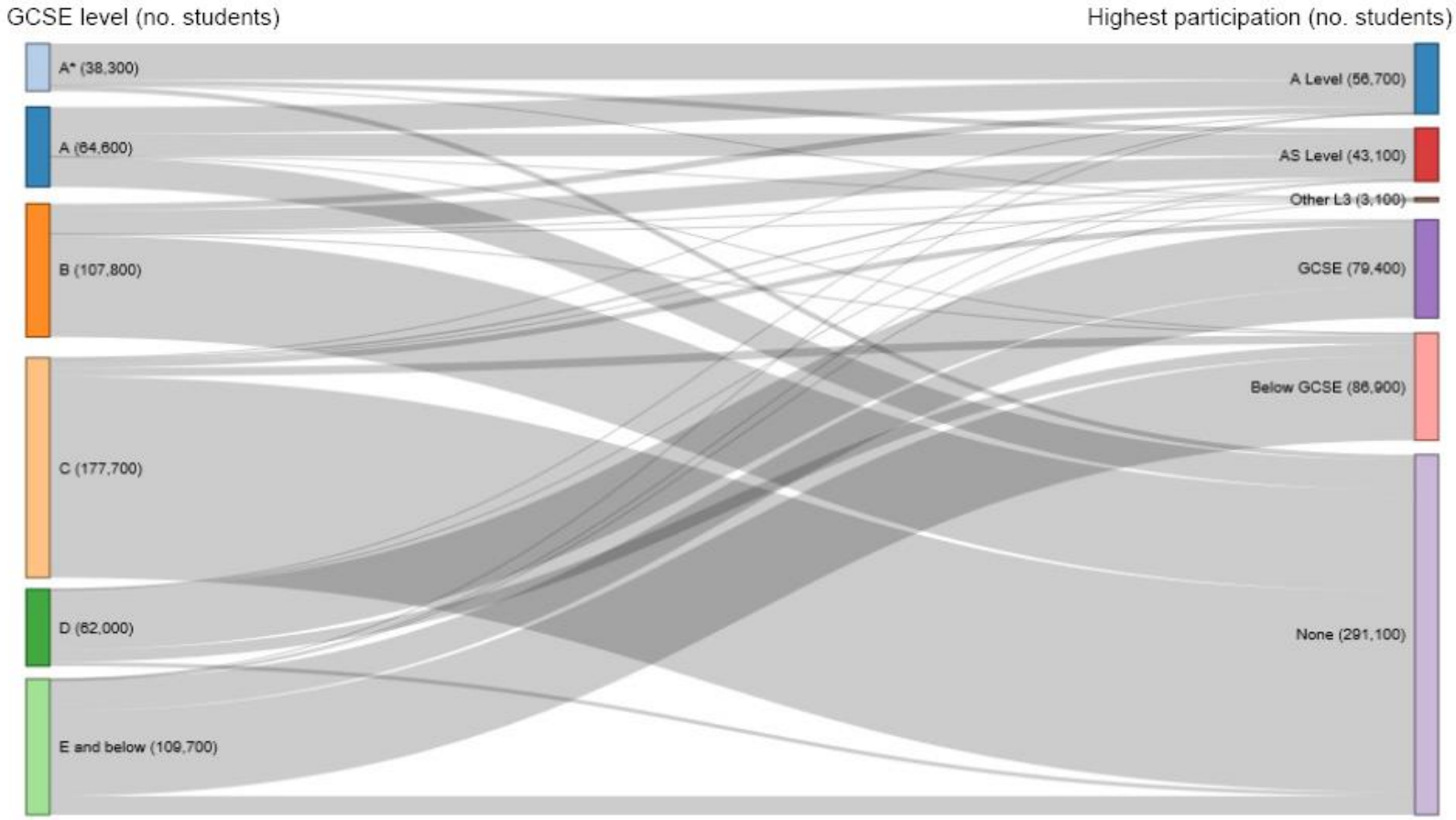

Figure 1. The highest level of participation in mathematics at academic age 16 or 17 for the 2013/14 GCSE cohort. GCSE mathematics grades are shown on the left; highest level of participation on the right for the same cohort.[132]

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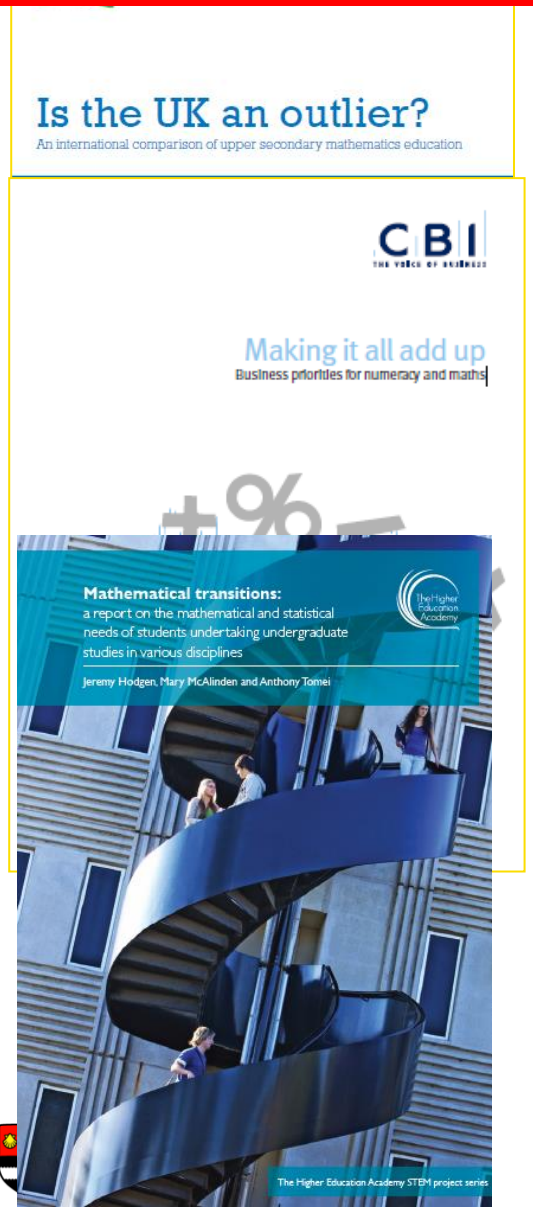
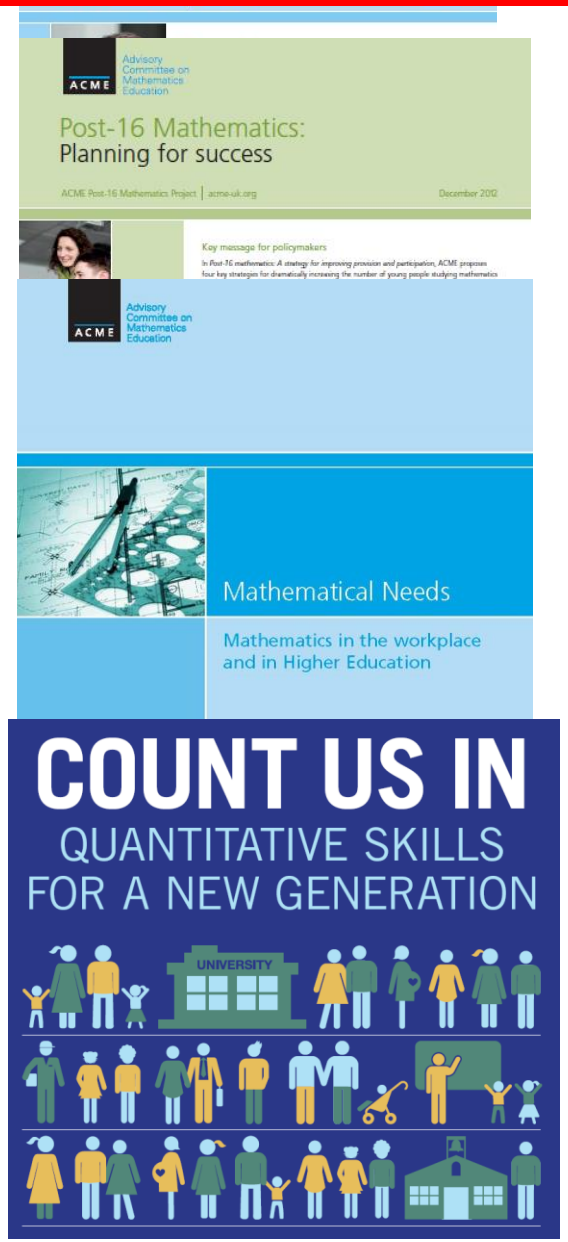
Post 16 review background



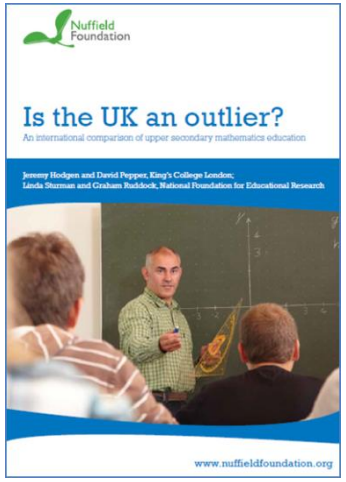


Nuffield report – 'Is the UK an outlier?', 2010

Develop alternative models for post-16 mathematics:

- The creation of an intermediate option or options between basic and advanced mathematics, aimed at those students who have already achieved an A*-C grade at GCSE.

- This would reflect the different career pathways of students and provide them with an appropriate option in mathematics at post-16 level.



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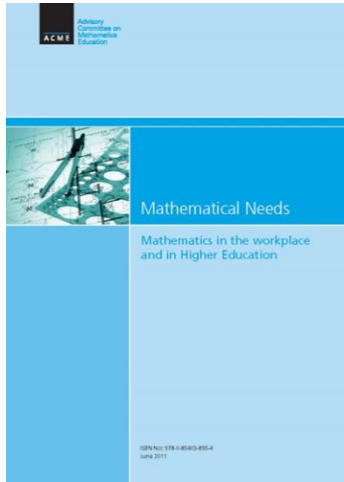
ACME report – 'Mathematical Needs: Mathematics in the workplace and in higher education', 2011

The report's key findings included the following:

- The quantitative demands of almost all university courses are increasing; even subjects like history, which traditionally had involved no mathematics, now recognise the importance of statistics.
- We estimate that of those entering higher education in any year, some 330,000 would benefit from recent experience of studying some mathematics (including statistics) at a level beyond GCSE, but fewer than 125,000 have done so.
- Data on higher education acceptances suggest that some 180,000 of those accepted will encounter a significant amount of mathematics on their courses.



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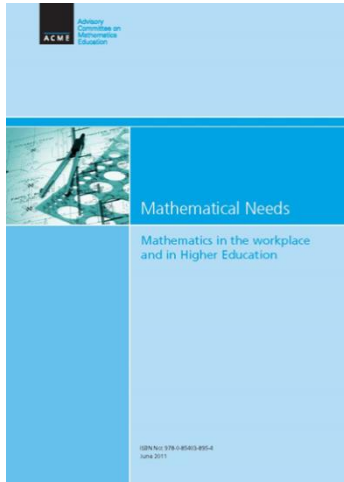
- The value of being able to communicate mathematics should be given more prominence as this is an essential skill in employment and in higher education.
- There should be an emphasis on building students’ confidence and their ability to use mathematics in a range of familiar and unfamiliar contexts.



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HEA report - ‘Mathematical Transitions’, 2014

- All the disciplines in the Higher Education Academy STEM project require Mathematics and/or Statistics to some extent.
- 85,000 students are admitted into university each year to study the seven disciplines in the project (Business and Management, Chemistry, Computing, Economics, Geography, Sociology, Psychology).
- Other disciplines will have similar mathematical and statistical needs, including biological sciences, medicine and dentistry, architecture, building and planning, and various technology degrees.
- The number of students affected is of the order of 200,000 pa.

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HEA report - ‘Mathematical Transitions’, 2014

- The number of students entering the disciplines with an A or AS-level in Mathematics has increased in recent years but has probably reached a limit.
- Many students arrive at university with unrealistic expectations of the mathematical and statistical demands of their subjects.
- Lack of confidence and anxiety about Mathematics/Statistics are problems for many students.

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Core Maths Qualifications: Technical Guidance, DfE, 2014

AS and A level mathematics:

extend students' experience of mathematical techniques significantly, developing advanced analysis of mathematical problems and construction of related arguments and methods of proof

Core Maths Qualifications: Technical Guidance, DfE, 2014

Core Maths qualifications:

- consolidate and build on students' mathematical understanding and develop further mathematical understanding and skills in the application of maths to authentic problems;
- provide a sound basis for the mathematical demands that students will face at university and within employment across a broad range of academic, professional and technical fields;
- prepare students for the varied contexts they are likely to encounter in vocational and academic study and in future employment and life, for example, financial modelling and analysis of data trends;
- foster the ability to think mathematically and to apply mathematical techniques to variety of unfamiliar situations, questions and issues with confidence;
- are likely to be particularly valuable for students progressing to higher education courses with a distinct mathematical or statistical element such as psychology, geography, business and management

Core Maths Qualifications: Technical Guidance, DfE, 2014

Core Maths qualifications will:

1. Deepen competence in the selection and use of mathematical methods and techniques.

2. Develop confidence in representing and analysing authentic situations mathematically and in applying mathematics to address related questions and issues.

3. Build skills in mathematical thinking, reasoning and communication.

Core Maths Qualifications launch

- Strong maths skills are an essential part of our plan for education and are also vitally important to our economy.

- Core Maths teaches pupils how to use and apply maths in real situations, and will help address a 16 to 18 ‘maths gap’ whereby students who achieve a good maths grade at GCSE currently drop the subject and start to lose their confidence and skills.

- Thanks to these new high-quality courses more pupils will be able to continue their study of maths, ensuring more young people leave education properly prepared for the demands of university, work and life in modern Britain.

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Post 16 Review - background

Motivation:

- the increasing importance of mathematical and quantitative skills to the future workforce
- by comparison with competitor economies, the low percentage of students in England continuing mathematics post-16

Task:

- the case for and feasibility of all students continuing some form of mathematics until 18, with mathematics being interpreted in its broadest sense, including quantitative skills, statistics and data analysis

Other considerations:

- local variations in provision and attainment
- the fundamental importance of Further Education in the post-16 landscape, underlined by the Sainsbury review and Post 16 Skills Plan

Post 16 Report – highlights & future

Importance of:

- students continuing with level 3 mathematics: AS and A-levels in Mathematics and Further Mathematics, and Core Maths
- signalling the benefits of all level 3 maths to HE
- funding for professional development for teachers of mathematics
- funding for post-16 providers to enable them to offer AS/A-level Further Mathematics and Core Maths
- technical education and training
- supporting areas of low participation and achievement in level 3 mathematics

The Future

Future:

‘we do not yet have the appropriate range of pathways available or the capacity to deliver the required volume and range of teaching for all to continue studying mathematics until 18’

but

‘would hope that if we were able to move forward over the next few years with many of the recommendations in this report, we might realistically aspire to such a vision within a decade’ (2017)

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Post 16 Report – recommendations

R1: The DfE should seek to ensure that schools and colleges are able to offer all students on academic routes and potentially students on other level 3 programmes access to a Core Maths qualification.

R13: The DfE should commission and fund interventions in local areas with low level 3 mathematics participation, co-ordinating local work to provide the best training and support for schools and colleges to build capacity at GCSE and level 3. This should include developing partnerships between schools and local and national sources of support.

R14: The DfE should seek to improve the evidence base on the role and effectiveness of technology in the teaching of 16–18 mathematics.

R17: The DfE should, in any future work to improve careers provision and related advice, prioritise and make clear the importance of mathematics to a wide range of future careers.

Post 16 Report – recommendations

R3: The Institute for Apprenticeships should work with the Royal Society Advisory Committee on Mathematics Education (ACME) to ensure appropriate expert advice is available to the panels of professionals developing technical routes.

R5: In view of the low GCSE success rates and new GCSE requirements, the DfE should review its 16–18 resit policy with the aim that a greater proportion of students without a grade C or equivalent attain appropriate mathematical understanding by age 18. Specifically, there should be fresh consideration of appropriate curricula and qualifications for these students and the extent to which current policy incentivises these to be offered.

R7: The DfE should improve the evidence base on the FE workforce teaching mathematics and quantitative skills in order to assess supply, teaching quality and the effectiveness of current recruitment measures.

R8: The DfE should expand its support to develop excellence in GCSE mathematics teaching across the FE sector. This should be informed by evidence of effective pedagogy for students who have not succeeded in the subject within secondary education and emerging evidence about the needs of the workforce.

Post 16 Report – recommendations

R12: The DfE, in supporting the Prime Minister's desire for higher education to engage more with schools, should seek ways to encourage universities to consider specialism in 16–18 mathematics if establishing new schools, sponsoring existing schools or providing other support to schools, particularly in local areas where level 3 mathematics participation and achievement is poor.

R15: The DfE, in conjunction with partners such as the Institute for Apprenticeships, should fund online professional development resources and materials aimed at increasing the numbers of teachers of mathematics and quantitative skills within new technical education routes and Core Maths.

R16: The DfE should commission a study, from pre-school onwards, into the cultural and other root causes of negative attitudes to mathematics, including gender and other sub-group effects.

DfE advice for 16-19 study programmes (March 2018)

Level 3 mathematics qualifications:

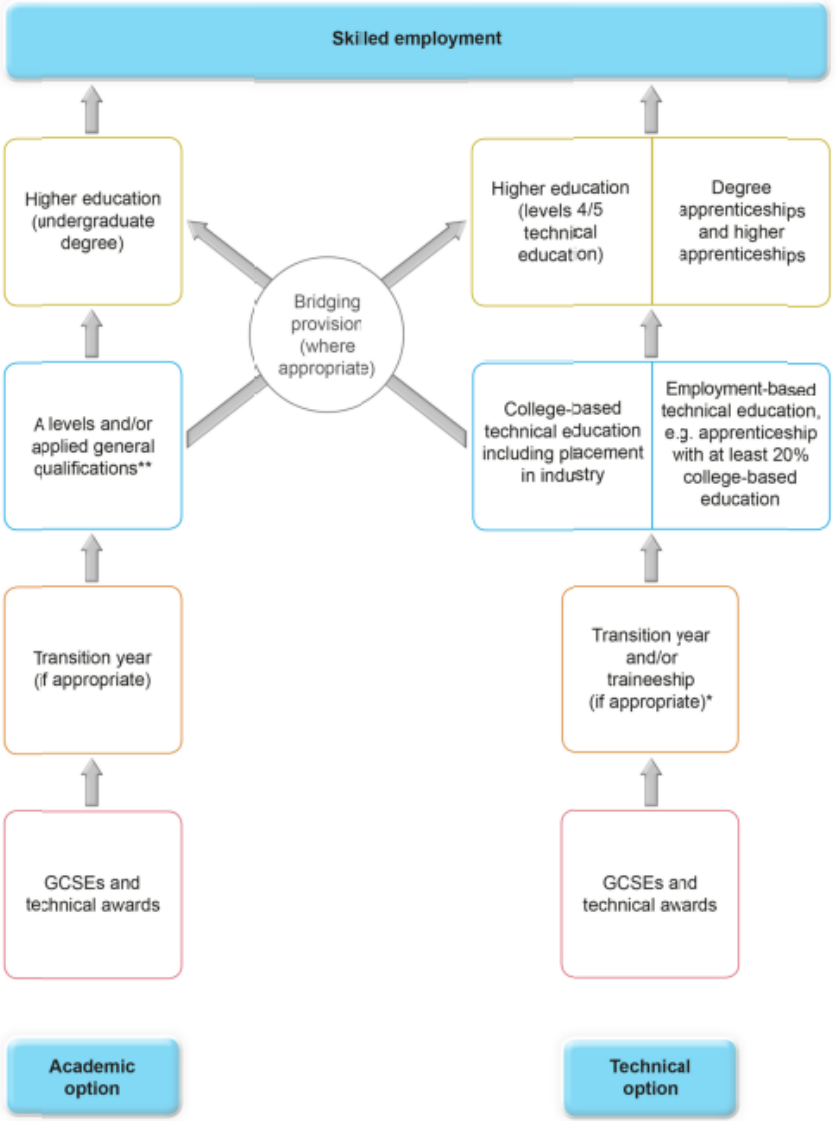
- Despite recent progress, participation in mathematics post-16 remains low in comparison to many other countries.
- There is a strong case that mathematical and quantitative skills are important for students' future study and career.
- Higher levels of achievement in mathematics are associated with higher earnings for individuals and many employers are looking for applicants with advanced mathematical and quantitative skills.
- To improve the life chances of students we would therefore like to see providers offering a range of level 3 mathematics qualifications and more students participating post-16.
- The advanced maths premium will to help education providers to increase the number of students studying high quality maths qualifications to level 3.

DfE advice for 16-19 study programmes (March 2018)

Level 3 mathematics qualifications:

- As well as new reformed AS and A levels in mathematics, statistics and further mathematics; awarding organisations have introduced new Core Maths qualifications at level 3 for students not taking A and AS levels in mathematics.
- The focus of core maths qualifications is on problem solving, reasoning and the practical application of mathematics and statistics. These new qualifications have been designed with the support and help of employers and universities to suit students with a range of pass grades at GCSE maths and provide them with the quantitative skills now needed in a wide range of jobs. We would encourage all providers to offer these new qualifications for their students.

Sainsbury review/Post 16 Skills Plan/T-levels



* Where a student does both, the traineeship will follow the transition year. Students doing both the transition year and a traineeship may progress directly to employment.

** Some students will move directly from A levels and/or applied general qualifications to degree and higher apprenticeships.

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T-levels – mathematical/quantitative skills

Sir Adrian Smith says in his recent review of Post 16 Mathematics:

- ‘Defining the appropriate mathematics for each of the technical routes is likely to be complex.

- The mathematics should be designed to reflect the requirements of the relevant occupations, wider society and the emerging economy.

- The increasing sophistication of technology is driving change to the economy and the nature of work. This is not only increasing the demand for mathematics and quantitative skills but is also changing the nature of required skillsets, in particular those relating to the analysis and use of “big data”.’

DfE response to T-level consultation

Establish a technical education system that rivals the best in the world, to stand alongside our world-class higher education system. **(*Industrial Strategy*)**

Implementation of T-level programmes

- "We are particularly supportive of high attaining students who want to take Core Maths or an A level in Mathematics alongside their T Level."

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Advanced Maths Premium

- Smith confirmed strong case for raising participation in advanced post-16 mathematics.
- Good mathematical and quantitative skills are increasingly required in more and more occupations, as the pace of technological innovation increases.
- Necessary in many higher education courses, extending beyond the mathematical and physical sciences to the social sciences, the humanities and the creative arts.
- Increased participation in level 3 mathematics would be likely to deliver longer-term economic benefits, including increased productivity and improved international competitiveness.
- Schools, colleges and other providers have already done much to increase mathematics take-up through building capacity to teach the subject and promoting the value of mathematics to students.
- Whilst take-up has grown, more needs to be done, especially for girls, disadvantaged pupils and those in areas of low participation, helping to boost social mobility.

Advanced Maths Premium

- Introduction of an Advanced Maths Premium over the next 3 years
- £600 per year per additional student for one or two years, depending on the type and size of qualification studied.
- Demonstrates commitment of Government and the importance they place on supporting greater participation in mathematics post-16.
- The premium will provide additional funding of £600 per year for each additional student taking a level 3 mathematics qualification in comparison to a baseline.
- AS Mathematics, Further Mathematics, Statistics, Core Maths – 1 year
- AL Mathematics, Further Mathematics, Statistics – 2 years
- If an additional student is studying both a Mathematics and Further Mathematics qualification in the same academic year, that student will be funded twice in the same year, to encourage the take up of Further Mathematics.

Advanced Maths Premium

- The premium will first be paid for the academic year 2019 to 2020.
- Number of additional students will be measured between the average of academic years 2015 to 2016 and 2016 to 2017 and academic year 2018 to 2019.
- Net increase - any decreases will be offset against any increases.
- Need for careful monitoring to ensure that the quality of mathematics provision is as high as students deserve.
- Monitor behaviour at provider level to indicate adverse behaviour and may follow up where data gives cause for concern.

Advanced Maths Support Programme (AMSP)

- NCETM & Maths Hubs will work in close partnership with the AMSP to ensure that schools and colleges receive effective support for increasing participation and improving teaching of Core Maths and AS/A-level Maths and Further Maths.

- Maths Hubs will support and complement the work of the AMSP.

- Maths Hubs' level 3 maths workgroup activities:

    - supporting Core Maths;

    - embedding technology in the teaching of A level maths ; and

    - developing pedagogy in A level maths.

Careers Strategy

Positive engagement with Science, Technology, Engineering and Maths (STEM)

Mathematical and quantitative skills will be increasingly required in the future, not just for traditional STEM routes but for a wide range of future careers. **(*Smith*)**

Basic numeracy skills are vital to everyday life and citizenship, highlighting the need for Government, employers, schools, and colleges to support and encourage more young people to study mathematics after the age of 16. **(*Smith*)**

Differences in progression to STEM qualifications between local areas and a significant gender gap.

Careers services must play a key role in encouraging people of all ages and backgrounds to consider the value of STEM qualifications and careers, dispelling stereotypes and making sure people have up-to-date information about the skills employers will need.

Careers Strategy

Children form views about careers at an early age.

Perception amongst many young people that STEM subjects are too challenging or not suitable for them.

Girls are less likely than boys to want to pursue a career in science, even when it is their favourite school subject.

Even where girls do pursue STEM subjects, they are much more likely to take some courses than others.

Across Government there are significant programmes aimed at encouraging more people into STEM careers.

Government committed to deepen the understanding of the gender disparity in subject choices at age 16.

Careers Strategy

Work with Government Equalities Office to take positive steps towards eradicating gender norms in the classroom that lead to girls narrowing their career choices.

Exploring how to close the gender divide in STEM across educational and professional routes, such as STEM apprenticeships and the new T levels.

The Advanced Maths Support Programme will work to inspire more students, particularly girls, to study maths after the age of 16.

The Department for Business, Energy & Industrial Strategy funds the STEM Ambassador programme, a UK-wide network of over 30,000 volunteers from a wide range of employers, who work with young people to provide stimulating and inspirational activities in both school and non-school settings.

Government will work with hundreds of industry partners to bring young people, their parents, and their teachers face-to-face with engineering activities, events, and role models.

Careers Strategy

The National Careers Service website will provide clear information on how young people and adults can enter or progress in STEM careers, including salary ranges and any specific skills or qualifications required. The Year of Engineering launches in January 2018.

Ask schools and colleges to make sure that STEM encounters, such as with employers and apprenticeships, are built into their careers programme by updating school and college statutory guidance.

Government will assess the breadth and effectiveness of current careers provision in schools and colleges on STEM, including activities to inspire students to pursue STEM careers, and will produce information about 'what works' and develop a toolkit for use in schools and colleges, trialling new approaches where needed.

A partnership between EEF, CEC, and Bank of America Merrill Lynch is currently testing the impact of "Generation STEM" – a programme focused on helping students get STEM-related work experience, as well as to get the most out of it. Government will make sure this is built into advice to schools and colleges about how best to engage students in STEM careers through work experience.

Centres for Excellence

- Industrial Strategy in response to Smith commits to improving basic maths for people over the age of 16.

- To achieve this Post-16 CfE will be established to build teaching capacity and spread best practice on what works to improve basic maths.

- The purpose of the CfE programme is to enhance maths teaching (up to GCSE or equivalent) so that students over the age of 16 with low prior attainment can improve their skills and secure valuable qualifications.

- This will be achieved by developing and testing pedagogical approaches that focus on teaching maths to students with low prior attainment and sharing this mathematical expertise across the post-16 sector over the next five years.

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Centres for Excellence

- The ambition of the programme is to increase the number of young people leaving compulsory education with the necessary maths skills for work, learning and life and to see a marked increase in the numbers of students passing their maths GCSE resit and equivalent level 2 maths qualifications.

- Each Centre for Excellence will be led by an exceptional Post-16 institution with the commitment, capacity and system leadership skills required to drive innovation and improvement in both their institution and beyond.

- The Centres and their networks will be supported by a central delivery partner with mathematical and programme management expertise to develop improved teaching methods for this cohort.

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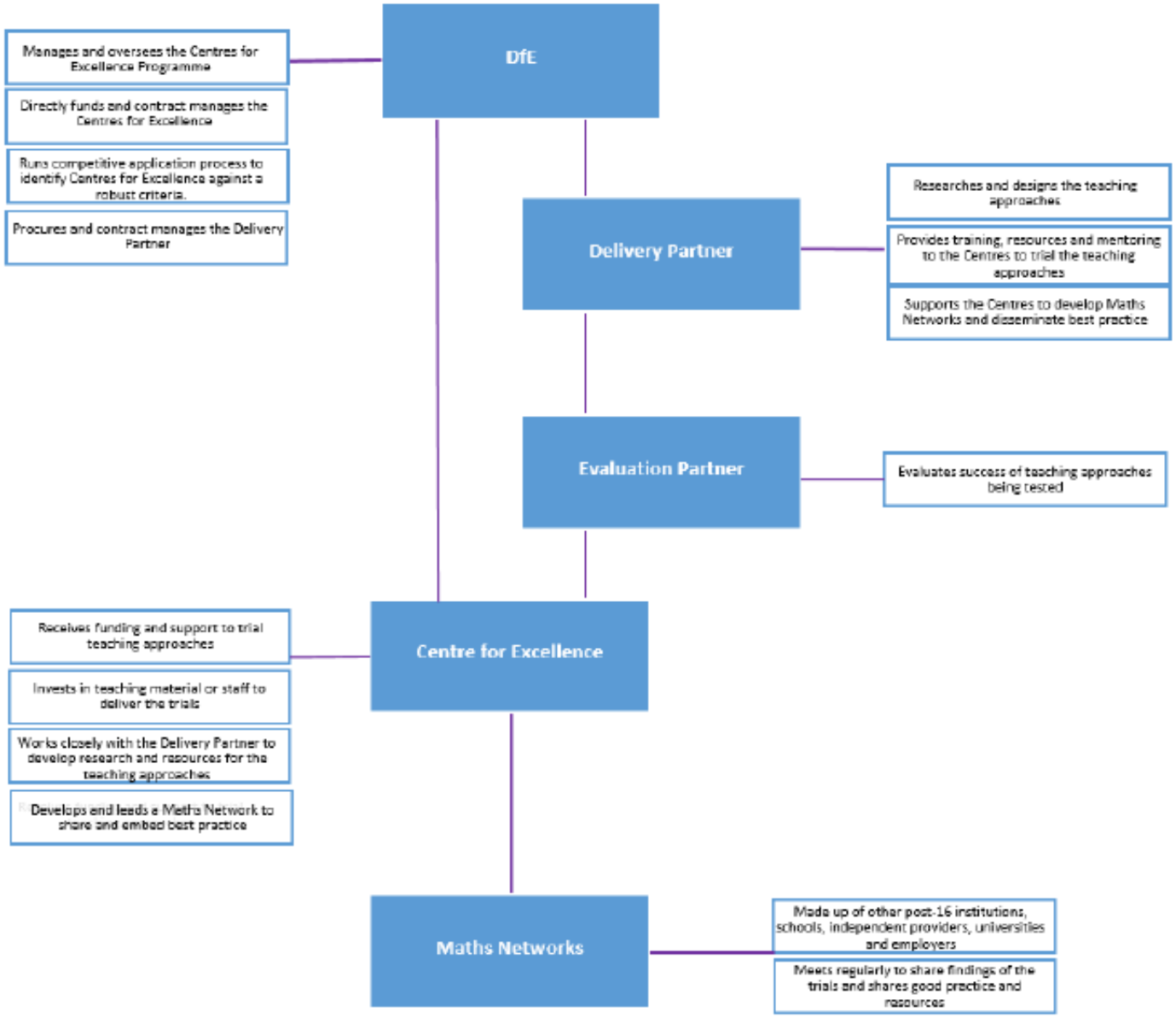
Centres for Excellence



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Centres for Excellence

- **An adapted mastery approach for lower attaining students post-16** – Mastery is an approach used in Maths Hubs to ensure pupils achieve a comprehensive understanding of mathematical concepts and learn how to apply the maths to a variety of contexts using a Shanghai/Singapore approach to teaching maths.

- **Motivating and engaging learners** - Evidence suggests that some students find re-sitting maths and English qualifications to be a demotivating experience. It is a significant challenge to engage students with low prior attainment to attend classes and to motivate students with catch-up provision. This approach will research, develop and trial engaging approaches to teaching maths to demotivated learners and practical methods to supporting students to overcome any barriers to their engagement.

Centres for Excellence

- **Contextualisation of content towards vocational learning** - We know that students can improve their engagement and attainment when maths aligns to their vocational aspirations. In anticipation of the 15 technical routes for T-Levels, we will trial embedding route-specific numeracy content into students' study programmes. The Delivery Partner will also consider how this approach applies to 'Transition Year' students.

- **Use of technology** - This theme will research, develop and trial the use of technology, exploring whether there are more efficient or intelligent ways to manage and support teaching and learning to improve attainment. This theme will explore the use of prior attainment data, diagnostics tools and online/virtual learning.

Basic maths premium

Post-16 basic skills

- Supporting the post-16 sector in a basic maths Centres for Excellence (CfE) programme, building teaching capacity and spreading good practice.
- Research, develop and disseminate high quality teaching approaches for post-16 basic maths.
- Basic maths premium pilot targeted at post-16 providers based in some of the most disadvantaged areas of the country, and will run from autumn 2018 for two years.
- Provide an up to £500 premium for each eligible student to support basic maths study, testing the impact of a payment by results approach.

Strategic College Improvement Fund (SCIF)

- The SCIF is part of a broader strategy to ensure that England's further education (FE) colleges help learners develop the knowledge and skills that drive individual success, social mobility and economic prosperity.

- It's intended that the SCIF will support colleges to deliver better outcomes for learners, employers and local communities.

- It will enable colleges to access resources that they need to improve their provision for students, including the best practice of other colleges, while at the same time mobilising and strengthening improvement in the FE sector.

Other activities/Activities of others

- Signalling

  RS/BA - Employers/Business/Industry & HE

  Prof Assoc/(Royal) Academies/Learned Societies e.g. Acad Soc Sci

  Nuffield

  ACME/Contact Groups (CG)

- Careers Strategy/girls' participation/culture

- Monitoring (& Developing) Qualifications (ALL!)

  DfE/Ofqual/ACME/CGs: A level; Post 16 Pathways

ACME

Current priority areas include:

- **Data skills** - Providing insights on the role of school and colleges in meeting the data science skills needs now and in the future.

- **Signalling** - Working with academia and industry to allow young people to see where science and maths can take them.

- **Technical education** - Providing advice on the mathematical and computational skills components of new technical education pathways in England.

Additionally, Contact Groups on:

EYs/Primary 11-16 A level Post 16 pathways

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Parliamentary Links Day

An annual event organised to strengthen the dialogue between the scientific community, MPs and Peers - this year's theme is Science and the IS.

John Bercow MP – Speaker, HoC
Chi Onwurah MP - Shadow Minister for IS
Patrick Vallance - Government Chief Scientific Advisor
Jonathan Flint - President Elect, IoP
John McGagh, Immediate Past President, ICE
Carol Monaghan MP, Stephen Metcalfe - HoC Science & Technology Select Committee
Carol Robinson - President Elect, RSC
Hetan Shah - Executive Director, RSS
Norman Lamb MP - Chair, HoC Science & Technology Select Committee
Rebecca Endean - Director of Strategy, UKRI
Peter Bruce - RS
Louise Leong - RSB
Sarah Main - Director, CASE
Greg Clark MP – SoS, BEIS

+ 20 Learned and Professional Societies in STEM

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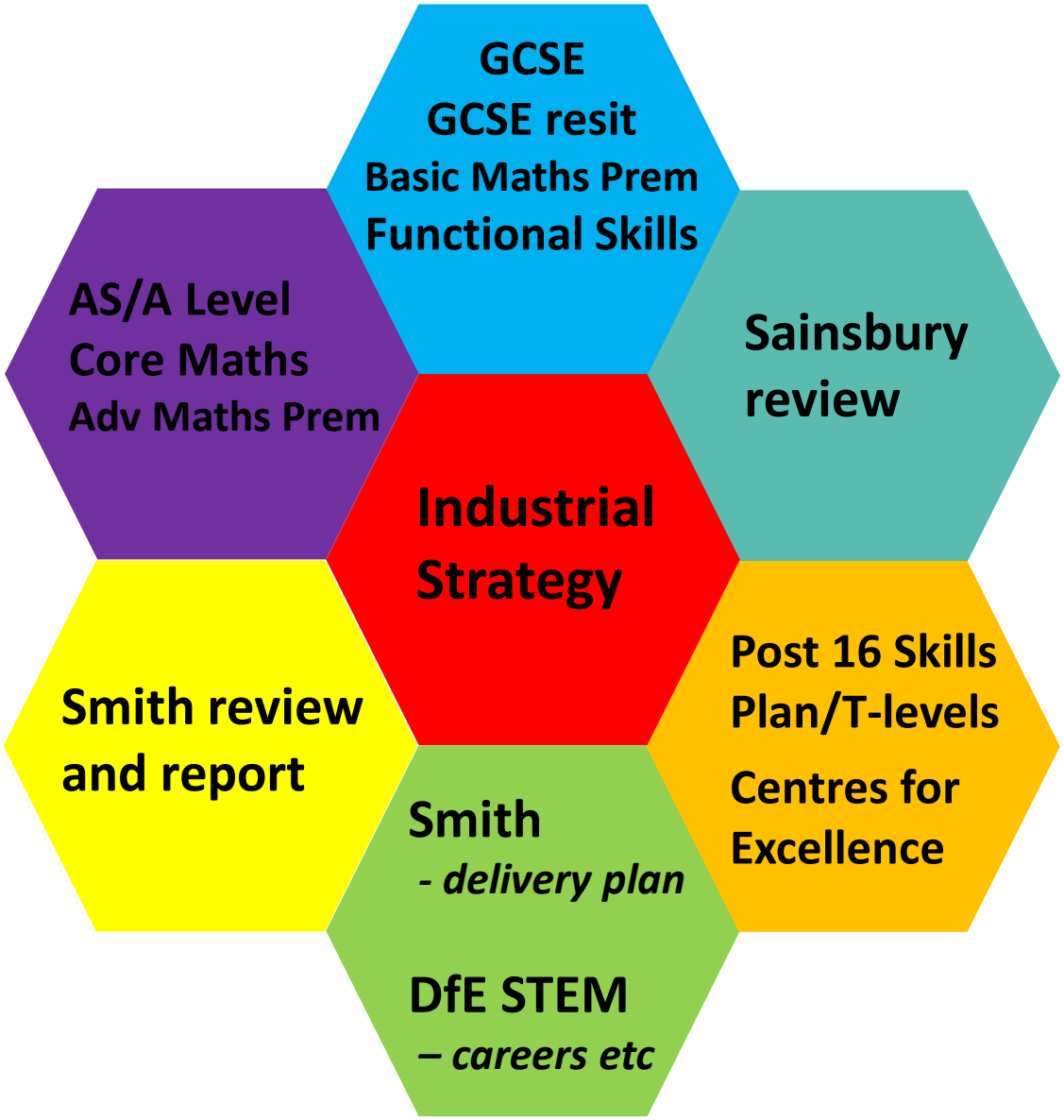
Baden-Powell

Sir Adrian Smith says in his recent review of Post 16 Mathematics:

- The increasing sophistication of technology is driving change to the economy and the nature of work. This is not only increasing the demand for mathematics and quantitative skills but is also changing the nature of required skillsets, in particular those relating to the analysis and use of "big data".'

R18: The DfE and the Department for Business, Energy & Industrial Strategy should commission a study into the long-term implications of the rise of data science as an academic and professional field, looking at skills required for the future and the specific implications for education and training in mathematics and quantitative skills.

Overall picture



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Thank you

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