

Education and skills for the data economy



Data: the driver of prosperity

Our wellbeing depends on economic prosperity, which in turn depends upon exploiting our investment in data, and on our skills as a society to understand and use data.

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To prepare for the data economy we need to skill up the nation.

1. Summary

Our *Data Manifesto* has called on the UK government to recognise the value of data and the importance that we, as a country, have the capability to use it. Numbers are everywhere, and the growth of data collected by technology plays a huge part in our economy and in our personal lives. The UK presently faces a major gap in skills for the data economy; we need investment in education and training to support industry growth, to widen participation in data-driven industries, and to develop good practice across all data-literate professions. Preparation to make use of data needs to start early in school, and to continue in colleges and universities and into the world of work. Everyone needs to be able to handle and interpret data to benefit their studies, to engage in democracy, and to make decisions at work and at home.

Achieving data literacy for the majority will mark a big break from the past, as a large proportion of UK adults find the use and analysis of numbers difficult¹. An OECD survey for the Programme for International Assessment of Adult Competencies (PIAAC), which was the first round of OECD assessments of this kind, has sought to assess adult competencies in literacy, numeracy, and 'problem solving in a technology-rich environment'. The study found 'particularly large proportions of adults that have poor numeracy skills' in England and in Northern Ireland². In the study's assessment of numeracy, young adults aged 16 to 24 in England did not perform better, on average, than older adults aged 55 to 65. In numeracy and in problem solving the England and Northern Ireland cohort was among the lowest scoring across the OECD countries.

Statistics is a technical and creative discipline: it is applied in a wide range of subjects, and in new disciplines that bridge mathematical and computer science, such as machine learning and data science. Rather than just providing abstract numbers, statistics as taught in school should relate to real situations that pupils should have an interest in. This can help to resolve number-phobia by making numbers part of everyday problem solving. As our report *A world full of data* has shown³, the scope to use data to support learning across a wide range of subjects could be much more fully realised. We need sufficient subject specialists, resources and technology for all young people to develop data skills, and to grow the scope for statistical enquiry across subject boundaries.

Requirements for new skills in industry are closely allied to the growth of digital technology, data, and data science. As an independent review for the government has concluded, '[digital skills have] to go beyond making sure adults are able to use digital technologies, to ensuring that they understand the concepts behind how they work and the impact of technology in society'⁴. We need to grow the number of college leavers, graduates and post-graduates who can apply mathematical, digital and data skills. We need to track participation in foundational courses such as pre-16 mathematics, statistics, Functional Skills and Core Maths, and champion progress to higher levels of training across disciplines. For our future use and understanding of data, it will be essential that more new entrants to the job market understand how to work with large complex data sets and analyse them using technology.



We believe that efforts to address the data skills gap should be inclusive, they should not only be aimed at future scientists, statisticians and data professionals. We set out several pathways below that are important to build data literacy for all. We then turn to the need to train teachers to encourage data literacy in young people.

2. Pathways for data skills

Big benefits will accrue from developing higher level analytical skills, with a strong foundation in 'core' mathematics.

Education in school forms the foundation for further education and training. We regard numerical and mathematical confidence for all students as one of the key foundations for improving data skills. However, the study of mathematics pre-16 does not guarantee the long-term mathematical fluency that employers and universities are looking for, as they seek people who can apply their skills outside of formal education and exam-based assessment^{5,6}. Employers have unmet demand for people with strong literacy and numeracy skills that can be applied in a variety of problem solving contexts^{7,8}, and there is a substantial skills gap in data-driven industries⁹. There is also a regional dimension whereby some places and schools may find it easier than others to address the challenge: participation in mathematics varies somewhat by local area¹⁰, and the rate at which young people decide to continue into higher and further education varies considerably across different regions of the country¹¹. Big benefits will accrue from developing higher level analytical skills across all regions of the UK, in collaboration with industry.

We believe that work in the data economy is strengthened by successful training in the mathematical sciences, data science and experimental science, and by awareness of technology and its applications. The future of statistics and data analytics is also linked closely to developments in social sciences, computer science and engineering. Data scientists can also draw on training in communication and the arts, to engage in critical thinking, and to communicate findings.

To address all of these elements we advocate **statistical enquiry** as a way of understanding the world that is transferable across a range of subjects and situations. In the statistical enquiry cycle, students learn to state a problem and to plan their own statistical or analytical approach. They then collect their data, or source existing appropriate datasets. They process, analyse and present their data, and then they interpret and communicate their findings to address the stated problem.

A range of education pathways are also needed to address students' numeracy and their understanding of how to use data for deeper subject learning, including statistical enquiry. Our work, which has focused on the curriculum in England, highlights several key pathways for improvement. It is especially important to address inclusion in these pathways as compulsory education is extended to the age of 18:



- Extend Functional Skills to provide an alternative to GCSE re-sits

During the last parliament, compulsory re-sits of GCSE Mathematics were introduced for students in England who did not attain a grade C. Results of re-sits have shown that although some students have improved the grade they receive in Mathematics, many continued to fall short of grade C or equivalent. This suggests that for most students an alternative approach is needed for them to reach Level 2 (Grade C equivalent) or higher. For this group we would like to see the Department for Education prioritise Functional Skills courses and support colleges to deliver them.

- Grow participation in Core Maths

Core Maths has been designed for students who have an adequate or good grade in GCSE Mathematics, but who are not planning to take Mathematics at A Level. This pathway is intended to develop students' mathematical and statistical skills so that they can apply them in future no matter what they go on to specialise in. Studying Core Maths is different from studying for an A Level in mathematics: the size of the qualification is smaller than an A Level, and the content focuses on problem-solving rather than theory. We believe that this makes it appealing and compatible for students with good but not outstanding grades at GCSE; however it will be important to continue to support uptake of the qualification in schools and colleges if any greater difference is to be made. We think refining the quality of Core Maths provision and widening the uptake of the qualification needs explicit support, particularly from higher education providers, training providers and industry who should all signal their demand for Core Maths.

- Develop AS and A level Statistics for a stronger foundation in data analytics

With its recently reformed subject content, AS and A Level Statistics is focused on applications of statistics. This key pathway should be used to address the skills gap in the many areas where statistics is applied, so that appropriate conclusions can be reached with greater confidence. AS and A Level Statistics is not repetitive of the statistics in Mathematics but is well suited to students aiming for higher level study in subjects such as psychology, biology, finance, and social sciences, which have a focus on quantitative research, quantitative analysis and reasoning with data. We would welcome renewed commitment from awarding bodies to retain and grow participation in this qualification¹².

- Maximise participation in AS and A level Mathematics for more highly numerate degrees

Participation in advanced mathematics sends a welcome signal to higher education and to employers that a candidate has mathematical skills. Recognition of how much this is valued has led to growing numbers of students choosing maths at A Level, to the point that in 2016, Mathematics had the highest participation of any A Level subject¹³. The recent uptick in participation should not be taken for granted; mathematics subject specialists, their teaching, and students' learning need to be supported to continue this trend. England's new linear structure of assessment from September 2017 will pose a challenge as students will have to complete the full A Level course if their AS Level studies are to count; this may discourage some students. Participation also appears to be linked to prior success at GCSE, so the effects of GCSE grading changes on participation need to be closely watched¹⁴.

- Embed learning about statistics across a wide range of subjects

Alongside pathways for statistical skills development in Mathematics and Statistics, we strongly advocate applied use and assessment of statistics across the curriculum; in sciences, geography, social science and



vocational subjects. In work with the Advisory Committee on Mathematics Education to look at several reformed A Level subjects¹⁵, we found that quality assurance for the mathematical and statistical elements of qualifications needs to be attended to by the awarding bodies and by Ofqual, with the help of subject bodies and subject experts.

3. Train teachers from primary school through to university lecturers to encourage data literacy in young people

Include basic numeracy and statistical literacy in teacher training and in CPD for the whole profession.

Training and professional development (CPD) for teachers will be a key ingredient for success. We need to go a step beyond 'maths mastery' and other maths-focused programmes, and would like to see inclusion of basic numeracy and statistical literacy in teacher training and in CPD for the whole profession. Training and development for data skills and data literacy will also be highly applicable for teachers in their working lives, as the use and management of data is a major part of the work of teachers and schools^{16, 17}.

In Scotland, numeracy across learning has been emphasised as a key area of the Curriculum for Excellence to provide learners with essential analytic, problem-solving and decision-making skills¹⁸. In England, although new standards for initial teacher training have recognised the need for literacy across subjects ('high standards of literacy, articulacy and correct use of standard English, whatever the teacher's specialist subject'¹⁹), the same has not yet been said for numeracy, or for the suite of skills that will help a teacher to ensure that their students interpret and use numbers appropriately. We believe a raised profile for numeracy across all four nations will help to make positive changes, and standards of training and professional development should reflect the need for this. Given the observed and ongoing shortfall of teachers with prior mathematical training²⁰, it is clear that smart investment is needed to support resources as well as courses, and to retain and develop the existing workforce.

In general, and as recommended by the OECD, we believe the UK government and political system could better support teachers by instituting a long term, independent process of curriculum review that is independent of the political cycle²¹. Teachers, exam boards and schools would have more confidence about learning to teach mathematical elements of their curriculum, in the knowledge that sweeping changes are not just around the corner.

We would also like to see models develop of how practical data science can be supported in schools and colleges, in ways that are transferable and flexible to suit different subjects and different assessment regimes. The agenda for data skills could then be better applied when training teachers in the sciences, social sciences, the arts, and mathematics in the years to come.



Endnotes

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This document is one of a series of notes to support our policy positions as summarised in the Royal Statistical Society's *Data manifesto*, and was published in November 2016.

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