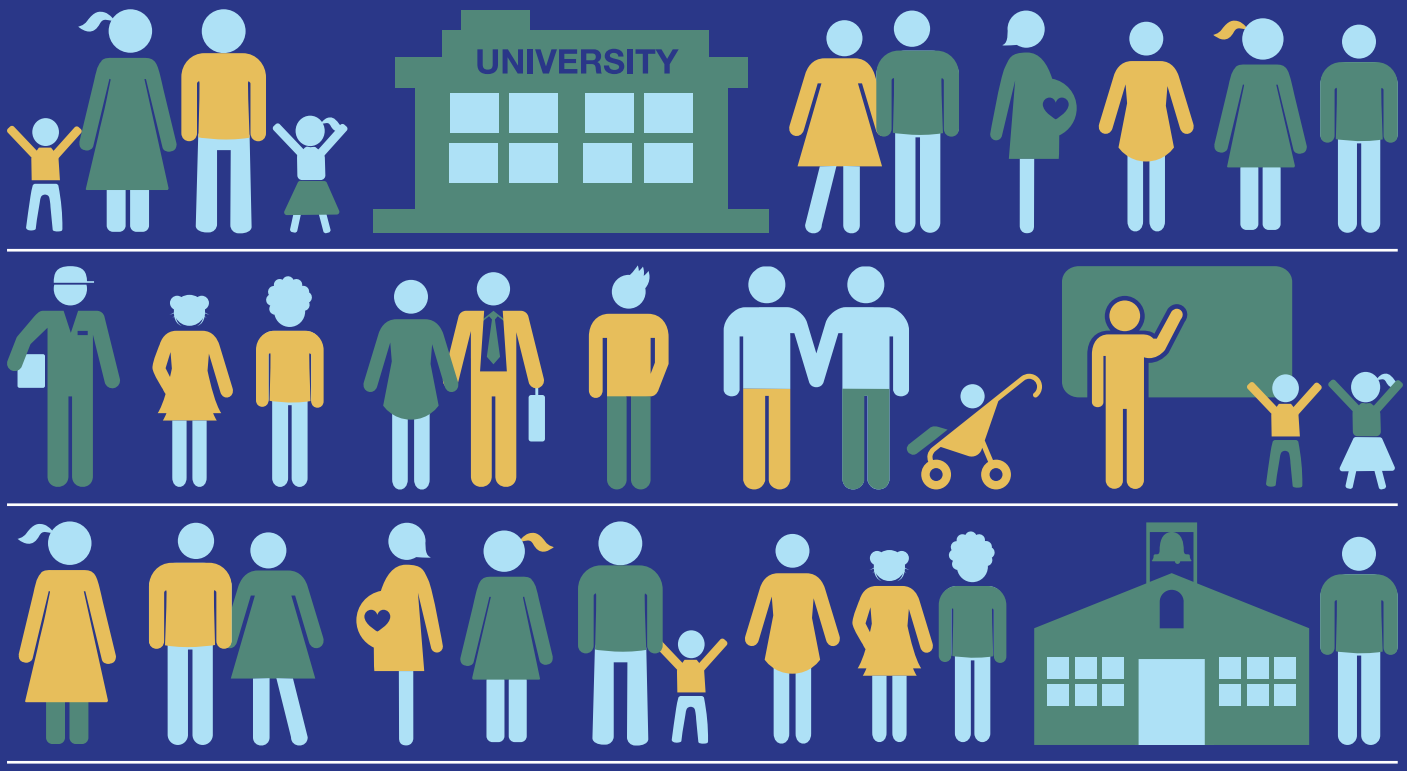
COUNT US IN

QUANTITATIVE SKILLS FOR A NEW GENERATION



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FOREWORD

Count Us In offers a vision of how the UK can rise to the potentially transformational challenge of becoming a data-literate nation.

For this ambition to be fully realised within a generation, we must not underestimate the cultural change that is required – starting now – primarily, but not entirely, with the UK's education systems.

The ubiquity of statistics makes it vital that citizens, scientists and policy makers are fluent with numbers. And there is a huge opportunity for those who are equipped and ready to take advantage of the data revolution that is already well underway.

There have been some important and encouraging developments to address the UK's weaknesses in quantitative skills. But the urgency of this challenge demands that much more should be done. What is needed now is a concerted, continuous national effort – with leadership from government.

Our vision requires action now. A structure must be put into place to enable quantitative skills to flourish at all levels, to meet the diverse needs across education and employment. And there must also be recognition of what needs to be done in the interim to address the existing skills needs of students, employees and citizens.

Grateful thanks are due to the members of the expert Steering Group and the Academy's High Level Strategy Group for their advice, to Warwick Mansell for producing the report, and to the researchers from the National Institute of Economic and Social Research who carried out the evidence review, *State of the Nation: A review of evidence on the supply and demand of quantitative skills*.

Our ability to handle data and reason using numbers will not be transformed overnight. But we need to put in place the structures that will begin to effect that change.

Whichever way we look at it – the sheer potential for our economy and society on the one hand, and the nascent risks of not acting on the other – this is an agenda that demands the interests of decision makers at the highest level.

Professor Sir Ian Diamond FBA FRSE FAcSS
Lead Fellow and Chair of High Level Strategy Group, British Academy Quantitative Skills Programme

Dame Jil Matheson DCB
Chair, British Academy Steering Group

SUMMARY

There is a need to transform the UK's quantitative skills: our ability to reason using numbers. Our evidence shows that a new, concerted national effort will be needed.

Our school pupils tend to be ranked only in the middle of developed nations in mathematics. Our undergraduates embark on degree courses with varying, and often weak, fluency in statistics. And, in the workplace, demand for more advanced quantitative skills has risen sharply in the past two decades.

There are many benefits to building quantitative skills in the UK population, including helping citizens to participate more fully in the democratic process; enhancing research in universities and in the workplace; and supporting the economy, taking advantage in particular of the advent of "big data".

A co-ordinated and continuous effort at improving quantitative skills across all phases of education and employment, in all four nations of the UK, is therefore now urgently needed.

OUR VISION

The Government should set out a strategy for realising this vision. It should include:

- Improving the quality of quantitative skills teaching in schools and colleges, with quantitative understanding built across the subjects of mathematics, science, social science and the humanities.
- Subjecting school curricula across the UK to continuous review.
- Continuing to address the fact that too many young people drop maths early.
- Building quantitative expertise in undergraduate students and in the research community.
- Encouraging employers to use the apprenticeship route and other training to improve the quantitative skills of their employees.
- Government, industry and academia working together to promote, oversee and monitor the improvement of quantitative skills across the workforce, universities and schools.

INTRODUCTION

The ability to understand and interpret data[1] is an essential feature of life in the 21st century: vital for the economy, for our society and for us as individuals.

There is a huge opportunity for those who can take advantage of the data revolution now happening across the globe. The ubiquity of statistics makes it vital that citizens, scientists and policy makers are fluent with numbers. And, at a more basic level, numeracy is essential for the modern citizen and employee.

Data analysis is revolutionising both how we see the world and how we interact with it. Examples range from the near real-time tracking of global deforestation and the human genome project's mapping of our genes to the monitoring of people's consumer preferences through their use of social media. Governments, including in the UK, are making unprecedented amounts of statistical information available to the public, in areas ranging from the performance of hospitals to the details of departmental spending. Globally, it was estimated in 2013 that 1.7 million billion bytes of data per minute are being generated.[2]

The focus of this report is on a significant factor in determining whether the UK will fully seize the opportunities of the data revolution: the quantitative skills needed to understand and interpret data.

The case to raise the UK's game on quantitative skills is urgent. The country is facing a crisis in levels of numeracy. The number of students dropping mathematics at 16 is higher than in our competitors[3] and our universities often struggle to equip students with the quantitative skills they need: for democratic participation; for producing, procuring and interpreting research; and in the workplace. Furthermore, research[4] commissioned for this report, *State of the Nation: A review of evidence on the supply and demand of quantitative skills*, by the National Institute for Economic and Social Research, demonstrates that there has been a rise in the number of jobs needing

What do we mean by quantitative skills?
The ability to reason using numbers. Understanding and interpreting numbers and data requires a diverse range of skills that can be applied within specific disciplinary, applied or research contexts. The skills themselves can range from basic arithmetic to handling advanced statistical analysis. Among other things, the possession of these skills allows for: confidence in the manipulation of numbers; an understanding of the possibilities and limits of measurement; and understanding the role of evidence in testing and modifying our understanding of social processes.

good quantitative skills. In this report, we set out a vision of how the UK can rise to the potentially transformational challenge of becoming a data-literate nation.

The economic prize

Raising the quality of quantitative skills throughout the population stands to reap rewards for individuals, companies and the economy as a whole.

There is clear evidence[5] that individuals are better off in terms of employment and earnings rates if they possess basic numeracy rather than being innumerate. Meanwhile, economic rewards may be in prospect for firms which can improve their use of data to give themselves a competitive advantage. Big data – the way we handle the explosion in volume and variety of information now available and the transformation in the speed at which it can be processed – is a part of that. Big data has been described[6] by the UK government as one of the "Eight Great Technologies" in which the country has the chance to be a world leader. Pinning down its likely precise value is difficult. However, a study has estimated[7] that between 2012 and 2017, 58,000 new jobs a year may be created in the UK in the big data marketplace. Across the economies of the European Union, the advent of "big and open data" has been predicted to contribute an extra £147 billion per annum to GDP by 2020.[8]

Benefits of a data-literate population

Beyond the economic argument, if the UK population is able to develop its skills in manipulating and interpreting numbers confidently, there will be benefits both nationally and also individually.

People's ability to make sense of the world is greatly facilitated by a mastery of numbers. Individuals with strong quantitative skills can command a premium in the employment market.[9] Consumers need the ability to compare, for example, alternative mortgage rates or retailers' discount offers.

Raising the quality of quantitative skills throughout the population stands to reap rewards for individuals, companies and the economy as a whole.

Individuals' facility with numbers can be safety-critical, such as in cases[10] of nurses calculating the dosage of medicine required by their patients. And we need to understand how data are generated and used. As citizens, our ability to understand and critically evaluate the statistical claims being put forward by participants in the democratic process is vital, including the quality of evidence put forward by governments and political parties.

The urgent need to improve the UK's position

Meanwhile, the UK's research and innovation base stands to be further empowered by the analysis of large datasets.

The UK is in many respects well-positioned to take advantage of the opportunities of the data revolution. The World Economic Forum's 2012 Global Competitiveness Rankings[11] place the UK seventh in the world for technological readiness. We have large and well-established public and private sector databases and our universities are among the world leaders for computer science, statistics, mathematics and social science.

Yet the UK faces a major challenge in relation to its population's quantitative skills. In 2011, a government survey found that three quarters of 16- to 65-year-olds in employment in England had a level of numeracy which might not be sufficient "to compare products and services for the best buy or to work out a household budget".[12] The maths skills of this country's graduates were reported as among the worst in the developed world by the Organisation for Economic Co-operation and Development in May 2015.[13] In recent years, our school pupils have generally ranked only in the middle of developed nations in mathematics. And, as confirmed in the *State of the Nation* evidence review,[14] employers frequently identify deficits in the facility of people with numbers.[15] This has implications for the future of the UK's status as a world leader in research and higher education, for the employability of our graduates, and for the competitiveness of the UK's economy.[16]

Existing stocks of quantitative skills, and new entrants to the labour market and HE

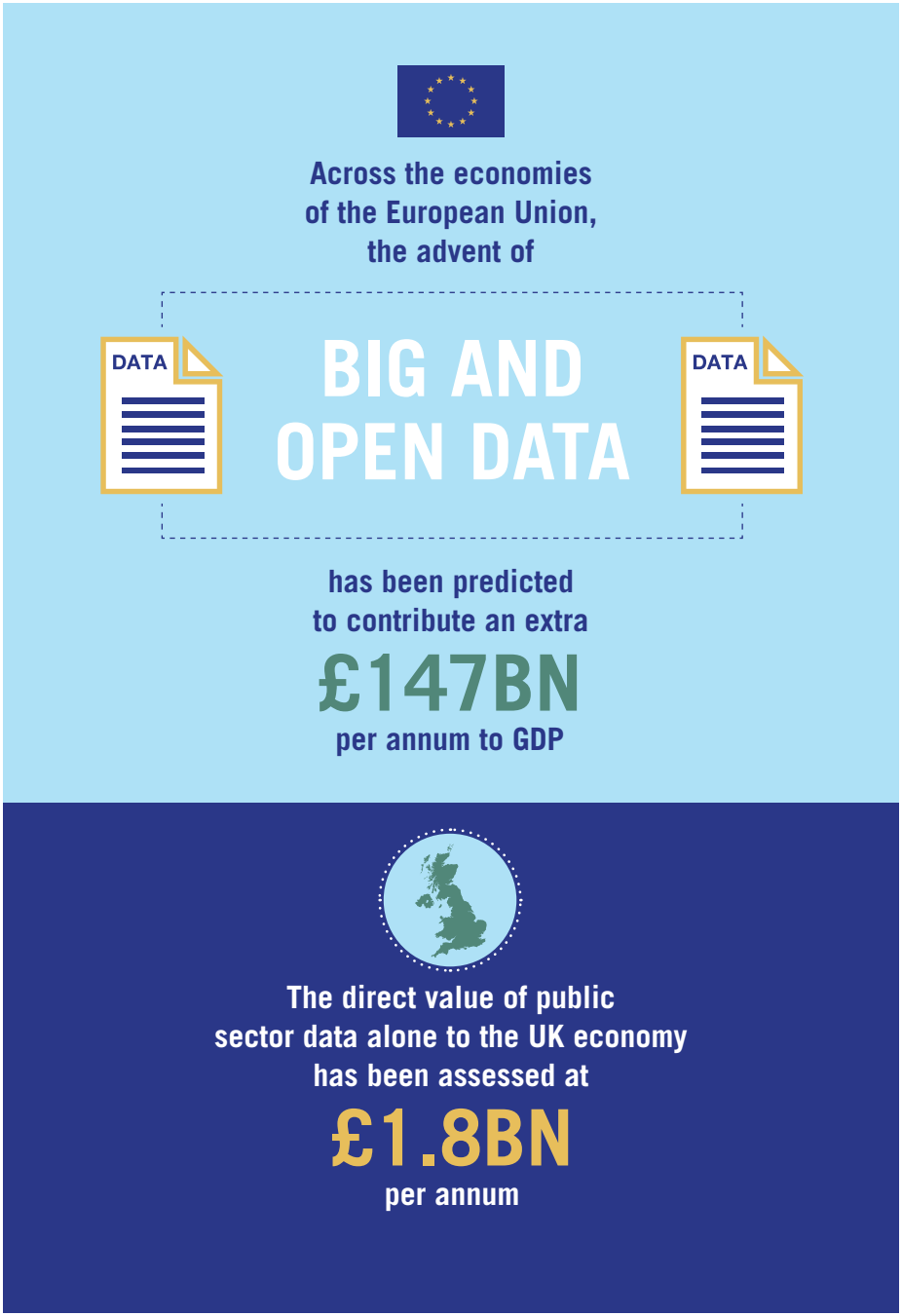
This presents challenges not just for our education system, which is charged with improving the quantitative skills of *new entrants* to the labour market and to universities. In addition it has implications for our employers and for the wider economy, which are affected by the *existing stocks* of quantitative skills within the workforce. The quantitative skills required both of new entrants, and of the existing workforce must be considered in order to adequately support the quantitative skills pipeline.

The challenge now

Successive governments have recognised the importance of this agenda, putting in place interventions aimed at improving confidence and fluency in handling and interpreting data. But the urgency of this challenge demands that much more should be done. A sustained and co-ordinated programme of work needs to be developed, with leadership and interventions across government, education, employment, research and innovation, to address the country's longstanding weaknesses in quantitative skills and to seize new opportunities.

The nation's quantitative skills will not be transformed overnight, but we need to put in place the structures that will begin to effect that change.

What is needed now is the development of an overarching strategy, addressing the need for the UK to raise its game on quantitative skills. This will need to address the quantitative skills requirements of school and college pupils and of higher education students and researchers, as well as improving the stock of quantitative skills among those already in the workforce. This is a UK-wide challenge and needs to happen throughout the four nations of the UK. The aim must be a process of continued raising of expectations and requirements, rather than a single "big bang" approach to reform. The nations' quantitative skills will not be transformed overnight, but we need to put in place the structures that will begin to effect that change.



OUR VISION:
A GENERATION OF CITIZENS, CONSUMERS, STUDENTS AND WORKERS AS COMFORTABLE WITH NUMBERS AS THEY ARE WITH WORDS.

OUR VISION: RISING TO MEET THE CHALLENGE

Our vision is of a fully data-literate population, able to engage with data and the world in which we live actively and intelligently.

We envisage a generation of citizens, consumers, students and workers as comfortable with numbers as they are with words, confidently engaging with data in a future driven forward by technological development and a drive for international competitiveness.

For this ambition to be fully realised within a generation, we must not underestimate the cultural change that is required – primarily, but not entirely, within the UK's education systems. In this report, we set out what must happen – in our schools and colleges, in our universities and in our workplaces – for this vision to be realised.

A body of active researchers who have skills and expertise in the most up-to-date analysis methods and technologies is required.

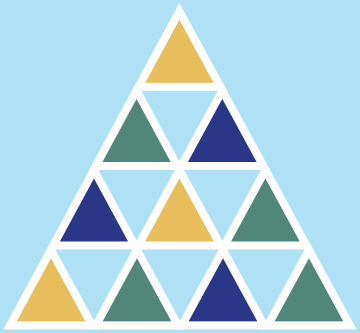
There must be a structure in place to enable quantitative skills to flourish at all levels. And there must also be recognition of what needs to be done in the interim to address the existing skills needs of students, employees and citizens.

The **economic incentives** for the UK as a whole and for individual companies also demand a dramatic improvement and investment in quantitative skills across the workforce.

For the benefit of **research and innovation** in the UK, including in universities, a body of active researchers who have skills and expertise in the most up-to-date analysis methods and technologies is required.

Within a generation, then, the UK should be a world leader in quantitative skills such that:

- Our schools and colleges have built, in young people, a strong, confident grasp of numbers from their early years, seeing them as key to dealing with data.
- Our universities can take full advantage of the potential of data in research, and ensuring that the quantitative skills of students and researchers are fully developed.
- Our employers no longer struggling with a quantitative skills deficit, and can build on their employees' skills of data analysis, and of basic numeracy, which have been developed in schools and in universities. Incentives to promote these developments are provided across schools, universities and employers.



There must be a structure in place to enable QUANTITATIVE SKILLS to flourish at ALL LEVELS

- There is both an organisational infrastructure and an evaluation system of interventions in place to ensure that the improvement of quantitative skills across education, government and the workplace is given a high priority.

SCHOOLS AND COLLEGES

Our schools and colleges need to be giving children and young adults a strong, confident grasp of data from an early age.

This is the starting point of the required culture change for the quantitative skills pipeline, which then feeds through to further and higher education and the working world. Starting the learning process correctly – in building confidence and fluency from the early years – is vital.

The UK's performance in mathematics generally makes it only middle-ranking among developed nations. This needs to change.

Although data handling has sometimes been among the stronger areas of UK pupils' results in international tests,[17] overall the country's performance in mathematics generally makes it only middle-ranking among developed nations.[18]

As other reports, such as the Royal Society's 2014 *Vision for science and maths education*, have argued, successfully bringing about change will involve not just reform of school and college curricula and qualifications but addressing the serious challenges of teacher supply.

Curriculum and qualifications

Successive governments have overhauled school curricula, across the UK, in recent years. We recognise the efforts of policymakers in emphasising the importance of science, technology, engineering and mathematics (STEM) in their reforms.

However, the task of improving curricula should not be seen as a matter of free-standing changes every few years, but as a structured, long-term project of continuous, strategic review.[19]

A number of subjects at school provide a rich context for the development of quantitative skills in schools – and not just in subjects which are formally labelled as mathematics or science, which can wrongly be seen as the only place to teach statistical and numerical understanding. Learned societies and subject associations have an important role to play here to enable the development of quantitative skills to be embedded within subject-based learning, thus demonstrating both application and relevance.[20]

As pupils grow older, the issue of premature specialisation needs to be addressed. Young people in England, Wales, Northern Ireland and – to a lesser extent – Scotland are much less likely to be studying mathematics beyond the age of 16 than is the case in other countries.[21] Policymakers need to continue to encourage more students to study mathematics and quantitative reasoning throughout their secondary school and college education, devoting more attention to the application of mathematical reasoning in diverse contexts. Policymakers also need to continue to develop and promote alternative routes to studying mathematics – in addition to A-levels in England, Wales and Northern Ireland and Scottish Highers and Advanced Highers in Scotland – to open up the subject post-16 to a broader spread of the school population. Qualification development should not be seen as a zero-sum game, where expanding one route leads to the contraction of another, but as a means of adding to the total numbers of young people taking mathematics post 16.

New Core Maths qualifications, designed to appeal to students who have gained a C grade or better at GCSE but do not currently take A-level mathematics, are a welcome first step in addressing the issue of premature specialism. Overall there is more

work to be done in seeking to give many more young people a firm grasp of quantitative skills before they move on to university and the workplace. This will be especially important for those whose working lives do not directly utilise quantitative concepts but who need them to participate in society as informed citizens.

Continuing to build quantitative skills in further education is important.

Further education colleges must not be neglected. In England, colleges provide around a quarter of A-level mathematics entries and most 16–19 vocational qualifications.[22] In Scotland, a substantial minority of students take higher education courses in colleges, so any drive to improve quantitative skills provision for young people should not overlook this route. Across England, Wales and Northern Ireland, many young people moving on to a wide range of careers in which a facility with numbers will be important – from nurses needing to calculate medical dosages to laboratory technicians preparing solutions – spend their first years post-16 in the college sector. Therefore, continuing to build quantitative skills in further education is important.

It will be important, also, to build firmer direct links between school and college education and the workplace through continued support for the apprenticeship route, further and continuing training and other schemes that allow people in work to up-skill. The apprenticeship route combines employment-based training with part-time attendance in vocational education classes or workshops related to the field of training. It is, therefore, in principle well suited to developing quantitative skills which can be applied in workplace settings.[23]

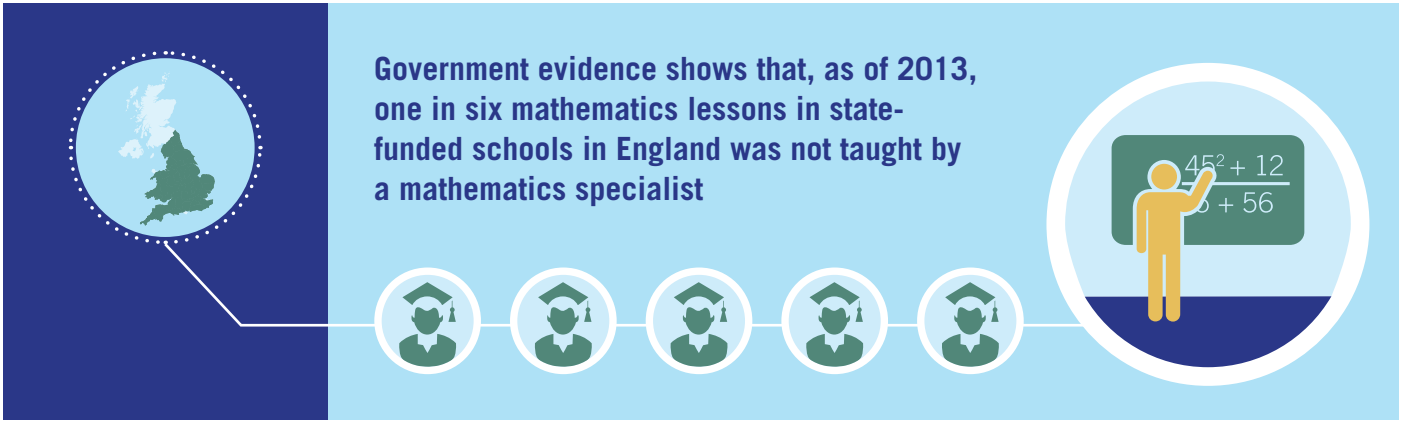
Teacher supply

We recognise that bringing about this transformation in young people's facility with data will place large demands on teachers. Government evidence illustrates the challenge, showing that, as of 2013, one in six mathematics lessons in state-funded schools in England was not taught by a mathematics specialist.[24]

However, teacher supply must be addressed well beyond the need for mathematics specialist teachers. As argued above, teachers of the sciences, social sciences and the humanities also need to incorporate numerical evidence and data into their teaching. Therefore, the recruitment, retention and professional development of data-literate teachers is important. This will require a strategic approach to considering the teaching workforce, at primary, secondary and college level.

Both initial teacher education and teachers' professional development will need to be improved if our schools and colleges are to recruit and retain more teachers who are confident with data.

Failing to address this agenda will simply store up further for our economy and for individuals themselves as they grow into adults.



UNIVERSITIES

The ability to analyse and interpret data is central both to "blue skies" research and to evidence-based policy analysis, across university subjects ranging from the social sciences and humanities to the natural sciences.

Across many fields of study, the quality of students' understanding stands to be enhanced if they get a good grounding in these skills. It has been argued that "the data revolution offers the possibility to reframe the epistemology of science, social science and humanities, and such a re-framing is already actively taking place".[25] Quantitative and qualitative skills are mutually supportive as tools for interpreting and understanding the world we live in. As sources of data multiply, the ability to make sense of them and draw appropriate conclusions presents more opportunities, as well as challenges.

The UK needs to move to a situation where it is normal for science, social science and humanities students to have developed significant quantitative skills in school.

In universities in the USA, Germany, the Netherlands, Belgium and Switzerland students typically develop much better quantitative skills than in even the best UK degree programmes. They are at the centre of the curriculum, while too often in the UK they languish in the margins.[26]

The university-school interface

Universities have the power not just to shape the content of their own courses and to improve the quality of their research, but also to send signals to schools about the importance of quantitative skills.[27] They need to act together to encourage or require prospective students to have quantitative skills qualifications. The UK needs to move to a situation where it is normal for science, social science and humanities students to have developed significant quantitative skills in school, and for this to be thought of dynamically, so that as provision improves at secondary level, universities can then strengthen their entry requirements.

The challenge for universities

UK universities suffer from a poverty of aspiration in relation to their students' quantitative skills.

With undergraduates embarking on courses with varying, and often weak, fluency in statistics, many universities have modified degree courses in a non-quantitative direction.[28] In some cases, these changes in course design reflect weaknesses in university teachers' own quantitative skills.[29] Students often graduate with little confidence in applying what skills they do have, which then has knock-on effects for businesses as graduates can be ill-prepared for the data demands of the workplace.[30]

The future

Reacting to these problems will involve building on, and expanding, some positive recent initiatives. Considerable resources have been devoted, in individual university departments, to remedying students' weaknesses in quantitative skills through compensatory teaching. The Q-Step programme, which aims to start a process of institutional change in university social science teaching, is a recent promising example of a more systematic approach.[31]

Rising to the challenge of improving students' statistical understanding is important, not just in terms of the knock-on effects for the economy of having a new generation of employees well versed in data analysis. It also stands to take knowledge forward, as students' substantive understanding is underpinned by the intellectual tools at their disposal. Quantitative skills are among those tools.

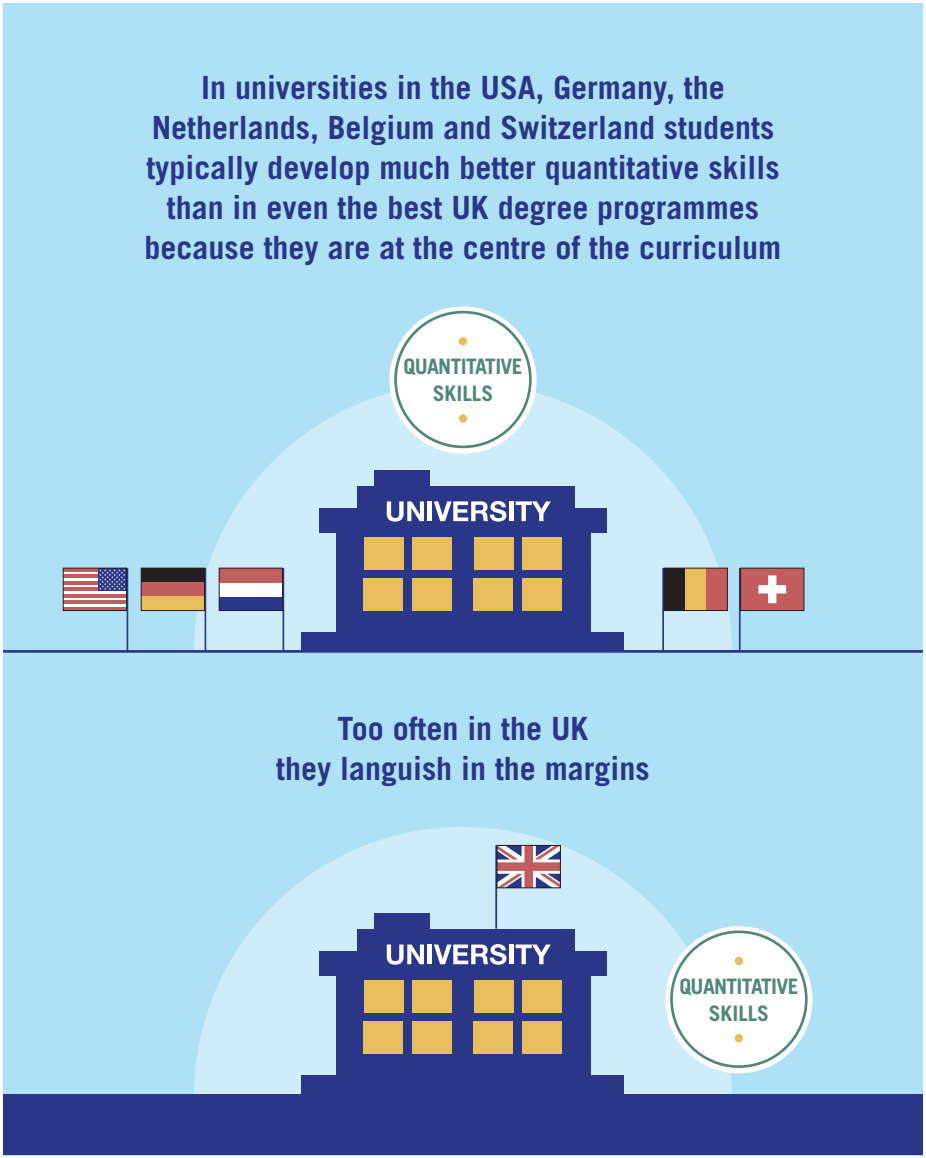
Transforming students' quantitative skills needs to take place bearing in mind that

many will leave higher education for the workforce after graduating, while others will stay in academia as specialist researchers. A broad base of quantitative skills needs to be built for all.

In seeking an improvement in students' quantitative skills, universities should review and if necessary redesign the content of social science and humanities degree programmes.[32] They need to signal with more clarity what level of quantitative skills is necessary for each course. Learned societies can play an important role here too, in fostering the development of quantitative skills at the disciplinary level. In doing so, they can draw on their capacities to influence QAA benchmarking statements, to support the development and sharing of good practice between departments in different universities and, in some case, in course accreditation roles.

With a great deal of data now collected and generated by the private sector, there is an increasing need for collaboration between universities and employers. The Economic and Social Research Council's Big Data Network[33] is seeing central and local government and business datasets being opened up for use by researchers. It is a positive development in this field.

The establishment of the Alan Turing Institute, a partnership of five universities co-ordinated by the Engineering and Physical Sciences Research Council, funded by government and aiming to make the UK a world leader in big data analysis, is an example of the power of a co-ordinated approach. Other countries also provide guides to a possible way forward[34] on strategic planning. In the United States, for example, the White House Office of Science and Technology Policy and the Networking and Information Technology Research and Development Program jointly announced big data collaboration projects in December 2013 to stimulate private sector interest in sectors such as medical research, geointelligence, economics and linguistics.



THE WORKPLACE

Many more people in the workplace need to be able to handle data fluently.

Research in the *State of the Nation* evidence review[35] shows evidence of rising demand for quantitative skills in the UK economy, with other studies[36] suggesting major economic rewards in prospect for companies which take advantage of the data revolution.

The UK needs to raise its game on quantitative skills at all levels of the workforce, from those jobs where the main requirement is for employees to have basic numeracy – but where sometimes they lack it – to data specialist positions where complex analysis and interpretation skills are needed.

The UK needs to raise its game on quantitative skills.

The four nations of the UK need to recognise the transformative power of the data analysis agenda, across the private, public and voluntary sectors. Much work is already going on in trying to facilitate government, industry and academia working together to promote an improvement in specialist data analysis skills in the workplace. These important initiatives need to be developed and widened, to take in the broader issue of confidence with numbers across the workforce.

Workplace demand for quantitative skills

About seven in 10 employees say that quantitative skills are essential or important in carrying out their work.[37] While roughly three in 10 jobs require basic arithmetic skills, a further four in 10 require the ability to apply quantitative skills to a more advanced level.[38] There is evidence[39] that demand for more advanced skills, which might range from the ability to use descriptive statistics to highly complex mathematical procedures, has risen sharply in the past two decades, with the proportion of employees saying advanced mathematics or statistics are important in their jobs rising from 29 per cent in 1997 to 38 per cent in 2012. Correspondingly, the number of people reporting that arithmetical skills are not at all important in their jobs has declined.

However, a substantial body of case study research suggests that many employees fail to understand fully the quantitative techniques they are using, and lack the ability to recognise obvious errors in their work.[40] One government survey conducted in 2011 found that three quarters of 16- to 65-year-olds in employment in England had a level of numeracy which might not be sufficient "to compare products and services for the best buy or to work out a household budget".[41]

Results of a further survey, published in 2015, showed that a general shortfall in the skills of employees is holding back one in two firms in the technology sector, with a consequent knock-on impact on economic growth as technology is not harnessed as effectively as it could be. Among four technologies which are used in the sector and which were analysed through the survey, "big data analytics" was found to have the largest gap between the skills needed among employees, and those they actually possessed, when a skills deficit of any kind was reported.[42]

Demand for quantitative skills is evident in the public and voluntary sectors, as well as in business. A recent survey[43] commissioned by the Department for Business, Innovation and Skills found that many civil servants lacked the skills to work effectively with data, while another survey[44] of public sector staff found 72 per cent of

respondents agreeing that it was increasingly important for all civil servants to know how to access, share and use data. In local authorities, a shortfall in data skills has also been identified as a concern.[45] And in the voluntary sector, the National Council for Voluntary Organisations has found that charities are experiencing demands for quantitative skills which they cannot meet.[46]

UK businesses are also building data analytics capability that combines quantitative skills with computer programming and industry 'know-how' to innovate and grow. In a forthcoming report, Nesta draws on a firm survey to identify the data analytics skills shortages that are being suffered by UK data-driven businesses.[47]

Changes in the workplace, including the impact of competitive pressures to increase efficiency and engage in innovation and the widespread use of information technology, have increased the need for data analysis skills. In many organisations, there is a division of labour between small numbers of employees who are technically skilled in the use of computer software packages and a much larger group who need to be able to interpret and utilise the statistics generated. The almost universal investment in technology by private, public and voluntary sector institutions does not negate the need for numerical understanding. Rather, it adds to it, as people require skills of investigation and interpretation. Nor are quantitative skills deficits confined to less senior employees: it has been estimated that as many as 58 per cent of people in "higher managerial and professional occupations" do not have numeracy skills at GCSE A*–C and above.[48]

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58%

of people in "higher managerial and professional occupations" do not have numeracy skills at GCSE A*–C and above

Benefits to firms and the economy as a whole

The economic benefits in this field have been reported as potentially huge. A report[49] published in 2012 found that data-driven firms were 40 per cent more likely to report launching products and services ahead of their competitors than those who were not data-driven. In the same year, another report[50] estimated that the UK economy as a whole stood to benefit by £74 billion in the years 2012–17 through companies making better use of data-driven "customer intelligence".[51]

A way forward

A transformation in the position of quantitative skills in the workplace will not happen overnight. Government and employers need to work together to facilitate change, with the aim both of improving the skills of the existing workforce and of raising the capabilities of new entrants.

On the former, employers will need to pay attention to the continuous development of employees' skills. Employers should be encouraged to provide short courses for their employees, sometimes in partnership with universities or relevant further education or private sector training providers. They should also be encouraged to recognise and take advantage of the potential of the apprenticeship route to improve the quantitative skills of new employees entering employment.

There needs to be a framework in which businesses work on this agenda. Two related initiatives in the fields of data infrastructure and the growth of the information industry may provide examples of a possible model for future collaboration. The E-Infrastructure Leadership Council,[52] which was established in March 2012, advises government on all aspects of the UK's electronic infrastructure, including on skills. It has comprised two ministers, leading figures from business and industry and representatives from other organisations including the Met Office and Research Councils UK.

Separately, the Digital Economy Council,[53] established in 2014, is a body jointly chaired by a minister and the president of the industry group techUK which is intended to drive the growth of the information industry. Again, it features leading industry representatives.

It will be important to promote, oversee and monitor the improvement of quantitative skills across the workforce – and beyond it, to schools and further and higher education.

GOVERNMENTS ACROSS THE UK SHOULD SET OUT A LONG-TERM STRATEGY FOR A TRANSFORMATION IN THE QUANTITATIVE SKILLS OF THE POPULATION

CALL FOR ACTION

Governments across the UK should set out a long-term strategy with the goal of realising the vision set out in this document for a transformation in the quantitative skills of the population.

To raise the quality of quantitative skills among future *new entrants* to the workforce, to higher education and to the adult population as a whole, this strategy should include:

- Improving the quality of quantitative skills teaching in schools and colleges. This will involve recruiting and retaining teachers, across STEM, social science and humanities subjects who are confident and fluent in quantitative skills and capable of motivating students. Policymakers, including government, will need to focus on recruitment and retention numbers and also on the quality of teachers' skills. Quantitative skills education in both teachers' initial training and in their ongoing professional development will need to be improved.[54]
- Subjecting school curricula across the UK to a process of continuous review, to ensure that all pupils are equipped to become confident and fluent in numbers and data.
- Ensuring that quantitative skills are embedded in school curricula and in qualifications taken in schools and colleges, within but also going beyond the subject of mathematics, from an early age.
- Continuing to address the fact that too many young people in the UK stop studying mathematics at an early age. This will involve building on qualification initiatives, such as Core Maths, which are designed to raise the numbers taking the subject post-16. It must encompass further education colleges as well as schools.
- Building on the success of recent initiatives such as Q-STEP, which are designed to improve the teaching of quantitative skills for social science at university, and to increase the number of quantitatively skilled social scientists through the redesign of the content of existing courses and the development of new degree programmes.
- Increasing the number of university researchers and university teachers who can use advanced statistical techniques. This will be required to raise the quality of research and development and innovation.
- Universities and learned societies work jointly with curriculum authorities to ratchet up quantitative content of social science and humanities programmes they offer, including introducing new courses where necessary. Policymakers should encourage co-ordinated steps by universities to ensure their student admission requirements encourage or require increasing quantitative skills engagement by students, as standards rise in schools.
- Universities working with business and public sector organisations to share their data expertise with students.
- Employers being encouraged to recognise and capture the potential of improving the quantitative skills of new employees entering employment.

To raise the quality of the *existing stocks* of quantitative skills within the workplace and the adult UK population as a whole, this strategy should include:

- Government, industry and academia working together to promote, oversee and monitor the improvement of quantitative skills across the workforce, universities and schools.
- Employers providing short quantitative skills courses for their employees, in partnership with universities or relevant further education or private sector training providers.

There should be an evaluation framework against which progress in the improvement of quantitative skills in schools and colleges, universities and the workforce can be assessed.

It will be for governments across the four nations of the UK, working with partners, to define the precise metrics.[55]

Endnotes

1. This report is about the need to transform the UK's quantitative skills, which are defined as the ability to reason using numbers (see full definition in the box at the end of the introduction). Terms such as numeracy, data analysis and statistical analysis fall within this broader term of quantitative skills.
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17. See, for example, England's performance in the latest Trends in International Mathematics and Science Study (TIMSS), in 2011.
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19. See the forthcoming report by the Advisory Committee on Mathematics Education and the Royal Statistical Society on the quality of implementation of reforms to curricula and qualifications, both within and across subjects. See Advisory Committee on Mathematics Education and Royal Statistical Society, 2015, forthcoming.
20. In Geography, for example, the Royal Geographical Society (with IBG) have sought to influence critical points in the education system to enable a generation shift in confidence and competence with quantitative skills: through engaging the Department for Education on curriculum reform and progression, advising Awarding Bodies on specification development, supporting teachers with professional development and also though engaging students.
21. Hodgen, J., Pepper, D., Sturman, L., & Ruddock, G. (2010). *Is the UK an outlier? An international comparison of upper secondary mathematics education*. Nuffield Foundation.
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26. See forthcoming report from Professor John MacInnes, commissioned by the British Academy, with international case studies exploring the teaching of quantitative skills in universities.
27. See forthcoming Universities UK report, *Making the most of data: data skills training in English universities*, which includes an audit of data analytic skills in undergraduate education, as part of the Government's Data Capability Strategy, July 2015.
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31. Q-Step is an initiative, jointly funded by the Nuffield Foundation, ESRC, and HEFCE, to facilitate the teaching of quantitative methods to social science students, across 15 UK universities and four affiliate centres. The aim of the programme is to foster a step change that will see social science students and teachers

engaging more with quantitative methods in their work.

32. Even courses where the advantages of enhancing quantitative skills elements might be less immediately obvious, such as Postgraduate Certificate in Education programmes for trainee teachers, law degrees or nursing degrees, would all benefit from it.,
33. See www.esrc.ac.uk/research/major-investments/Big-Data/
34. In Canada, also in 2013, the Social Sciences and Humanities Research Council, the Natural Sciences and Engineering Research Council, the Canadian Institutes of Health Research, the Canada Foundation for Innovation and Genome Canada joined together to produce the document: *Toward a Policy Framework for Advancing Digital Scholarship in Canada*. See www.sshrc-crsh.gc.ca/about-au_sujet/publications/digital_scholarship_consultation_e.pdf
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36. As set out in notes 32 and 33 above.
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46. Heywood, J. (2013). Voluntary Sector Data Use and Needs: Strand Three- sector survey and interviews. Presentation to NCVO Voluntary Sector Data Use and Need event.
47. See forthcoming Nesta report, *Skills of Datavores* and a Nesta-UUK policy briefing setting out an agenda of change across the education pipeline, including schools, universities and the labour market, with the goal of improving the supply of talent with the data analytics skills that UK businesses demand, July 2015.
48. Department for Business, Innovation and Skills. (2012)*The 2011 Skills for Life Survey: a survey of literacy, numeracy and ICT levels in England*. Department for Business, Innovation and Skills.
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51. There is a need to be cautious in interpreting causality here. Correlation between the development of quantitative skills and the growth of the digital economy does not prove causality. Economic growth may also depend on the interaction between quantitative skills and the development of other qualities in individuals, such as curiosity, self-motivation and entrepreneurship.
52. See: www.gov.uk/government/groups/e-infrastructure-leadership-council
53. See: www.techuk.org/about/digital-economy-council
54. The "100kin10" initiative for STEM teachers in the United States may provide a guide.
55. Possibilities could include measures of the confidence of school teachers and college and university lecturers in the teaching of quantitative skills; measures as to how many students are studying maths post-16; and measures of how satisfied employers are with their employees' quantitative skills.

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In 2011, the British Academy launched a new programme, with funding from the Department for Business, Innovation and Skills, targeting deficits in languages and quantitative skills. The programme of work reflects the Academy's longstanding concerns about deficits in these areas of the humanities and social sciences, as well as in UK education and research. Through the programme, the Academy funds research and relevant initiatives, and seeks to influence policy in these areas.

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